Cognition and Instruction

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Contents

1 Preface

There is a significant body of research and theory on how cognitive psychology can inform teaching, learning, instructional design and educational technology. This book is for anyone with an interest in that topic, especially teachers, designers and students planning careers in education or educational research. It is intended for use in a 13-week undergraduate course and is structured so students can study one chapter per week. The book is more brief and concise than other textbooks about cognition and instruction because it is intended to represent only knowledge that can be mastered by all students in a course of that duration. The book prepares students who wish to pursue specialized interests in the field of cognition and learning but is not a comprehensive or encyclopedic resource.

The need for brevity has forced difficult decisions about what topics to include. We have chosen to exclude giftedness, special education, learning disabilities, autism spectrum disorder, and related topics. These aspects of educational psychology, so important for teachers, deserve fuller treatment than can be given here. For similar reasons we have mostly excluded the important topics of classroom management and assessment of learning. The book has no coverage of Piaget's stage theory of cognitive development (or any other stage theory) as decades of research have qualified and limited its reach to the point where it contributes little to our current understanding of cognitive learning processes in educational contexts.[1]

The later chapters in the book are dedicated to cognitive aspects of learning in the subjects of reading, mathematics and science. There are plans to add another chapter on writing. These chapters are intended for all students of cognition and instruction, not only those who will specialize in these subjects. Each subject-oriented chapter deals with cognitive phenomena that are particularly salient in one subject but also play a role in other subjects. For example, the barriers to learning presented by persistent, alternative conceptions acquired from prior experience have most often been studied in the context of science education but appear in many other contexts. Although there is no chapter on history and social studies, theory and research relevant to that subject is introduced in the chapters that deal with critical thinking, argumentation and learning from text and multimedia.

1.1 References

1 American Psychological Association, Coalition for Psychology in Schools and Education. (2015). *Top 20 principles from psychology for preK-12 teaching and learning.* Retrieved from `http://www.apa.org/ed/schools/cpse/top-twenty-principles.pdf` (PDF, 662KB).

2 Theories of Learning & Development

This chapter is about the origins of and influences on cognitive psychology.

2.1 Origins in Philosophy

2.1.1 Nature Vs Nurture

Nature versus nurture has been the debate on psychological development between theorists for over 2000 years and is commonly seen as rival factors. The debate is whether children develop their psychological characteristics based on genetics, which is nature, or how they were raised and their environment, which is nurture. It is difficult to say whether one theory has more influence over the other but "as of now, we know that both nature and nature play important roles in human development."[1]

To break down each theory for a better understanding, nature refers to an individual's heredity, genetics, biological processes, and maturation. The coding of genes in each human cell determines the different physical traits humans possess. For example, height, hair colour, eye colour, etc, are gene-codes in a human's DNA. The theory of nurture refers to environmental contexts that influences development such as education, parenting, culture, and social policies.[2]. Examples of nurture are more abstract attributes such as personality, behaviour, and intelligence.

Genetic characteristics are not always obvious, however, they become conspicuous through the course of maturation. Maturation can only occur with the support of a healthy environment. The theory of nurture "holds that genetic influence over abstract traits may exist; however, the environmental factors are the real origins of our behavior"[3]. Nature's partner is nurture and nature never works independently[4]. A good example is in the comparison of fraternal twins who were raised apart from one another, they will most likely have a significant amount of similarities in their behaviour. However, the environment each twin was raised in will greatly influence their behavior as well. Today, the environment and the biological factors are seen as critical and emphasized as complex co-actions.

1 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

2 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.

3 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

4 McDevitt, T.M., & Ormrod, J.E.(2010). Nature and Nurture. Retrieved from www.education.com/reference/article/nature-nurture.html ^{`http://www.education.com/reference/article/nature-nurture.html`}

2.2 Behaviourism

Behaviourism is a psychological approach directed towards the individual‘s behaviour; many of these behaviours are learned through conditioning and modeling[5]. Through experience, people develop their language, emotions, and personalities. Some theories that are relevant toward the behavioural development of people are operant conditioning, classical conditioning, and modeling.

2.2.1 Operant Conditioning

Operant conditioning is the type of learning that is determined and influenced by consequences. The consequences can be both positive and negative, as well as rewarding and punishing[6]. In the context of operant conditioning, positive does not necessarily mean a good thing; it means the addition of something following an action. For example, a child does not make it home before their nightly curfew so their parents punish them with requiring them to complete more house chores. In opposition, a negative consequence is the removal of something following an action. An example of negative reward is when a child does significantly well in school, receiving high report card grades, resulting in their parents removing the amount of house chores the child have to complete that day. Rewards influence the increase of certain behaviours while punishment should reduce the amount of the behaviours.

One of the most well-known researchers in this field is B. F. Skinner[7]. Skinner did work with several animal species and was very successful in his research. His perspectives were simple, but he believed that human beings were too complex for the classical conditioning approach (explained in the following section). One of his main studies was called the Skinner‘s Box, and found consistent results in rats, cats, and pigeons. The animals were put in the box with a button or lever to press, while hungry. The animals were rewarded intermittently whenever they pressed the button or lever. As a result, there was an increase in the behaviour (pushing the button) as they were rewarded. This has been proven in many studies, as well as in our daily lives. For example, look at how parents raise their children.

2.2.2 Role of Models

Modeling is one of the most commonly used form of teaching and is one of the most successful forms of learning. This type of learning works by imitation alone. Many people might also know of this by the term of vicarious learning; learning and developing behaviours by observing other people[8]. When we enter new situations, for example the first time in

5 `https://www.google.ca/?gws_rd=ssl#q=define+behaviourism`
6 McLeod, S. A. (2015). Skinner - Operant Conditioning. Retrieved from www.simplypsychology.org/operant-conditioning.html
7 `http://www.simplypsychology.org/operant-conditioning.html`
8 McLeod, S. A. (2016). Bandura - Social Learning Theory. Retrieved from www.simplypsychology.org/bandura.html

a formal restaurant, we follow the cues of the people around us. This is just one form of modeling seen easily in everyday situations.

Children are the best at this, even when we do not always want them to be. Children will mimic their peers and parents, things they watch on TV and hear in songs. Alberta Bandura was one of the first major researchers in this field of study[9]. He was working with children in an experiment called the Bobo Doll; in which children watched a model play with this doll, some in an aggressive way and others were neutral. After watching the video, the children were put in a room with a Bobo Doll and other decoy objects. More children were aggressive towards the doll and added novel actions into their play; such as using weapons and adding verbal aggression.

Conditioning and modeling are a few different approaches to the development of learning in the field of psychology. They have been studied for hundreds of years and are continually being explored for their accuracy and truths.

2.3 Cognitive psychology

Cognitive psychology focuses on mental activities and processes. This encompasses areas of mental activity such as learning, remembering, problem solving, and perception and attention.

2.3.1 Piaget's Genetic Epistemology

2.3.2 Vygotsky's Dialectical Epistemology

2.3.3 Attention

Attention is a cognitive function that is fundamental for the human behavior. It is the ability of selectively concentrating on external or internal information. Attention "is the prerequisite to learning and a basic element in classroom motivation and management"[10].

For years, attention has been a subject of examination and there has been curiosity towards finding out where the origin of the sensory cues, signals, and the functions relate to attention.

Attention is a valuable skill most people possess, however it is a skill that oscillates. Attention can be performed unconsciously or voluntary. The level of concentrating is affected by one's surroundings and environment. There are also differences in attention such as selective attention: meaning one will select the most important information out of the given context. Also, there is divided attention: meaning separating ones focus in situations where two tasks are performing at the same time, in other words multi tasking[11].

9 `http://psychology.about.com/od/profilesofmajorthinkers/p/bio_bandura.htm`
10 `http://www.ascd.org/publications/educational-leadership/dec92/vol50/num04/What-Brain-Research-Says-About-Paying-Attention.aspx%C2%A0`
11 http://www.happy-neuron.com/brain-and-training/attention

Although paying attention may seem as easy as getting rid of distractions, focusing, organizing, and prioritizing ones thoughts, it is not that easy for everyone. Children who are affected by attention disorders such as **dyslexia** or **attention deficit and hyperactivity disorder** (ADHD) experience symptoms that cause difficulty in their learning development. Early signs of attention disorder in children can make their daily lives and learning more challenging than the average child.

2.3.4 Critical Thinking

Critical thinking is "reflective thinking focused on deciding what to believe or do." It is the ability to think rationally and surely[12]. When thinking critically, the goal is not to solve the problem but to obtain more knowledge and better understand the problem. The purpose of critical thinking allows people to evaluate information and authorizes them to make informed choices and decisions. Someone who possesses critical thinking skills are able to gather, interpret, and evaluate information to make informed decisions. They can construct arguments, solve problems systematically, see and understand the importance of ideas and the connections, and they can reflect on their own beliefs and values[13].

Critical thinking should not be mistaken for problem solving because it differs in two ways. When problem solving, the process involves solving well-defined problems from a specific domain. However, critical thinking usually involves better understanding of ill-defined problems in several domains. Lastly, critical thinking differs from how it is being evaluated. Most problems that involve problem solving are external states, while critical thinking involves internal states[14].

2.3.5 Information Processing Theory

In the early 1950s, researchers developed a model called the Information-processing model to understand how the human mind processes information. Although there are other models such as the Modal Model, the Information-processing model is known to be the best and most researched. This model consists of three main branches: sensory memory, working memory and long-term memory[15].

Sensory memory processes information for a very short period of time from about 0.5-3 seconds. The process is so short; one can only remember five to nine discrete elements. An example of sensory memory is when one tries to remember a phone number for a brief period of time, just enough time to write it down. There is only a limited amount of information that can be processed in sensory memory because its main purpose is to screen the most relevant incoming stimuli at the given time.

After the process of sensory memory, the information will either be transmitted into working memory or be forgotten. In the process of working memory, "information is assigned

12 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.
13 Lau, J., & Chan, J. (2004-2016). What is critical thinking. Retrieved from http://philosophy.hku.hk/think/critical/ct.php
14 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.
15 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

meaning, linked to other information, and essential mental operations such as inferences are performed”[16]. An example is when one is learning to drive a car; one must perform the task repeatedly until it become automatic, which leads to long-term memory.

Working memory and sensory memory are limited capacity for information, whereas long-term memory has no limitations. The purpose of long-term memory is to “provide a seemingly unlimited repository for all the facts and knowledge in memory”[17] and is said to have the capability to hold millions of pieces of information at a time.

2.3.6 Constructivism

Constructivist theories revolve around the belief that learning is a constructive process. Humans generate knowledge and meaning from the interaction between their experiences and their ideas. New information is built upon prior knowledge, and people are constructing their own representations of knowledge based off that prior knowledge as well as new information.

Individual and Social Learning

Individual learning places the emphasis on learning in a more independent manner, while social learning shifts the focus to learning on a wider scale, through the social interaction between both peers and teachers. A large part of constructivist learning is that it acknowledges the uniqueness of each individual[18].

Social learning helps individuals learn in a way that individual learning cannot. Vygotskian theory includes the notion of **collaborative learning** among individuals, to share understanding of material. The zone of proximal development, according to Vygotsky, is ”the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers”[19]. By using peer-to-peer interactions, students may better understand material through the support of classmates or those who are on the same learning ‘level’, than that of someone who has a higher skill level[20]. An example of this would be that of a typical math classroom, where one student who is performing poorly in class, asks for clarification on certain methods and formulas from a fellow student who is performing better. The higher performing student understands how to communicate ideas more to the level of a typical student, hence the zone of proximal development.

16 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

17 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

18 Salomon, G., & Perkins, D. N.. (1998). Individual and Social Aspects of Learning. *Review of Research in Education*, *23*, 1–24. Retrieved from http://www.jstor.org.proxy.lib.sfu.ca/stable/1167286

19 `http://www.simplypsychology.org/Zone-of-Proximal-Development.html`

20 McLeod, S. (2010, December 25). Zone of Proximal Development - Scaffolding | Simply Psychology. Retrieved February 27, 2016, from http://www.simplypsychology.org/Zone-of-Proximal-Development.html

Nature of Learning (Responsibility and Motivation)

The learners themselves hold a certain amount of responsibility when it comes to learning and understanding material. They must be involved with the learning process, even more so than the instructor. Acquiring and comprehending the material in their own terms is the responsibility of the student, not simply rote memorizing what they have learned. The only person that can pin point the strengths and weaknesses of a student, is the student themselves. The responsibility of making sense of information and trying to find sources of motivation ultimately falls on the shoulders of the student. In regards to the classroom environment, the concept of shared responsibility is a good way to encourage students to perform to the best of their ability. Focusing in a certain direction to give a clear purpose, and giving students the chance to reflect on themselves as well as to colaborate helps students in accomplishing their goals[21].

Motivation also builds upon the learner's responsibility, affecting their potential for learning and confidence of self. Hard-to-grasp, extremely challenging work has shown to often discourage the learner from understanding new information and work that is too easy often bores the learner. For this reason, it is important for teachers to find that sweet spot that challenges the learner just enough, and provides the **buffer** and motivation to learn new material.

Role Of Facilitators

Following a constructivist view, the role of facilitator is not the same as a teacher. Avoiding the lecture style of most teachers, the role of a facilitator is to encourage discussion and ask questions. The main difference here for the student, is to take part in the active learning process and not sit idly as the teacher speaks[22]. Encouraging peers to interact with each other, take part in class discussion, and giving guided questions as well as other methods, all fall under the role of the facilitator. Creating rapport with the students and knowing when to give and when to stop scaffolding is essential in aiding the student to think for themselves without giving them too much assistance. For example, instead of blatantly giving away the answer to a math problem, a possible means of scaffolding could include asking the student to try a method they went over in an earlier class or possibly guide the student slowly through the problem and letting them solve a certain part before going onto the next.

To a certain degree, it is also important for the teacher to create a positive teacher-student relationship, as this can impact the learner's belief of self, which is especially critical for high-risk students[23]. Frequent negative feedback from the teacher can often give the student a negative view of themselves, and as such, it is important to show the student what they did right, rather than what they did wrong.

21 http://www.ascd.org/publications/books/101039/chapters/A-Framework-for-Building-Shared-Responsibility.aspx
22 Education Theory/Constructivism and Social Constructivism in the Classroom. (n.d.). Retrieved February 27, 2016, from http://www.ucdoer.ie/index.php/Education_Theory/Constructivism_and_Social_Constructivism_in_th
23 https://steinhardt.nyu.edu/scmsAdmin/uploads/007/642/McClowry%20et%20al%202013%20Cluster%20article%20.pdf

2.3.7 Constructivism In The Classroom

Constructivism in classroom settings, usually follows the pattern of switching focus from the instructor to the students. The main value that constructivism follows is problem solving. The teacher acts as a guide to provide the students with the opportunities needed to understand material. There is an emphasis placed on the cultural backgrounds of students and the social interaction or collaborative learning among each other. Interaction discussions are usually facilitated and directed by the teacher, clarifying confusing concepts and materials to the students by acting as the overseer. **Situated learning** can also follow this form of facilitation, which can be defined as learning being applied within the context it is learned. For example, culinary students cooking in the kitchen as they listen to the instructor who oversees their work, rather than sitting in a classroom taking notes on the culinary arts[24].

Some methods of utilizing constructivism in classrooms are reciprocal teaching, cooperative learning, anchored instruction as well as encouraging group discussion and teamwork[25]. Reciprocal teaching involves the creation of a collaborative group among 2-3 students, plus a teacher, and take turns discussing the topic at hand. This creates a zone of proximal development. Cooperative learning is similar in that higher skilled students help other students by working in their zone of proximal development. Anchored instruction involves creating lessons revolved around a topic of interest to the students. Doing this engages the student and encourages more thoughtful engagement in discussions when discussing a topic students feel strongly about.

2.4 Influences from Humanistic Psychology

Humanism is a more personal approach to learning which focuses on the learner's ability to self-actualize, as well as, their own natural desire to fulfill their potential.

2.4.1 Facilitation Theory

The facilitation theory was coined by Carl Rogers. His beliefs were that humans were naturally curious and that every human being is 'good' by nature. Learning is a process that is done through experimenting and interacting through activity. His facilitation theory views the teacher as the facilitator and not as a walking textbook. As a result of this, it is important that the teacher has the proper rapport and attitude when teaching students. Rogers states that there are three qualities, also known as core conditions, that are needed for proper facilitation[26]. The first condition is called realness, which is the teachers' ability to act as themselves and not another persona. The second is trust, and the teacher's ability to actually care for the student. The final requirement is the teachers' ability to empathize and visualize themselves in another person's shoes.

24 http://www.instructionaldesign.org/theories/situated-learning.html

25 Education Theory/Constructivism and Social Constructivism in the Classroom. (n.d.). Retrieved February 27, 2016, from http://www.ucdoer.ie/index.php/Education_Theory/Constructivism_and_Social_Constructivism_in_the_

26 Facilitation Theory. (n.d.). Retrieved February 27, 2016, from http://teorije-ucenja.zesoi.fer.hr/doku.php?id=instructional_design:facilitation_theory

2.4.2 Self-Determination Theory

2.5 Conclusion

There are many different types of theories involved in the learning and development process that all focus on different beliefs and views. These theories are primarily explained by the interactions of learners, the building of knowledge upon prior experiences, and the ability to construct understanding in an attempt to realize and accomplish learning within a classroom environment.

2.6 Cognitive Science

2.7 Neuroscience

2.8 Glossary

Attention - the act or faculty of attending, especially by directing the mind to an object.

Behaviourism - A school of psychology that regards the objective observation of the behaviour of organisms (usually by means of automatic recording devices) as the only proper subject for study and that often refuses to postulate any intervening mechanisms between the stimulus and the response

Cognitive load - Refers to the total amount of mental effort being used in the working memory.

Collaborative learning - A situation in which two or more people learn or attempt to learn something together.

Constructivism - A theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their ideas and experiences.

Modeling - A standard or example for imitation or comparison

Object permanence - knowing that an object still exists, even if the object is not in sight.

Operant conditioning - A process of behaviour modification in which a subject is encouraged to behave in a desired manner through positive or negative reinforcement, so that the subject comes to associate the pleasure or displeasure of the reinforcement with the behaviour.

Situated learning - Learning that takes place in the same context it can be applied in, such as workshops, kitchens, field trips to archaeological digs, etc .

Zone of Proximal Development - is the difference between what a learner can do without help and what he or she can do with help

2.9 Suggested Readings

- Driscoll, M. (2005). Psychology of Learning for Instruction, 2nd ed, Chapter 10
- Hartley, P., Hilsdon, J., Keenan, C., Sinfield, S., & Verity, M. (2011). Learning development in higher education. Basingstoke, Hampshire: Palgrave Macmillan.
- Salomon, G., & Perkins, D. N.. (1998). Individual and Social Aspects of Learning. Review of Research in Education, 23, 1–24.

2.10 References

3 Learning and Memory

Learning and memory are fundamental behind understanding cognitive processing, but are often confused for one another. Although the relationship between the two are clearly related and very much dependent on each other, learning and memory are still two distinct topics that require appropriate attention in order to comprehend them. The following chapters will examine the concepts behind learning and memory, from the approach of cognitive psychology. In other words, our focus will be placed on how humans process information, through series of approaches, such as perception, attention, thinking, and memory. We first begin by presenting the theory of multimedia learning as a way to introduce and identify a link between learning and memory. We then move on to discussing how human thoughts work, by using the idea of information processing. The next chapters will examine in detail how memories are structured, as well as the cognitive processes associated with them. We believe that these concepts are imperative in understanding how to achieve meaningful learning. Finally, the chapter assesses the relationship between learning and memory as a means of improving the quality of learning and teaching.

3.1 Learning

Many theorists and psychologists attempts to determine the definition of **learning** and its processes. Three perspectives in particular have been widely recognized to view learning through a western outlook and have been major contributions to the study of learning and educational practices. The three are the behaviourist, constructivist, and the cognitive perspectives [1]. The focus of this chapter will be to examine learning through a cognitive psychologist's view, and in close association with the memory process. The human experience of learning becomes one that involves the active construction of meaning. But in order to construct meanings, human cognition first needs to understand how information is acquired and processed in memory. Researchers describes learning as how information is processed, encoded, and stored [2]. In other words these three processes, are performed in sequence with how one perceives, learns, thinks, understands, and retains information. Information on these three processes will be presented in much more detail as we move further along this chapter. However, as an introduction, it is under the assumption of cognitive researchers that learning is first obtained through the senses, such as sight, hearing, and touch. This chapter will begin with Richard Mayer's theory of multimedia learning in order to determine how sensory inputs work hand in hand with learning and memory.

1 Resnick, L. B., Greeno, J. G., & Collins, A. M. (1996). Cognition and instruction.Handbook of Educational Psychology, 15-46.

2 Sternberg, R. J., & Sternberg, K. (2012). Cognitive Psychology (6th ed.). Belmont, CA, America: Wadsworth.

3.2 Working Memory

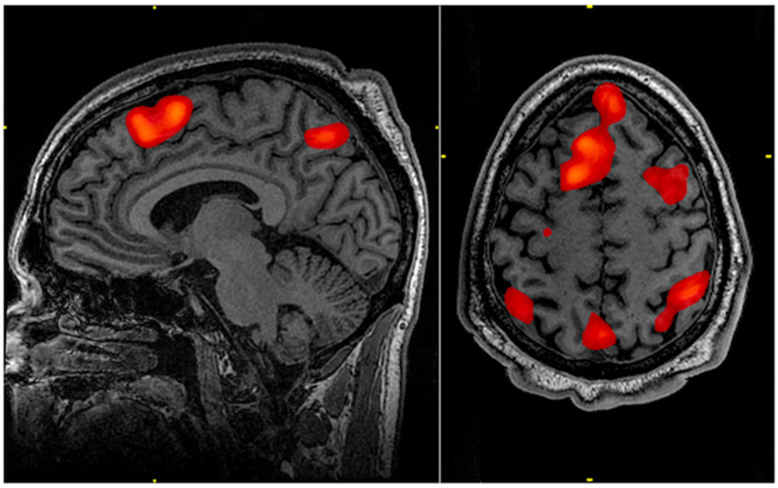


Figure 1 Figure 1. This is a FMRI scan of a brain during working memory task.

Many types of developmental disabilities can be traced at least partially to problems with the memory. Problems with working memory subsystems seem to lie behind the way in which patients with autism become confused over large amounts of information, and deficiencies in working memory are also implicated in attention deficit hyperactivity disorder. A number of other developmental disabilities, such as Williams Syndrome, Down syndrome, and dyslexia can also be connected with improper functioning of memory[3]. Below we focus on autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD) because the role of memory in these two disorders has been studied in detail, allowing us to use them to shed light on how the memory functions in practice.

3.2.1 Information Processing Theory

The traditional concept of memory saw it as a simple container that stored what the senses dumped into it for later use by the brain. With the advent of electronic data processing systems, the metaphors drawn from these have become the most popular ways to conceptualize memory. These metaphors are powerful and suggestive, but they can also be misleading, since the brain differs in many ways from a computer[4].

One of the main reasons for the use of data processing metaphors is that memory is a function that cannot be easily linked with specific parts of the brain. Thought is seen as information processing, and a key component of information processing is storage and retrieval. Information that is to be stored for the long term has to be encoded, processed to make it suitable for storage. The efficiency of this encoding can be enhanced by emotional

3 Gathercole & Alloway, 2006, Practitioner Review: Short-term and working memory impair-ments in neurodevelopmental disorders: diagnosis and remedial support. *Journal of Child Psychology and Psychiatry, 47*(1), 4–15.

4 Watson, A. (1997). Why can't a computer be more like a brain? *Science, 277*(5334), 1934-1936.

arousal.[5]The concept of encoding and decoding of memories suggests that they are not simply raw information but are constructed by the brain when recalled, and the construction may be influenced by the circumstances under which they were recalled.

Again reflecting the metaphor of an electronic computer, information processing theory saw memory as the interaction of several subsystems, each devoted to one specific task, that passed information one to the other as needed. The requirement for conscious attention by some processes means these systems have a limited capacity[6]. The limited amount of memory affect learning and it caused the learning disabilities. The disabilities of grabbing on to memory is associated with autism and ADHD.

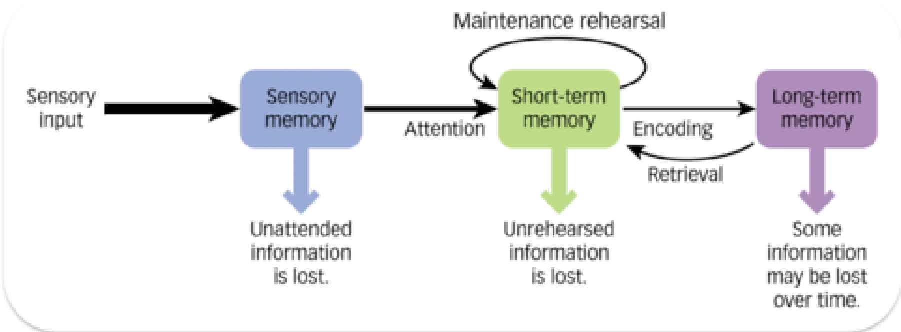


Figure 2 Figure 2. Modal model.

3.2.2 The Modal Model and Disability

The modal model (Figure 2), also known as the multi-store or Atkinson-Shiffrin model (from the researchers who first put it forward in 1968) is assumed by all varieties of information processing theory. It postulates different mental subsystems, each with a distinct function, that support and feed information to each other. The basically modal structure of the memory was supported by cases of brain damage that affected different parts of the memory unequally[7]. Most versions of the modal model were divided into three major sections: sensory memory or sensory register, short-term memory, and long-term memory[8]. As noted below, the concept of "short-term memory" is now obsolete. The unequal part of memory challenges students' ability to learn simultaneously, ability to grasp the knowledge.

5 Leventon & Bauer, 2016.
6 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). *Cognitive Psychology and Instruction.* Fifth Edition. Boston, MA: Pearson.
7 Howes, M. B. (2006). *Human memory: structures and functions.* SAGE Publishing.
8 Howes, M. B. (2006). *Human memory: structures and functions.* SAGE Publishing.

3.2.3 Three-part Working Memory Model

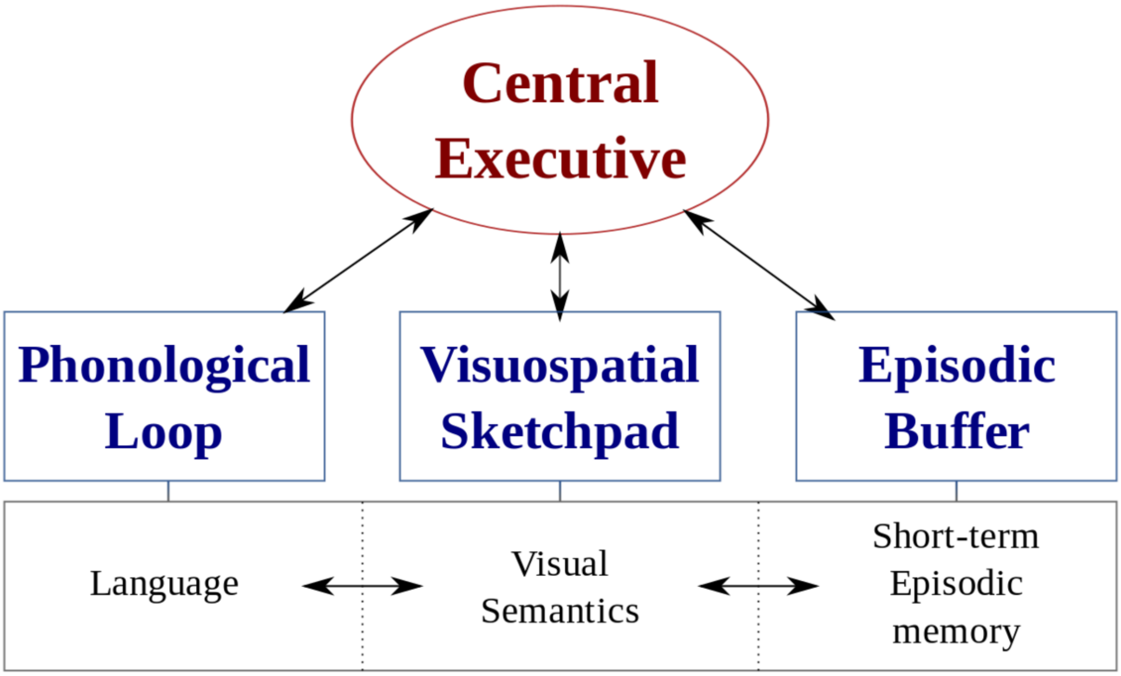


Figure 3 Figure 3. The three- part working memory model.

It was obvious that something had to be carrying out the processes assigned to short-term memory. However, researchers gradually became frustrated with the concept's inability to provide a model of how these processes took place[9]. Thus, beginning in the 1970's, the "short-term memory" model was supported or replaced by a function labeled "working memory." The "working memory" holds the information and images that the person in question is engaged with at the moment[10]. Figure 3 presents the three-part working memory model.

There are many variations of this model, reflecting the uncertainty researchers have about how exactly it functions. However, it is generally agreed that the working memory is tightly linked with the long-term memory, since past knowledge has a very strong influence on conceptions in the present. It is also agreed that unlike the concept of short-term memory, which was thought to store information passively in an average of seven "slots" and transmit it unchanged, the working memory is active, not passive, making it central to the construction of meaning[11][12].

9 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). *Cognitive Psychology and Instruction.* Fifth Edition. Boston, MA: Pearson.
10 Howes, M. B. (2006). *Human memory: structures and functions.* SAGE Publishing.
11 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). *Cognitive Psychology and Instruction.* Fifth Edition. Boston, MA: Pearson.
12 Swanson, H. L. & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition, and reading comprehension in learning disabled readers: Does the executive system have a role? *Intelligence, 28*(1), 1-30.

The most influential scheme for the working memory was put forward by Baddeley[13]. This divided the working memory into three components: an executive control system, an articulatory loop, and a visuo-spatial sketch pad[14][15]. This multi-component scheme is supported by a number of pieces of experimental evidence, such as the KF Case Study, where an accident severely impaired verbal processing while leaving visual processing almost intact. This strongly implies that verbal and visual processing are controlled by two different systems[16]. It is also supported by the observation that visual and phonemic tasks can be carried out at the same time with relatively little **impairment**, showing that they do not depend on the same mental resources[17].

Central Executive

The central executive or executive control system has been compared to a director controlling the activities of two subordinates, the phonological loop and the visuo-spatial sketchpad. It oversees the functions of the working memory, selects information and strategies, and decides what the working memory will concentrate on. It coordinates performance on different tasks, decides among retrieval strategies, switches focus among different inputs, and interacts with the long-term memory to retrieve and work with information[18].

Despite its critical importance, little is known about the detailed working of the central executive. It has been criticized as "little more than a homunculus," a humanoid "boss" that coordinates all the other functions of the system[19]. Whether it carries out its various functions as a single coordinated system or a collection of independent subsystems is not clear[20].

Phonological loop

The phonological loop deals with spoken and written information. It is a passive short-term storage system for information that is received by reading or hearing[21]. Information

13 McLean, J. F. & Hitch, G. J. (1999) Working memory impairments in children with specific arithmetic learning difficulties. *Journal of Experimental Child Psychology 74*, 240–260.

14 McLean, J. F. & Hitch, G. J. (1999) Working memory impairments in children with specific arithmetic learning difficulties. *Journal of Experimental Child Psychology 74*, 240–260.

15 Swanson, H. L. & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition, and reading comprehension in learning disabled readers: Does the executive system have a role? *Intelligence, 28*(1), 1-30.

16 McLeod, S. (2012). Working memory. *SimplyPsychology.* Retrieved from http://www.simplypsychology.org/working%20memory.html

17 Howes, M. B. (2006). *Human memory: structures and functions.* SAGE Publishing.

18 Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology, 49A*(1), 5-28.

19 Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology, 49A*(1), 5-28.

20 Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology, 49A*(1), 5-28.

21 Swanson, H. L. & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition, and reading comprehension in learning disabled readers: Does the executive system have a role? *Intelligence, 28*(1), 1-30.

is stored in an articulation code, which means that written data must be converted before it can be retained. **Aural data** goes directly into the store[22].

The phonological loop is divided into two parts. The first is the phonological store or "inner ear," governing speech perception, which can hold aural information (spoken words) for several seconds. The second is the articulation control process, or "inner voice," which is in charge of producing speech, and which can rehearse and store input from the phonological store[23].

Visuo-spatial sketchpad

The visuo-spatial sketchpad or the "inner eye" deals with visual information and spatial concepts. It is a passive short-term storage system for visual and spatial information received through the eyes. It is responsible for situating a person in space, so that s/he can move through other objects without constantly colliding with them. Information is stored as images, which must be interpreted to retrieve specific details. It also creates and manipulates mental images, and turns material in the long-term memory back into usable information on spatial arrangement[24].

The visuo-spatial sketchpad appears to function even in individuals that have never enjoyed the power of sight, since such individuals have clear concepts of spatial distribution. This indicates that concepts of spatial distribution are independent of visual input. It has thus been suggested that the visuo-spatial sketchpad be split into two independent functions, one concerned with purely visual data, and another with spatial concepts.

3.3 Multimedia Learning

Developed by Richard Mayer, the **multimedia learning** derives from the concept that learning works effectively with the use of words and images. Multimedia learning draws upon three major assumptions: our working memory can only process a limited amount of received information at a given time; the way we process verbal and visual stimuli in working memory are independent of each other; information needs to be actively processed to make sense of the presented information [25].

22 McLeod, S. (2012). Working memory. *SimplyPsychology.* Retrieved from http://www.simplypsychology.org/working%20memory.html

23 McLeod, S. (2012). Working memory. *SimplyPsychology.* Retrieved from http://www.simplypsychology.org/working%20memory.html

24 Swanson, H. L. & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition, and reading comprehension in learning disabled readers: Does the executive system have a role? *Intelligence, 28*(1), 1-30.

25 Reed, S. K. (2006). Cognitive Architectures for Multimedia Learning. Educational Psychologist, 41(2), 87-98.

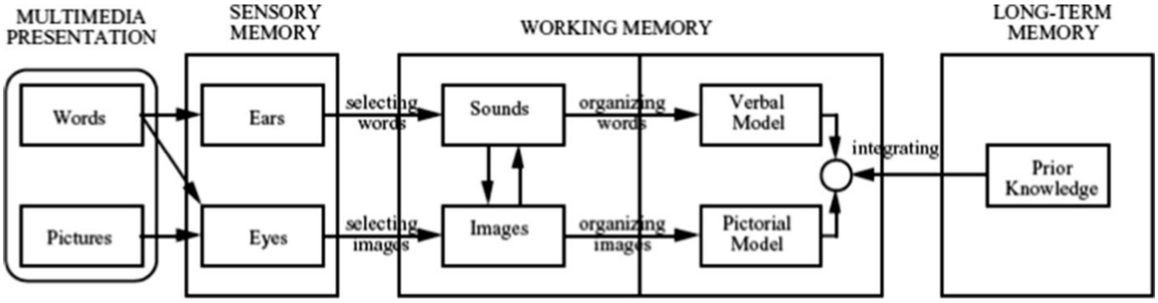


Figure 4 Acquired from
`http://www.laval.k12.nf.ca/pub/?n=MUN6615.LearningEffects`

`http://`

3.3.1 Cognitive Load Theory

Cognitive load is a concept proposed by John Sweller who states that having a high amount of information at a given time, will exceed the capacity of the working memory [26], which composes of articulatory and acoustic components. A human's working memory, is assumed to only have a limited capacity at a given moment, as it is continuously processing information. If the information received by the human brain exceeds the limit of what the working memory can temporarily hold, then it cannot be retained into storage[27]. Because the working memory acts as a system for storing and processing new information, we face the challenge of transferring acquired information for long term memory, ultimately placing strain on learning, when there are exceeding amounts of incoming stimuli.

26 Schweppe, J., & Rummer, R. (2013). Attention, Working Memory, and Long-Term Memory in Multimedia Learning: An Integrated Perspective Based on Process Models of Working Memory. Educational Psychology Review Educ Psychol Rev,26(2), 285-306.

27 Schweppe, J., & Rummer, R. (2013). Attention, Working Memory, and Long-Term Memory in Multimedia Learning: An Integrated Perspective Based on Process Models of Working Memory. Educational Psychology Review Educ Psychol Rev,26(2), 285-306.

3.3.2 Dual-Coding Theory

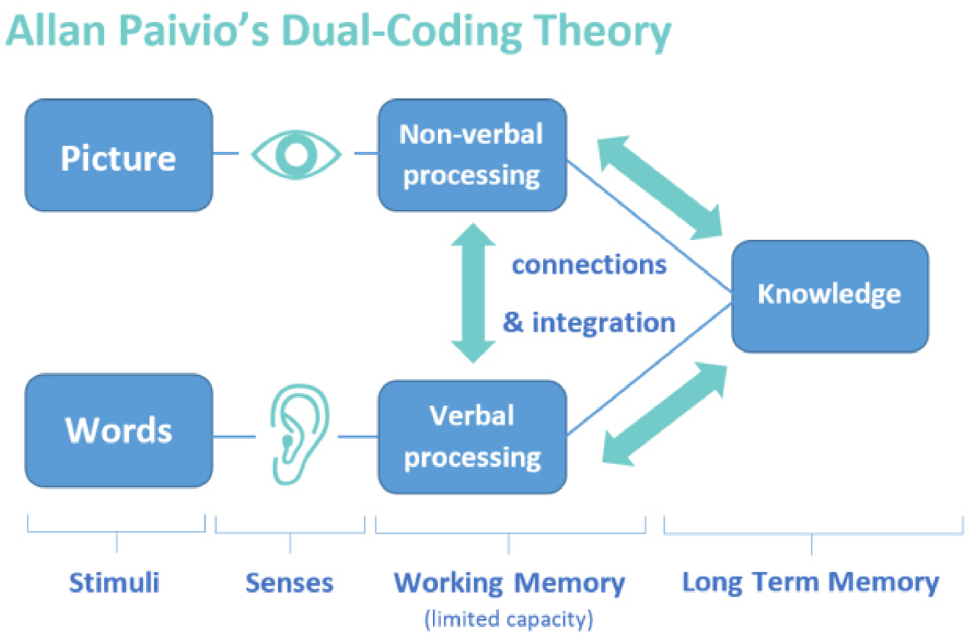


Figure 5 Acquired from `https://thinkypictures.files.wordpress.com/2015/08/tesskou_paivio_dualcoding1.jpg`

`https://`

Allan Paivio's **Dual-Coding** theory separates audio and visual information, stating a human's mind analyzes visual and verbal responses in separate independent codes [28]. According to Mayer's multimedia model, learning, primarily enters the human brain through words and images. In fact, visual imagery, when compared to verbal texts that require a person to generate a kind of imagery in one's mind, provided a more reliable and retention in memory [29]. Mayer's research indicates that through the simultaneous use of images and words, learning becomes much more meaningful. In order to test this statement, many researchers conducted studies to find correlations for improved performance though the use of multimedia learning principles. A brief review of the research conducted by Billie Eilam and his colleagues will be examined as an example. Eilam conducted an experiment involving 150 college students, whereby participants were evenly divided into two groups. Each individuals received the same amount of cards required to perform a given homework. Group one received cards that were printed in texts, while the second group received information in both text and images, such as graphs. Results indicated that the latter group performed much more accurately compared to the first group [30]. Experiments performed by Eilam

28 Reed, S. K. (2006). Cognitive Architectures for Multimedia Learning. Educational Psychologist, 41(2), 87-98.
29 Reed, S. K. (2006). Cognitive Architectures for Multimedia Learning. Educational Psychologist, 41(2), 87-98.
30 Eilam, B., & Poyas, Y. (2008). Learning with multiple representations: Extending multimedia learning beyond the lab. Learning and Instruction, 18(4), 368-378.

and his colleagues, as well as other studies, were designed to determine and assess learning strategies as a means to improving student's learning, in relation to how information is processed through the human's memory system.

3.3.3 Active Processing

Active processing, is the last assumption that is based on the cognitive theory of multimedia learning. It states that the human mind processes information actively, in order to construct meaningful learning and retention of memories, through three main cognitive measurements: selection, organization, and integration [31]. More specifically, humans are active learners because of their ability to process received input. How well people process incoming information however, depends on their ability to make sense of the materials they draw from and to make connections with information gathered, in order for meaningful learning to take place. This idea draws from Wittrock's theory of generative learning, which states that humans make connections between prior knowledge and new incoming knowledge, leading to the creation of new understanding [32]. It may be helpful then, to examine strategies or methods that help to foster active learning in people through paying attention, filtering, and organizing selected materials into coherent representations, thereby integrating it with previous and new information.

31 Mayer, R.E. (2005). Cognitive Theory of Multimedia Learning. (2nd Ed.), The Cambridge handbook of multimedia learning. Cambridge, NY: Cambridge University Press.

32 Mayer, R.E. (2005). Cognitive Theory of Multimedia Learning. (2nd Ed.), The Cambridge handbook of multimedia learning. Cambridge, NY: Cambridge University Press.

3.4 Information Process Model

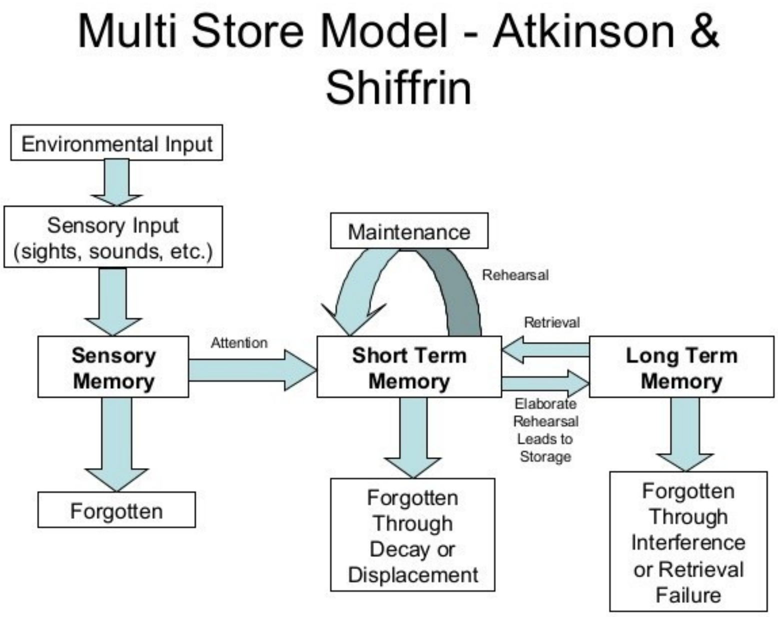


Figure 6 acquired from `http://www.slideshare.net/Snowfairy007/aqa-as-psychology-unit-1-memory`

`http://`

Cognitive psychology at its core carries the fundamental idea of information processing. More specifically, cognitive psychology compares how the human mind processes, much in the same way a computer processes. With the development of computers, the study of cognitive psychology adopted a concept behind computer simulations, which became a fundamental tool for understanding how cognitive processing in humans worked [33]. The computer model is one that imitates the cognitive functions of a human mind. The similarities include receiving information from an exterior stimulus, organizing and encoding input in various ways, transferring data to storage systems, and retrieving of output when needed. Through the analogy of information processing approach, psychologists determined that human thoughts could only process a limited amount of information at a given time [34]. Atkinson and Shiffrin (1968) proposed that human memories (like a computer) are formed through a series of channels. Atkinson and Shiffrin's **information processing model** is divided into three central components that break down how human memory works: the sensory register, short-term memory, and long-term memory (which will be further examined in the later chapters below). Similar to a keyboard entering information onto a computer, the human mind initially receives information through what is called the sensory register, or in other words, sensory organs. Inputted information is then processed by the Central

33 Sternberg, R. J., & Sternberg, K. (2012). Cognitive Psychology (6th ed.). Belmont, CA, America: Wadsworth.

34 Ruisel, I. (2010). Human Knowledge in the Context of Cognitive Psychology.Studia Psychologica, 52(4), 267-284.

Processing Unit of a computer, equivalent to a human's working or short-term memory. By then, information is either transferred for use, discarded or stored into long-term memory. For a computer, this stage of processing would take place on a hard disk in a computer [35]. To begin with, the human mind transforms multiple forms of sensory information (e.g., visual and auditory stimulus) received from the environment.

3.5 Memory Structure

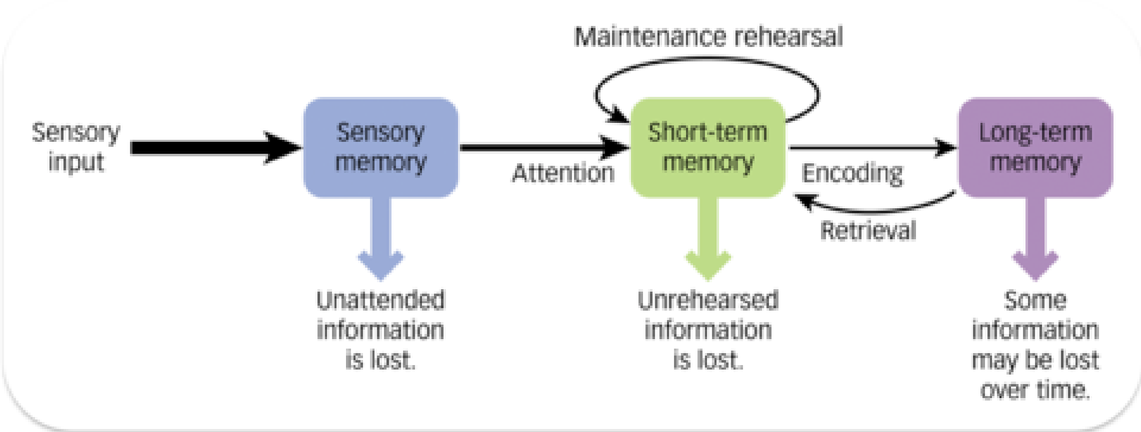


Figure 7 thumbnail

Memory structure is first introduced by Richard Atkinson and Richard Shiffrin in 1968. They created the modal model, which was also known as information processing model, to distinguish control processes and memory structures. Control processes are basically the specific processes that information stored, such as, encoding, retrieval processing. The human memory structure is consisted of three separate components, sensory memory, short-term memory and long term memory.[36] Each component has a specific function, on the whole, memory structures allow us to process and move information around in our brain. One criticism that worthy to mention is that the modal model maybe not just a unidirectional flow, the actual information processing is more complex.[37] Next, let's look at how sensory memory, working memory and long term memory interact and influence each other.

35 Atkinson, R. C. (1967). Human memory: A proposed system and its control processes. Stanford, CA: Institute for Mathematical Studies in Social Sciences.

36 Hockley, W. (2002). The Modal Model Then and Now. Journal of Mathematical Psychology, Volume 44, 336–345. doi:10.1006/jmps.2000.1306

37 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.

3.5.1 Sensory Memory

Sensory memory is a system that holds environment input in sensory registers so that perceptual analyses can work before that information fade away. Unfortunately, perceptual analyses take time and effort and the environment may change rapidly. The duration of holding information in our sensory memory is extremely short.[38] In 1960, George Sperling first demonstrated the existence of sensory memory. In his experiment, participants were showed a slide of arrays of letters. The first study result illustrated that the length of time exposed to participants directly influenced their performance. Base on this result, he made two assumptions, first, subjects only saw limited amount of letter within the short period. Second, all the letters were registered, but lost. He then developed partial report method to test his assumptions [39]. Participants only reported one of the rows letters after hearing a tone. If the tone appears immediately, participants recalled 3 of the 4 letters. The fewer letter were recalled with the delayed tone appeared. The result showed us that sensory memory storage and duration is very limited, although information were registered in our memory, they lost rapidly. [40]

3.5.2 Working Memory

In The Magic Seven Study, George Miller argued that people can hold no more than 7 chunks in memory at one time. The only way for people to memorize more information is increasing the size of chunks and implementing information with meaning. It is interesting to mention that in Cowan's embedded processes theory, Cowan argued that "the magic seven" is not true, the real capacity of working memory is about four chunks, although each of the chunk may contain more than one item.[41] Baddeley's working memory model is consist of **executive control system**, articulatory loop and visual-spatial sketch pad. The executive control system has the similar role as brain in our body, it controls the other two systems and decides what kind of the information enters memory. **Articulatory loop** and **visual-spatial sketch pad** holds acoustic information and visual spatial information respectively.[42]

Factors that influence working memory performance

Cognitive load theory is influenced and extended by Baddeley's working memory model. It is worthy to mention that several factors may influence the working memory performance.

38 Garcia, R., Mammarella, I., Pancera, A., Galera, C., & Cornoldi, C. (2015). Deficits in visual short-term memory binding in children at risk of non-verbal learning disabilities. Research in Developmental Disabilities, 45-46. Retrieved from `http://www.sciencedirect.com.proxy.lib.sfu.ca/science/article/pii/S0891422215001213`

39 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.

40 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.

41 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.

42 Baddeley, A. (2012). Working Memory: Theories, Models and Controversies. Annual Review of Psychology,63, 1-29.

Firstly, individuals have different background knowledge and capacity of working memory. If individuals are knowledgeable in certain domain, then they are more able to use the working memory efficiently. Secondly, the complexity of information is another constraint. Last but not least, the instructional approach is another factor, working memory performance is improvable if helpful and appropriate instruction is available. For example, learning to chunk information, or dividing the learning task. Furthermore, the amount of studies suggested that working memory maintenance is a critical step for long term encoding. As Baddeley once said, his attitude on this issue is that working memory activate many areas of the brain that include long term memory.[43]

3.5.3 Long-Term Memory

Long term memory is different from working memory because it can maintain information for a long period of time. It could be days, weeks, months and years. Examples of long term memory include remembering the graduation day, or the experience of your first day at working. Theoretically, long term memory has unlimited capacity of storage, but people still lose memory due to unsuccessful long term encoding. Generally, long term memory is divided into 2 components: explicit memory and implicit memory. Explicit memory is known as memories that are available in our heads, the past events pop out in our mind sometimes.[44]. It usually refers to the facts and declarative knowledge. The example would be that Vancouver is a city in Canada. While implicit memory is an unawareness memory that influence our actions and performance in daily life. This unconscious memory is about procedural knowledge, which is not just knowing about the facts, but knowing the process of performing the task. For instance, you are driving a car. Since we prior learned about the skill, we knew how to perform but we were not consciousness remembering it.[45]

3.6 Cognitive development

3.6.1 physical development of brain

Human development had various aspects, physical development, personal development, social development and cognitive development. Development refers to certain changes that occur in different stages over the lifespan, here we are going to take a deep look of cognitive development. **Cognitive development** refers to our mental processes are gradually changing and becoming more and more advanced over the lifespan. People do not become mature once they reached a certain age, development takes time and happens gradually. Inside our brain, there are billions of neurons. Neurons are grey colour nerve cells that function in accumulating and transmitting information in the brain. These neuron cells are so tiny, they are about 30000 fit on the head of a pin.[46] Each nerve cell includes dendrites

43 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.
44 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.
45 Bruning, R., Schraw, G., Norby, M., & Ronning, R. (2004). Cognitive psychology and instruction (4th ed.). Pearson Education.
46 Woolfolk, A., Winne, P., & Perry, N. (2016). Educational Psychology. Ontario: Pearson Education.

and axon to make connections with the other nerve cells. A tiny gap, which called synapse, exist between each cell's dendrite. Neurons transmit and share information by releasing chemical substances through these synapses. The numbers of neurons will be decreased if some neurons not serve as main function. Magically, if a child are deaf from birth, the auditory processing brain area will expect to process visual information rather than the auditory stimulation. [47]

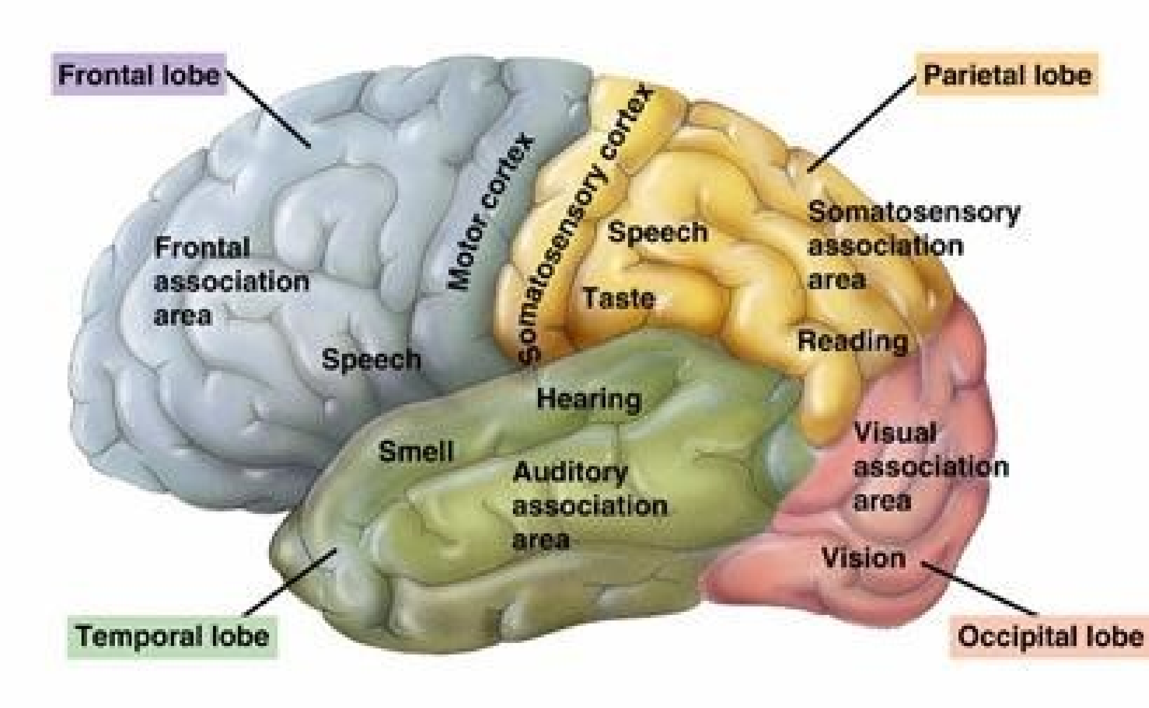
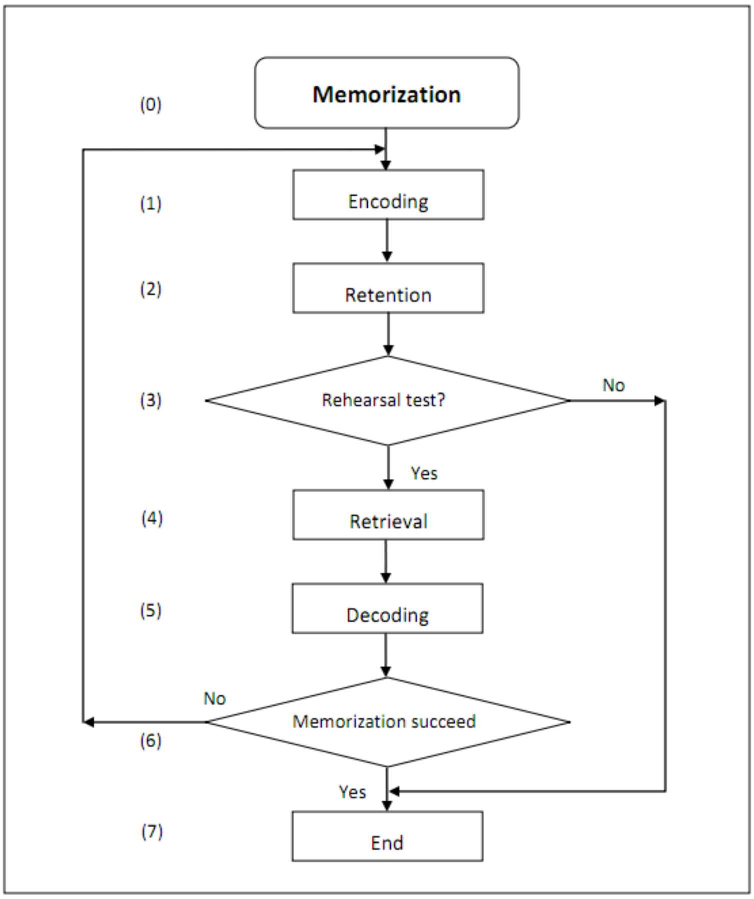


Figure 8 thumbnail

The cerebral cortex is the largest area of the brain which contains numbers of neurons, and it is covered under the outer. The cerebral cortex allows us to do the abstract thinking and complex problem solving. Every part of the cortex also has different function and different mature periods. The region of the cortex that control our physical movement usually matures first, then comes with our vision and auditory cortex. The Frontal lobe which takes charge of the high order abstract thinking processes always mature at last. Moreover, the temporal lobes which is responsible for the emotion development, language acquisitions and judgement will not completely mature until human body become physically mature[48]. Although each part of the brain has its own function, they have to work collaboratively in order to complete complex functions, for example, Alice is reading a story. Her vision cortex is the first part to be stimulated and then sends the visual information to the other cortexes in her brain, finally, she is able to memorize and retell the story. [49]

47 Woolfolk, A., Winne, P., & Perry, N. (2016). Educational Psychology. Ontario: Pearson Education.
48 Woolfolk, A., Winne, P., & Perry, N. (2016). Educational Psychology. Ontario: Pearson Education.
49 Woolfolk, A., Winne, P., & Perry, N. (2016). Educational Psychology. Ontario: Pearson Education.

3.7 Cognitive Process



The cognitive process of memorization

Figure 9 thumbnail

Cognition is a process of acquiring and understanding knowledge through people's thoughts, experiences and senses. **Memorization** is a key cognitive process of brain at the metacognitive, as well as the cognitive process reveals how memory is created in long-term memory (LTM) [50]. The logical model of the **cognitive process** of memorization can be described as shown in the diagram:

(1) **Encoding process**, which convert information to a form that can be stored in LTM; (2) **Retention**, this step stored the information in LTM; (3) Rehearsal test, this step checks if the memorization result in LTM needs to be rehearsed. (4) Retrieval process, which recalls the information from LTM; (5) **Decoding process**, this step is about information

50 Yingxu,W. (2009). Formal Description of the Cognitive Process of Memorization. M.L. Gavrila et al. (Eds): Trans. on Comput. Sci. V, LNCS 5540, 81-98.

reconstruction; (6) **Repetitive memory test**, which tests if the memorization process was succeed or not by comparing the recovered concept with the original concept.

3.7.1 Encoding Process

Encoding allows information stored in the brain to be converted into a construction, which can be recall from long-term memory. Memory encoding process is like hitting "save" on a computer file, once file is saved, it can be retrieved as long as the hard drive is undamaged. The process of encoding begins with the identification, organization of any sensory information in order to understand it. Stimuli are perceived by the senses, and related signals travel to the thalamus of the human brain, where they are synthesized into one experience [51]. There are four types of encoding: visual, acoustic, elaborative and semantic. **Visual encoding** is the processing of encoding images and visual sensory information. The creation of mental pictures is one example of how people use visual encoding. **Acoustic encoding** is that people use auditory stimuli or hearing to implant memories. **Elaborative encoding** uses information that is already known and connects them to the new information experienced. **Semantic encoding** involves the use of sensory input that has a specific meaning or be applied to a context. For instance, you might remember a particular phone number based on a person's name or a particular food by its color.

3.7.2 Retrieval Process

Retrieval is a process of re-accessing of information previously stored in the brain in the past. In other words, it is the process of getting information out storage. When people are asked to retrieve something from memory, the information will be retrieved from short-term memory (STM) and long-term (LTM) memory. STM is stored and retrieved sequentially, while LTM is stored and retrieved by association. There are two types of memory retrieval: recall and recognition. In **recall**, the information must be retrieved from memories. In **recognition**, a familiar stimulation will provide a cue to let people feel that the information has been seen before. A cue might be an object, a word, a scene, or any stimulus that reminds a person of something related, and individuals recall the information in memory quickly according to the cue. **Decision-making** requires retrieval of memory, which contains two fundamental retrieval aspects during decision-making: automatic and controlled activation of memory representations. Take-the-best (TTB) is a strategy typically employed for decision from memory [52].TTB requires the sequential retrieval of attributes by the order of importance and stops information search as soon as a given attribute was allowed for making a decision. This sequential processing requires controlled retrieval from long-term memory, consequently, a repeated updating of working memory content [53]. Manipulating

51 Michael,C. C. Kuo, Karen, P. Y. Liu, Michelle, B., Jacqueline, W., Nikki, T., Rosalind,B., & Leung-Wing,C. (2014).Memory Encoding Processes in Young and Old Adults. Arch Neurosci, 2 (1): ei19813

52 Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast frugal way: Models of bounded rationality. Psychological Review, 103, 650-669

53 Patrick, H. , Thorsten, P., Lilian, A. E. W., & Kerstin, J. (2015). Neural Signatures of Controlled and Automatic Retrieval Process in Memory-based Decision-making. Journal of Cognitive Neuroscience, 28;1, 69-83

automatic memory activation, which is the number of association with a retrieval cue, by varying the number of attributes to which a decision potion is associated [54].

3.7.3 Limitations of Memory

The **limitation of memory** means the brain's storage capacity for memory is limited. This is similar to the space in an iPod or a USB flash drive. However, the capability of brain is difficult to calculate. First, people do not know how to measure the size of a memory. Like no one will know a 10 digits phone number will take how much space of people's mind. Secondly, some memories involve more details and then take up more space; other memories are forgotten and that helps free up space. For instance, **working memory** refers to the temporary storage of information; it is also associated with conscious processing information within the focus of attention. Working memory and attention interact in a way that enables people to focus on relevant items and maintain current goals. However, working memory processing capacity and duration are severely limited when dealing with novel information. The importance of the learner organized knowledge base is primarily determined by its ability to effectively reduce the capacity limitation of working memory by encapsulating many elements of information into higher-level chunks that could be treated as single units in working memory [55]. It shows the processing limitation of working memory significantly affect learning processes.

3.7.4 Metacognition

Metacognition can be defined as cognition about cognition, thinking about thinking. It refers to how people learn and processes information, and individuals' knowledge of their own learning processes. There are two components of metacognition: metacognitive knowledge and metacognitive experience. **Metacognitive knowledge** refers to acquire knowledge about cognitive processes, knowledge that can be used to control cognitive process [56]. While **metacognitive experiences** can refer to use of metacognitive strategy, which is the process of using cognitive activities to ensure a cognitive goal. Self-questioning is a common metacognitive strategy. For example, after students read an article, they will question themselves about the main ideas or concepts about the article. Their cognitive goal is to understand the article. Therefore, **self-questioning** is used to ensure that the cognitive goal of comprehension is met. Additionally, metacognitive strategy often occurs when cognitions fail, such as the recognition that students did not understand what they just read. Such an impasse is believed to activate metacognitive processes as the learner attempt to correct the situation.

54 Anderson,J. R. (1974). Retrieval of propositional information from long-term memory. Cognitive Psychology, 6, 451-474.

55 Ericsson, K. a., & Kintsch, W. (1995). Long-term working memory. Psychological Review, 102, 211-245.

56 Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. American Psychologist, 34 (10): 906-911

3.8 Relationship between learning and memory

Compare to previous section, this section is about the relationship between memory and learning. There is an interaction between learning and memory, they depend on each other. Therefore, this section focus more on how memory processes interact with learning. Based on memory processes, people learn new information or knowledge and put them into their memory. Also, people recall their already known information from memory to relate with new information, to make new information meaningful, and in order to learn it effectively. Further more, based on knowing how memory works, this section also addresses the implementations of some strategies (such as chunking) on designing learning activities.

3.8.1 Interaction of Learning and Memory

First of all, defining of learning and memory would help us to understand their relationship better. **Learning** is the process of gaining new and relatively lasting information and behaviours[57]. **Memory** refers to the process of recording and retrieving experiences and information[58].

Information Processing Model is a basis for the interaction of memory and learning. And the process of learning is quite similar to this model, people perceive new knowledge, identify and memorize it, and then encoding it into personal knowledge as encoding it into long-term memory [59]. Also, the information processing model includes every components of how memory works. There are three main memory types in this model, which are sensory memory, short-term/working memory, and long-term memory[60]. In sensory memory, information is stored shortly, also only 5-9 chunks can be hold for about 15-30 seconds in short-term memory. However, once the information transfers to long-term memory, it would be last yearly[61]. There are two processes that happen between short-term/working memory and long-term memory, one is called **encoding processes** that refers to the process of moving information from short-term memory to long-term memory, and the other one is **retrieval processes** which is the process of information is delivered to working memory from long-term memory[62]. Both of the processes play a significant role in learning.

Learning process is following the steps of information processing model, it also works as a mental process[63]. To relate learning process with the information processing model, using learning how to drive a car as an example. First of all, a learner has to memory basic

57 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6
58 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6
59 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6
60 Bruning, R. H., Schraw, G. J., & Norby, M.M. (2011). Cognitive Psychology and Instruction, Bostom, MA, Allyn & Bacon. ISB-13: 9780132368971
61 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6
62 Bruning, R. H., Schraw, G. J., & Norby, M.M. (2011). Cognitive Psychology and Instruction, Bostom, MA, Allyn & Bacon. ISB-13: 9780132368971
63 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6

knowledge about driving, either road rules or names of car devices. The learner perceives knowledge of driving and car devices, then he encodes it into long-term memory. When the time the learner actually sits in a car and try to drive it, the basic knowledge of driving he encoded is retrieved into working memory to help him knows what he needs to do for driving a car. After he practices driving many times, he would turn the driving skill as a procedural knowledge which means knowing "how"[64] into his long-term memory. As long as the learner's driving skill gets more and more mature, the driving skill can be recalled unconsciously.

3.8.2 Memory limitations affecting Learning

Limited Attention in capacity

People require attention to learn[65]. As mentioned in the previous section, human **attention** is limited in capacity. Hence, without attentions, people cannot learn effectively, which means learning without attentions is wasting time. For example, when a person is reviewing a history lecture while he is thinking what stuffs he needs to buy for holding a home party. For sure this person's attention is allocated into two totally different fields, and he will not review the history lecture effectively because the limitation of attention in capacity. However, there are some strategies that can help people in general to deal with the limitations of attention, and they will be addressed lately in this section.

Forgetting Curve

Ebbinghaus identified **the forgetting curve** (Figure 1) idea in 1885[66]. This curve addresses the regular pattern of people's forgetting. The curve shows that we start to forget immediately and rapidly right after we learn, then the speed of forgetting slows down. To roughly talk about the bases of it, the curve shows that people can forget 50 percent of the knowledge's content they just learned in an hour. Then, 8 hours, 24 hours, 6 days and 31 days are also the forgetting time points people generally have, and the percentage of the content people hold gets decreasing along with the forgetting time points[67][68]. Consequently, people would totally forget the knowledge. Then, learning a knowledge is meaning less because it will be forgotten after all. Whereas, as long as we know the regular pattern and the certain time points of forgetting, we would have an appropriate strategy which will be addressed lately to deal with forgetting.

64 Bruning, R. H., Schraw, G. J., & Norby, M.M. (2011). Cognitive Psychology and Instruction, Bostom, MA, Allyn & Bacon. ISB-13: 9780132368971

65 Dosher, B. A., Han, S., & Lu, Z. (2010). Perceptual learning and attention: Reduction of object attention limitations with practice. Vision Research, 50(4), 402-415. doi:10.1016/j.visres.2009.09.010

66 Wherry, R. J. (1932). The curve of forgetting: its statistical application. Journal Of Educational Psychology, 23(8), 621-624. doi:10.1037/h0070645

67 Easley, H. (1937). The curve of forgetting and the distribution of practice. Journal Of Educational Psychology, 28(6), 474-478. doi:10.1037/h0057409

68 Wherry, R. J. (1932). The curve of forgetting: its statistical application. Journal Of Educational Psychology, 23(8), 621-624. doi:10.1037/h0070645

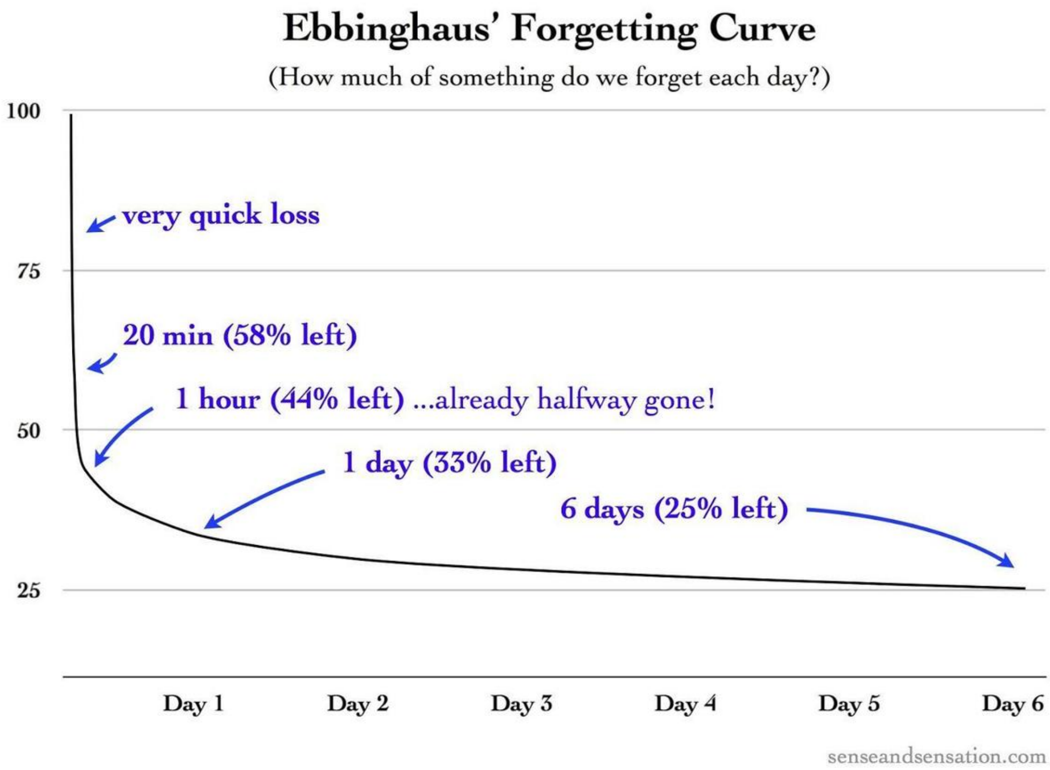


Figure 10 Acquired from
`http://www.laval.k12.nf.ca/pub/?n=MUN6615.LearningEffects`

`http://`

3.8.3 Implementations of teaching and learning

Chunking

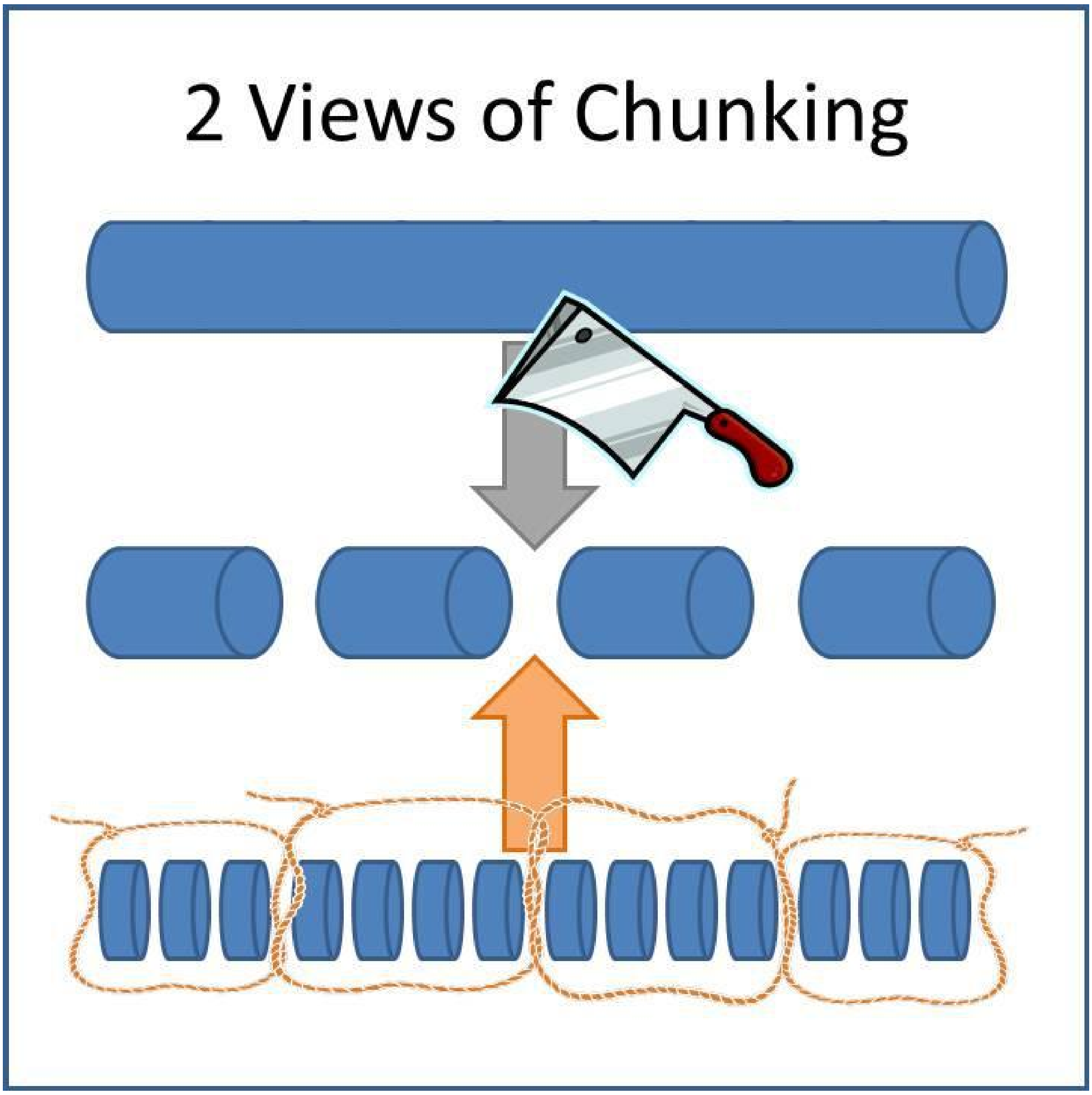


Figure 11 Acquired from
`http://presentationswithresults.com/are-you-chunking-your-content`

`http://` As being mentioned previously, short-term memory can hold about 9 chunks for around 30 seconds[69], which limits information to be processing; also, attention is limited in capacity. In order to deal with these limitations, **chunking** is one of the best strategies. In 1956, Miller talked about people's short-term memory is not sensitive to the chunks' size,

69 Passer, M., Smith, R., & Atkinson, M. (2011). Psychology: Frontiers and Applications, McGraw-Hill Ryerson; 4th edition. ISB-13: 978-0-07-000526-6

but the number of them[70][71]. Chunks are defined as units of information that are related and partakes traits appears as a group[72][73].

As Collins and Quilian (1970)[74] defined that the lowest level of the class of category's name conforms to the smaller categories, such as dog; and the highest level conforms to the larger categories, such as animal. Similar to the lowest level of the class of category, one view of chunking is to cut a big amount of information into couple of small groups. Taking memory numbers as an example. 5616289938, they may be meaning less to you. Let us put a dash line between them, 56-16-28-99-38, then we get five small groups of number instead of some random numbers. We can also think 56, 28,99 and 38 as ages, while 16 as a year. To make these number more meaningful, we can make a sentence like "my father is 56 year-old in 2016, I will be 28, and my grandmother is 99, my cousin is 38." Now, these numbers are meaningful, and easy to remember and recall.

The other view is similar to the highest level of the class of category, which is to put and relate pieces of small information into couple of groups. For example, "concert", "February", "strawberry", "Starbucks", "mailbox", "short-term", "learning", and "chunking". To memory these words are not easy because they are meaningless to you; hence, it is hard to recall them after 30 seconds. However, by using chunking, we can put these words into two big groups, one is the words start with an "s", and the other one is the words start without an "s". Additionally, to make a relation between these words would help to memory them easier because they become meaningful, such as "I went to a concert in February. Before going, I had a strawberry frappuccino in Starbucks. When I went back home, there was a mail in my mailbox, it talked about how people using chunking to enhance their short-term memory and the quality of learning."

Therefore, when students receive a big amount of new information or knowledge, they can cut them into groups, and make them relate to something is already known or meaningful. Consequently, students can learn effectively because the new knowledge is cut into appropriate units and put into a group with meaning. As an instructor, for example, instead of just giving random vocabulary, teachers can ask students to put vocabulary into different groups and make meanings for these groups. Additionally, asking them to use these vocabulary to make a logical sentence, in order to learn and memory them.

70 Bruning, R. H., Schraw, G. J., & Norby, M.M. (2011). Cognitive Psychology and Instruction, Bostom, MA, Allyn & Bacon. ISB-13: 9780132368971

71 Miller, G. A. (1956) The magical number seven, plus or minus two: some limits on our capacity for processing information . Psychological Review , 101 (2), 343-352.

72 Miller, G. A. (1956) The magical number seven, plus or minus two: some limits on our capacity for processing information . Psychological Review , 101 (2), 343-352.

73 Obaidellah, U. H., & Cheng, P. C. (2015). The role of chunking in drawing Rey complex figure. Perceptual And Motor Skills,120(2), 535-555. doi:10.2466/24.PMS.120v17x6

74 Collins, A.M., & Quillian, M. R. (1970). Does category size affect categorization time? Journal of Verbal Learning and Verbal Behavior, 9(4), 432-438. doi: 10.1016/S00225371(70)80084-6

Reviewing of learned materials

After knowing the regular forgetting pattern, we come to find out doing review practices that follows along with the forgetting curve is an appropriate method to reduce forgetting[75]. To extend this suggestion specifically, according to the forgetting curve, people start to forget immediately after they learn. Therefore, a quick reviewing can decrease the percentage of content we would forget. Thus, students better to review right after they learn the knowledge, for instance, **reviewing** the lecture content in an hour after the lecture. And before go to sleep, reviewing the content again. After around 24 hours, do the content review again, and try to come up some questions about it or do some practice assignments. Then, reviewing the content every week but not every day, in order to know it quite well and be available to retrieve it quickly when you need it.

Tests of learned knowledge

Recalling can help students to reduce forgetting[76]. As an instructor, tests is a common strategy that asks students to recall the knowledge they have learned. Based on the forgetting curve, at certain time to give an either small test (such as quiz) or a big test (such as midterm) can effectively enhance recalling and reducing forgetting[77]. For example, to give a quiz at the end of the lecture class, which helps students to quick review and restudy the lecture content. Also leaving a small practice assignment about the lecture taught today, and asking students to submit it the following day. After one week, to give another quiz about the lecture, which helps students to recall their knowledge of this content. After a month, to give a midterm which covers the lecture content to students, in order to test their understanding[78] and recall their knowledge about this content.

According to the World Health Organization (WHO) it estimated 1 in every 160 children will be diagnosed with Autism Spectrum Disorder (ASD) and currently 39 million individuals are living with an Attention Deficit Hyperactivity Disorder (ADHD) diagnoses [79,80]. Working Memory is a system used to implicate the process of encoding, decoding and maintenance of our memory (Figure 1)(specifically short-term memory) while , at the same time maintaining activity and accessibility [81,82]. Research suggests developmental disabilities

75 Easley, H. (1937). The curve of forgetting and the distribution of practice. Journal Of Educational Psychology, 28(6), 474-478. doi:10.1037/h0057409

76 Carpenter, S. K., Pashler, H., Wixted, J. T., & Vul, E. (2008). The effects of tests on learning and forgetting. Memory & Cognition, 36(2), 438-448. doi:10.3758/MC.36.2.438

77 Carpenter, S. K., Pashler, H., Wixted, J. T., & Vul, E. (2008). The effects of tests on learning and forgetting. Memory & Cognition, 36(2), 438-448. doi:10.3758/MC.36.2.438

78 Obaidellah, U. H., & Cheng, P. C. (2015). The role of chunking in drawing Rey complex figure. Perceptual And Motor Skills,120(2), 535-555. doi:10.2466/24.PMS.120v17x6

79 World Health Organization. (2016). Autism spectrum disorders. Retrieved from http://www.who.int/mediacentre/factsheets/autism-spectrum-disorders/en/

80 Vos, T., Barber, R. M., Bell, B., Bertozzi-Villa, A., Biryukov, S., Bolliger, I., & ... Atkins, e. S. (2015). Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: A systematic analysis for the Global Burden of Disease Study 2013. The Lancet, 386(9995), 743-800. doi:10.1016/S0140-6736(15)60692-4

81 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971

82 Gluck, M. A., Mercado, E., & Myers, C. E. (2014). Learning and Memory: From

such as those as defined in the Diagnostic Statistics Manual of ASD and ADHD impact working memory. This chapter, within the framework of Baddely's working memory model attempts to understand the inner workings of these prevalent disorders.

3.9 Autism Spectrum Disorder (ASD)

Autism spectrum disorder (ASD) and autism are both general terms for a group of complex disorders of brain development and such classified as **intellectual** and **developmental disability**. These disorders are characterized, in varying degrees, by difficulties in social interaction, verbal and nonverbal communication, repetitive behaviors and difficulties in motor coordination and attention. Because of overlap and **variability** in symptoms, The DSM IV introduced the concept of autism spectrum disorder as opposed to a stand alone disorder.[83]

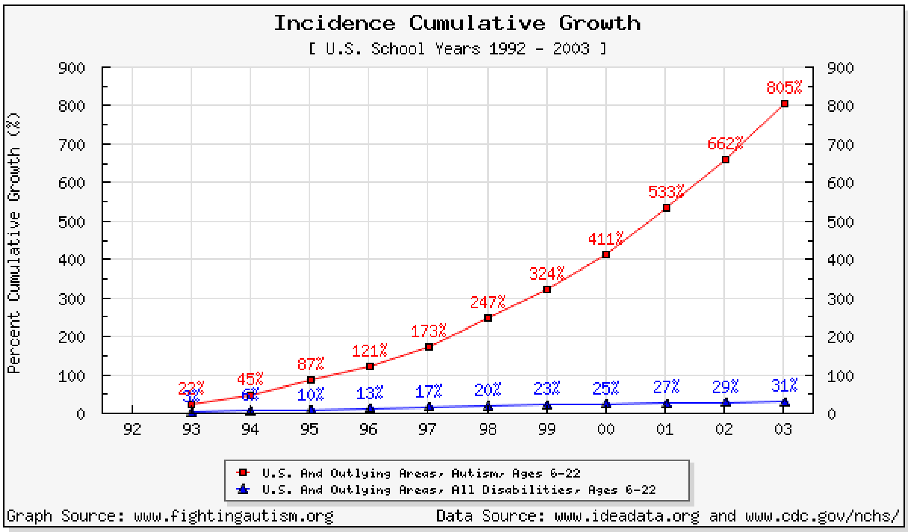


Figure 12

While ASD occurs more often in boys than girls, early detection nonetheless is critical in diagnosis because proactive interventions have shown considerable improvements in areas such as language and social skills. Often this early detection is a result of **statistically significant** diminished capacities often referred to as impairments. Some early signs of impairment include: Communication (social), behaviors (verbal and non-verbal) and interests. While each pattern is unique, most common symptom is diminished capacity of language. **DSM** IV suggests three main types of ASD:

- Asperger's syndrome (AS)
- Pervasive developmental disorder, not otherwise specified (PDD-NOS)
- Autistic disorder (AD)

Brain to Behavior. (2nd Edition). Worth Publishing

83 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

The **DSM** V while it made changes to ASD descriptions, further research should be considered when assessing the changes. Listed below are some of the common autism disorders.

Asperger's Syndrome (AS)

The mildest form of autism, Asperger's syndrome (AS), involves repeated interest, discussion on a specific topic. Children with AS often show great impairment in social skills and uncoordinated; however, above average intelligence has also been reported. High functioning Asperger syndrome (HFAS) if left unsupported can lead to depression and anxiety in later life.[84]

Pervasive Developmental Disorder, Not Otherwise Specified (PDD-NOS)

Because of the generalized description, captures most children and is considered more severe than AS (but less severe as ASD). PDD-NOS symptoms include (but not exclusive) **impaired language skills**, social interaction and later age of onset. Difference of PDD-NOS from AS and Autism disorder (AD) include fewer repetitive behavior and **variability** of symptoms offers a challenge to diagnosis.[85]

Autism Disorder

Children who meet more rigid criteria for a diagnosis of autism have autistic disorder. They have more severe impairments involving social and language functioning, as well as repetitive behaviors. Often, they also have **mental retardation** and seizures. Common symptoms while similar to AS and PDD-NOS also include absences of name recognition and use of single or two word phrases.

While ASD includes many subtypes and often the numbers can be underestimated because of **variability**, Figure 4 gives an overview of prevalence and incidence rates in the United States (1993-2003). This suggests ASD continues to be persuasive and increasing exponentially (compared to other disabilities). While ASD is the most common of the developmental disabilities, the second most prevalence learning disability is attention deficit hyperactivity disorder.

3.10 Autism Spectrum Disorder and Working Memory

Approximately seven percent of children suffer with literacy disorders such as Autism Spectrum Disorder (ASD) and ADHD[86] Working memory is a fundamental function for the developmental process which is known to impact the neuro-cognitive domain with impairments[87][88] Widely held beliefs on ASD and working memory suggest deficits in

84 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

85 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

86 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5$^{\text{th}}$ ed.

87 Bordignon, S., Giulini, E., Trentini, C.M., & Bosa, C.A. (2015). Memory in children and adolescents with autism spectrum disorder: a systematic literature review. *Psychology and Neuroscience, 8, 211-245.*

88 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5$^{\text{th}}$ ed.

phonological loop processing, visuo- spatial challenges and inability to regulate **executive functioning** [89] [90]Controversial debate related to **heterogeneity** of ASD subjects and the various components of working memory function continue today. For example, a child with ASD may show attention to a specific object (e.g. zippers) while another child with similar diagnosis would not react to the same object (zipper). The second child may show interest in a bike instead. This suggests an impairment with the phonological loop. While ASD and working memory are complex, current research continues to focus on identifying specific impairments and its relationship to the different components of working memory when considering solutions in the instructional environment.

3.10.1 ASD and Central Executive

The central executive is the "most important component of working memory" because it is responsible for monitoring and coordinating the operation of the slave system (phonological loop, visuo-spatial sketch pad) and relates to long term memory [91]

ASD's impairments in social interaction, verbal, non-verbal communication, and restrictive behaviors appear in early childhood and persist in later life. Hill & Frith (2004) (as cited by Cui et al.) suggest this is a result of **executive dysfunction**. [92]Conflicting research suggests ASD dispute a relationship to central functioning because working memory may also be influenced by factors such as age, IQ, task measured [93] which is often not accounted for in research literature. However, since Hill & Frith were able to use a battery of working memory tasks which aimed to isolate to Asperger syndrome in early-school-age children, (thereby removing the variables) were able to address these concerns and therefore it can be concluded there is a partial deficit in central executive.

3.10.2 ASD and Phonological Loop

The phonological loop is assumed to be responsible for the manipulation of speech based information[94] It may be extremely difficult to study ASD and its relationship with the phonological loop because, as was mentioned, the **heterogeneity** of ASD subjects. Differences in each ASD individual with how they utilize the spoken and written language is unique; yet often when considering working memory and the phonological loop, non ASD individuals show similarities in learning. In spite of this **variability**, language impairments include decreased communication, phonology, semantics, and syntax.[95] Fischbach et

89 Bordignon, S., Giulini, E., Trentini, C.M., & Bosa, C.A. (2015). Memory in children and adolescents with autism spectrum disorder: a systematic literature review. *Psychology and Neuroscience, 8, 211-245.*

90 Vries, M.D., & Geurts H.M. (2014). Beyond individual differences: are working memory and inhibition informative specifiers with ASD? *Journal of Neural Transmission, 121,1183-1198.*

91 Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology, 49A*(1), 5-28.

92 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

93 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

94 Baddeley, A. (2003). Working memory: looking and looking forward. *Neuroscience,* 4, 829-839

95 Loucas, T., Riches, N.G., Charman, T., Pickles, A., Simonoff, E., Chandler, S., & Baird, G. (2010). Speech perception and phonological short-term memory capacity in language impairment: preliminary

al (2013)[96] conclude because of left-hemisphere brain deficits commonly found with ASD this may impact the ability of processing language. They add because of these deficits, compensatory effects in right hemisphere could lead to strengths in visuo-spatial processing (discussed below). While his compensation is important in that memory can adapt to brain disruptions, the challenge is that the left hemisphere does not advance functioning. It is important to note, as most research on ASD suggests, because of the changes in early development, phonological store is greatly impacted in reaction time among adolescents when studying speech in phonological short term memory (PSTM). Comparisons with typically developing (TD) subjects, the level of **cognitive load** during the phonological loop processing for ASD is significantly associated with reaction time and accuracy. This suggests perception of speech impacts access to speech. Controversy remains with this assertion when Williams et al (2014)[97] while studying visuo-spatial memory argue no association with impairment of verbal storage and ASD. [98]

3.10.3 ASD and Visuo-Spatial Sketch Pad

In working memory, the visuo-spatial sketch pad is assumed to be responsible for manipulating visual images. Prospective memory (PM) are highly prevalent in daily life and range from relatively simple tasks to extreme life-or-death situations. Examples include remembering to pick up milk at the grocery store after work or remembering to attach the safety harness when climbing buildings. This ability of the PM to remember to carry out a task (Williams et al, 2014)[99] conclude that when considering time based tasks, ASD subjects because they show "diminished capacity have difficulty with processing visual storage", an important component of working memory and the visuo-spatial sketch pad (Sachse et al., 2013)[100], when considering high functioning ASD (HFASD) such as Asperger syndrome while they did not find verbal memory impairment, conclude because visual motor information is impaired spatial working memory (SWM) "was impaired because of differences in **cortical** networks which led to higher number of working memory errors". [101] Combining all aspects of working memory (central executive, phonological loop and visuo-spatial sketchpad), Because of the **variability** in ASD, researchers looked at various tasks specific to the working memory components with specific age populations (early school aged). Be-

evidence from adolescents with specific language impairment (SLI) and autism spectrum disorders (ASD). *International Journal of language and Communication Disorders, 45, 275-286.*

96 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.

97 Williams, D.M., Jarrold C., Grainger, C., & Lind, S.E. (2014). Diminished time-based, but undiminished event-based, prospective memory among intellectually high functioning adults with autism spectrum disorder: relation to working memory ability. *Neuropsychology, 28, 30-42.*

98 Williams, D.M., Jarrold C., Grainger, C., & Lind, S.E. (2014). Diminished time-based, but undiminished event-based, prospective memory among intellectually high functioning adults with autism spectrum disorder: relation to working memory ability. *Neuropsychology, 28, 30-42.*

99 Williams, D.M., Jarrold C., Grainger, C., & Lind, S.E. (2014). Diminished time-based, but undiminished event-based, prospective memory among intellectually high functioning adults with autism spectrum disorder: relation to working memory ability. *Neuropsychology, 28, 30-42.*

100 Sache, M., Schlitt, S., Hainz, D., Ciaramidaro, A., Schirman, S., Walter, H., Poustka, F., Bolte, S., & Freitg., C.M. (2013). Executive and visuo-motor function in adolescents and adults with Autism spectrum disorder. *Journal of Autism Developmental Disorders,* 43, 1222-1235.

101 Sache, M., Schlitt, S., Hainz, D., Ciaramidaro, A., Schirman, S., Walter, H., Poustka, F., Bolte, S., & Freitg., C.M. (2013). Executive and visuo-motor function in adolescents and adults with Autism spectrum disorder. *Journal of Autism Developmental Disorders,* 43, 1222-1235.

cause of matched IQ, HFASD had significant disadvantages around visuo-spatial sketchpad implicated by partial deficits in central executive.[102]

Unlike ASD and working memory implications, ADHD has very different etiology on working memory.

3.11 Attention deficit hyperactivity disorder (ADHD)

According to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition, **DSM** V, it states the diagnostic features of ADHD. People with ADHD would show a persistent phenomenon of Inattention and/or hyperactivity-impulsivity that affect development and/or normal functioning. [103] (Reference table 1)

Inattention: *6 or more symptoms present for children who are below 16 years of age, or 5 or more symptoms must be presented for adolescents older than 17; these symptoms of inattention have been present for at least 6 months, and they are inappropriate for developmental level:*[104]	**Hyperactivity and Impulsivity:** *6 or more symptoms present for children who are below 16 years of age, or 5 or more symptoms must be presented for adolescents older than 17; these symptoms of hyperactivity-impulsivity have been present for at least 6 months to an extent that is disruptive and inappropriate for the person's developmental level:*[105]
• Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or with other activities.• Often has trouble holding attention on tasks or play activities.• Often does not seem to listen when spoken to directly.• Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace .• Often has trouble organizing tasks and activities.• Often avoids, dislikes, or is reluctant to do tasks that require mental effort over a long period of time.• Often loses things necessary for tasks and activities .• Is often easily distracted• Is often forgetful in daily activities.[106]	• Often fidgets with or taps hands or feet, or squirms in seat.• Often leaves seat in situations when remaining seated is expected.• Often runs about or climbs in situations where it is not appropriate (adolescents or adults may be limited to feeling restless).• Often unable to play or take part in leisure activities quietly.• Is often "on the go" acting as if "driven by a motor".• Often talks excessively.• Often blurts out an answer before a question has been completed.• Often has trouble waiting his/her turn.• Often interrupts or intrudes on others[107]

In addition, the following conditions must be met:

• Several inattentive or hyperactive-impulsive symptoms were present before age 12 years.

• Several symptoms are present in two or more setting, (such as at home, school or work; with friends or relatives; in other activities).

• There is clear evidence that the symptoms interfere with, or reduce the quality of, social, school, or work functioning.

• The symptoms are not better explained by another mental disorder (such as a mood disorder, anxiety disorder, dissociative disorder, or a personality disorder). The symptoms do not happen only during the course of schizophrenia or another **psychotic disorder**.[108]

102 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

103 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

104 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

105 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

106 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

107 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

108 American Psychiatric Association (2013). *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.). Arlington: American Psychiatric Publishing. pp. 59–65. ISBN 0890425558

Sub-types of ADHD

There are three sub-types of ADHD that categorized by the different categorize of ADHD.

• Predominantly Hyperactive-Impulsive Type: in order to fulfill this sub-type, in the past six weeks, the person has filled the entire requirement for symptoms of Hyperactivity-impulsivity, but not the symptoms of inattention

• Predominantly Inattentive Type: In this sub-type, the person has filled the entire requirement for symptoms of inattention, but not the symptoms of Hyperactivity-impulsivity.

• Combination Type: In this sub-type, the person has filled both requirement for the symptoms of Hyperactivity-impulsivity and inattention. This is the most common type of ADHD. [109]

With these definitions of ADHD and ASD in mind (including symptoms), it is important to consider its relationship with working memory.

109 Simon, Harvey. (2013, July 03).Attention deficit hyperactivity disorder. Retrieved from umm.edu/health/medical/reports/articles/attention-hyperactivity-disorder

3.12 Attention Deficit Hyperactivity Disorder and Working Memory

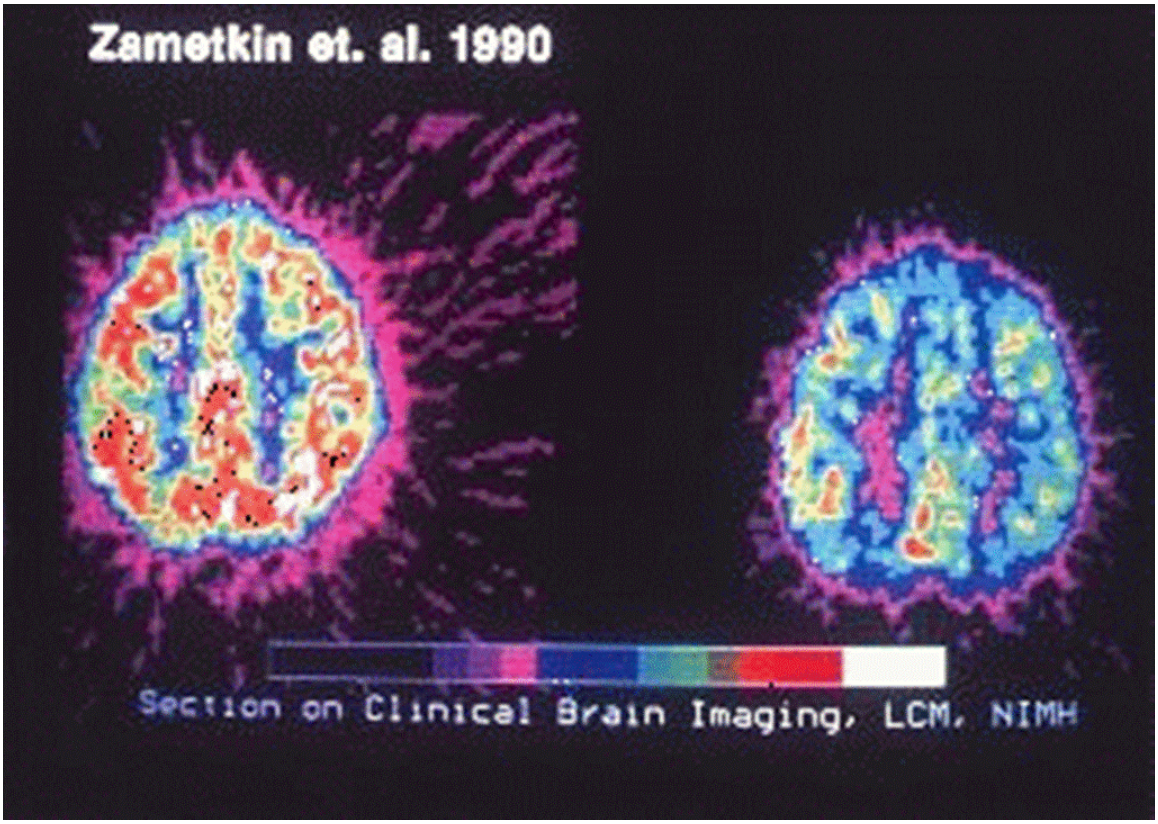


Figure 13 Figure 5.The above brainscan of brains shows the differences between adult with and without (Left) ADHD

People with ADHD usually accompany with some difficulties on their working memory, when we focus on the brain structure of the ADHD children, we could see that their brain structures are usually differ from children without ADHD, Several brain regions and structures, such as **pre-frontal cortex**, **striatum**, **basal ganglia**, and **cerebellum** tend to be smaller than people without ADHD. The overall brain size from ADHD children is generally 5% smaller than children without ADHD (Figure 5).These brain regions are closely related to how our working memory works, especially the **pre-frontal cortex**[110], thus with a smaller brain size, ADHD children's working memory would perform poorly.

3.12.1 ADHD and Central Executive

The central executive seems equally impaired in both subtypes. A research used the Chessboard Task to test whether the subjects could maintain and reorganize visuospatial infor-

110 Attitude Editors. (2015). ADHD Is Biological, What causes attention deficit disorder? Although researchers know much about ADHD, they can't pinpoint its cure. Retrieved from www.additudemag.com/adhd-wed/article/5008.html

mation, thus the Central Executive has been tested in this research. The result shown that ADHD children score lower than the normal students, nevertheless, the result of ADHD children improved when they received high level of reinforcement but not the control group [111].

In another research, the researchers used The Digits Backward, to test their capacity to store and manipulate information, and The Dual Task, to test their ability to coordinate two separate tasks. The result shown that ADHD children repeated fewer digits than the controls in The Digits Backward task and gain lower score in The Dual Task, these tasks show that central executive functions are critical for the variance in goal-setting skills in children with ADHD [112].

3.12.2 ADHD and Phonological Loop

ADHD children performed similarly in the Phonological loop tests with normal children, their score in The Digits Forward and The Word Recall tasks are similar. These tasks tested whether subjects could repeat the digits in a correct order. This result is consistent with the results of several earlier studies showing that deficits in the phonological loop are not characteristic of children with ADHD [113].

There is a research accompanied the ADHD children with Specific language impairment, also suggested that ADHD children have less impact in phonological loop. ADHD-C children with SLI scored significantly lower than those without SLI and normal children. Which support the hypothesis that Phonological loop are not the characteristic of ADHD children [114].

3.12.3 ADHD and Visuo-spatial Sketchpad

ADHD-I children and ADHD-C children who have **motivational deficits**, they have a destructive effect on their visuo-spatial working memory performance, according to The Chessboard Task, their score are lower than the control group [115]. In Visuo-Spatial Test, it measures the ability to remember the number filled matrix, the result shown that children

111 Dovis, S., Van der Oord, S., Wiers, R. W., & Prins, P. M. (2015). ADHD subtype differences in reinforcement sensitivity and visuospatial working memory. Journal Of Clinical Child And Adolescent Psychology, 44(5), 859-874. doi:10.1080/15374416.2014.895940

112 Nyman, A., Taskinen, T., Grönroos, M., Haataja, L., Lähdetie, J., & Korhonen, T. (2010). Elements of working memory as predictors of goal-setting skills in children with attention-deficit/ hyperactivity disorder. Journal Of Learning Disabilities, 43(6), 553-562. doi:10.1177/0022219410375001

113 Nyman, A., Taskinen, T., Grönroos, M., Haataja, L., Lähdetie, J., & Korhonen, T. (2010). Elements of working memory as predictors of goal-setting skills in children with attention-deficit/ hyperactivity disorder. Journal Of Learning Disabilities, 43(6), 553-562. doi:10.1177/0022219410375001

114 Jonsdottir, S., Bouma, A., Sergeant, J. A., & Scherder, E. A. (2005). The impact of specific language impairment on working memory in children with ADHD combined subtype. Archives Of Clinical Neuropsychology, 20(4), 443-456. doi:10.1016/j.acn.2004.10.004

115 Jonsdottir, S., Bouma, A., Sergeant, J. A., & Scherder, E. A. (2005). The impact of specific language impairment on working memory in children with ADHD combined subtype. Archives Of Clinical Neuropsychology, 20(4), 443-456. doi:10.1016/j.acn.2004.10.004

with ADHD performed more poorly than the control group [116]. Nevertheless, High reinforcement can improve the working memory performance in both ADHD groups, but not the control group [117].

There are some minor differences between different subtypes ADHD. In the task of the Hopkins Verbal developmental Test–Revised (HVLT-R), The official Norwegian research versions, and the Brief Visuospatial Memory Test-Revised (BVMT-R), these tasks measure the performance of Auditory or verbal and visuospatial ability. The results shown that there are more **impairment** about developmental and delayed memory in the ADHD-I children when we compared the result with the ADHD-C children [118].

3.12.4 ADHD and ASD Developmental Implication

There are several behavioral strategies and treatments could help the ADHD patients, in order to improve their behaviors. For example a good and effective Classroom management could change the behavior of ADHD students,a more structured classroom, provide closer attention to students, and limitations of distractions could help to change the behavior of ADHD, these modifications may not have an effective assessment, but they usually included in the treatment plans.[119] Some behavior therapies can be implemented to teachers and parents through some training programs, like Parent Management Training, Operant-conditioning usually involved in these programs, a positive reinforcement (consistent rewards for achieving goals and idea behavior) and positive punishment (provide a negative consequence after the present of an undesired behavior).[120] Teachers learn classroom Management as a technique to change behavior, Token economy (student earns rewards when performing desired behaviors and loses the rewards when performing undesired behaviors), daily feedback and structured classroom activities

However,a research in 2013 shown that working memory training like the Cognitive training could only provide a short term improvements, and there are only little evidence that those improvements are permanent.[121] Also in 2014, researchers analyzed that the current evidence for the accuracy of cognitive training for treatment of ADHD symptoms is not completed.[122]

116 Nyman, A., Taskinen, T., Grönroos, M., Haataja, L., Lähdetie, J., & Korhonen, T. (2010). Elements of working memory as predictors of goal-setting skills in children with attention-deficit/ hyperactivity disorder. Journal Of Learning Disabilities, 43(6), 553-562. doi:10.1177/0022219410375001

117 Jonsdottir, S., Bouma, A., Sergeant, J. A., & Scherder, E. A. (2005). The impact of specific language impairment on working memory in children with ADHD combined subtype. Archives Of Clinical Neuropsychology, 20(4), 443-456. doi:10.1016/j.acn.2004.10.004

118 Andersen, P. N., Egeland, J., & Øie, M. (2013). Learning and memory impairments in children and adolescents with attention-deficit/hyperactivity disorder. Journal Of Learning Disabilities, 46(5), 453-460.

119 Clinical practice guideline: Treatment of the school-aged child with attention-deficit/hyperactivity disorder. (2002). Journal of the American Academy of Child & Adolescent Psychiatry, 41(5), 537

120 Clinical practice guideline: Treatment of the school-aged child with attention-deficit/hyperactivity disorder. (2002). Journal of the American Academy of Child & Adolescent Psychiatry, 41(5), 537

121 Melby-Lervåg, M., & Hulme, C. (2013). Is working memory training effective? A meta-analytic review. Developmental Psychology, 49(2), 270-291. doi:10.1037/a0028228

122 Sonuga-Barke, E., Brandeis, D., Holtmann, M., & Cortese, S. (2014). Computer-based cognitive training for ADHD: A review of current evidence. *Child And Adolescent Psychiatric Clinics Of North America*, *23*(4), 807-824. doi:10.1016/j.chc.2014.05.009

3.13 Conclusion

The purpose of this chapter was to provide insight on appropriate and effective implementations of learning, through the understanding of the mechanics of memory. This chapter begins with an introduction to multimedia learning and provides an idea as to how learning is more effective through the use of words and images. It presents the topics of multimedia learning, which includes theories of cognitive load, dual-coding, and active processing. The next key topic discusses the information processing model, which explores the process of human memory, usually referred to as the memorization of information. Three main memory structures are said to be sensory memory, short-term/working memory and long-term memory. Each structure has specific nerves required in order to function properly. This processing model also provides a foundation for the learning process. Moving on, the idea behind cognitive process focuses more on encoding process and retrieval process which occurs amidst short-term memory and long-term memory. By understanding how these two processes work, we can then discern how to make information meaningful, and how to access information when required. Furthermore, by examining the systems of short-term memory and long-term memory, it provides us with an idea about how we acquire knowledge. Forgetting curve and limited attention capacity tells people the challenges of learning. By recognizing the challenges faced in learning, use of strategies such as chunking, reviewing, and tests, as well as teaching strategies (mentioned in this chapter) are ways that can help people deal with these challenges. Teachers can apply these strategies on students in order to help them learn to be more efficient and effective, or students can use these implementations on their own. By the end of this chapter, the hope is to foster a better understanding and knowledge about memory and the underlying processes behind it, while providing insight on the appropriate implementation of learning.

3.14 Glossary

Active processing: refers to the idea that meaningful learning takes place only when humans actively organize, integrate and build connections with prior and new knowledge.

Acoustic: relating to sound or the sense of hearing.

Attention: the capacity of focusing on a stimulus.

Articulatory loop:holds acoustic information

Chunks: defined as units of information that are related and partakes traits appears as a group

Cognitive load: total amount of load that can be placed on the working memory

Cognitive development:a gradual changes in our mental processes of becoming more and more advanced over time.

Decoding: convert a code message into intelligible language.

Dual-Coding theory: a theory proposed by Allan Paivio that suggests that the human memory detects visual and verbal responses as separate systems.

Ebbinghaus' forgetting curve: a curve presents memory is decreased as time goes by.

Elaborative: worked out with great care and nicety of detail.

Encoding: conver information or an instruction into a particular form.

Executive control system:controls the other two systems and decides what kind of the information enters memory.

Information processing model: theory proposed by Atkinson and Shiffrin which compares sequence of computer processing to that of humans.

Learning: active process of acquiring new information

Learning process: the journey of learning, works as a mental process

Long term memory: It can maintain information for a long period of time. It could be days, weeks, months and years.

Memorization: a process of committing something to memory.

Memory: the process of recording and retrieving experiences and information

Metacognition: awareness and understanding of one's thought processes.

Multimedia learning: a type of learning model based on the belief that materials presented through images and words improve understanding, than in words or pictures alone.

Recalling: to retrieve the information from long-term memory.

Retention:the continued possession, use , or control of something.

Retrieval: a process of getting something back from somewhere.

Reviewing: to relook at and rememory the knowledge that has been learned.

Self-questioning: examination of one's own actions and motives.

Semantic: realting to meaning in language or logic.

Sensory memory is a system that holds environment input in sensory registers so that perceptual analyses can work before that information fade away.

Two views of chunking : One view is to cut a big amount of information into couple of small groups. The other view is to put and relate pieces of small information into couple of groups

Visual-spatial sketch pad: holds visual spatial information

Aural data – Data that is relating to or perceived by the ear.

Intellectual disability- A disability characterized by significant limitations in both intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18.

Developmental disability- A diverse group of chronic conditions that are due to mental or physical impairments.

Impaired language skills- A *language* disorder that delays the mastery of *language skills* in children who have no hearing loss or other developmental delays.

Variability- How spread out or closely clustered a set of data is.

Impairments- In health, any loss or abnormality of physiological, psychological, or anatomical structure or function, whether permanent or temporary.

Mental retardation- A condition diagnosed before age 18, usually in infancy or prior to birth, that includes below-average general intellectual function, and a lack of the skills necessary for daily living. When onset occurs at age 18 or after, it is called dementia, which can coexist with an MR diagnosis.

Psychotic disorder- Severe mental disorders that cause abnormal thinking and perceptions.

Executive dysfunction- A disruption to the efficacy of the executive functions, which is a group of cognitive processes that regulate, control, and manage other cognitive processes.

Cognitive load- the total amount of mental effort being used in the working memory.

Diagnostic Statistical Manual (DSM)- The standard classification of mental disorders used by mental health professionals in the United States. It is intended to be used in all clinical settings by clinicians of different theoretical orientations

Heterogeneity- A word that signifies diversity.

Pre-frontal cortex- The cerebral cortex which covers the front part of the frontal lobe.

Striatum- Also known as the neostriatum or striate nucleus, is a subcortical part of the forebrain and a critical component of the reward system.

Basal ganglia- A group of structures linked to the thalamus in the base of the brain and involved in coordination of movement.

Cerebellum- The part of the brain at the back of the skull in vertebrates. Its function is to coordinate and regulate muscular activity.

Frontal cortex- Cortex of the frontal lobe of the cerebral hemisphere

Motivational deficits- Motivation is defined as the product of expectancies and values.

Statistically significant- The likelihood that a result or relationship is caused by something other than mere random chance.

Executive functioning- A set of mental skills that help you get things done. These skills are controlled by an area of the brain called the frontal lobe.

Cortical-Consisting of cortex,the outer layer of the cerebrum.

3.15 Suggested Readings

Burt, B., & Gennaro, P. (2010). Behavior solutions for the inclusive classroom: a handy reference guide that explains behaviors associated with Autism, Asperger's ADHD, sensory processing and other special needs. Canada: The Donahue Group. • Eysenck, M. W., & Keane, M. T. (2001). Cognitive psychology (4th ed.). New York: Psychology Press.

• Mccabe, J. (2010). Metacognitive awareness of learning strategies in undergraduates. Mem Cogn Memory & Cognition, 39(3), 462-476.

• Miller, M. D. (2011). What College Teachers Should Know About Memory: A Perspective From Cognitive Psychology. College Teaching, 59(3), 117-122.

3.16 References

4 Long-Term Memory

When a student studies for tests and memorizes class material, where does it go? The **long-term memory** remains absolutely necessary and important in learning, as all information that a student learns is remembered, or *stored* in either short- or long-term memory. While both short- and long-term memory remain important for storage of all information learned, a person's memories can also influence one's learning, how they perceive things, and how they build up the meaning or cognition of what they perceive. Learning and memory constantly influence one another, as one's memories or prior knowledge of certain concepts, subjects or items can enhance learning. In this chapter, we will describe first the framework and functions of the long-term memory, including also the short-term memory, and link this framework to cognition, and the many methods in how it is formed. Lastly, we will discuss newer and more developed models which describe how views of memory have evolved over time.

4.1 Framework for Long-Term Memory

The long-term memory is the supposedly limitless and permanent capacity for all sorts of information that one experiences within a whole lifetime. Having the long-term memory is necessary for all learners, but understanding how it works, its makeup and processes within it, can help learners to better understand their own learning. Below is a description of the framework of long-term memory, including the lower structures that make up long-term memory, as well as descriptions of encoding strategies and processes, and their implications towards instructors.

4.1.1 Structures of Long-term Memory

Many structures make up the long-term memory, each with its own separate function. The process in how information travels and gains meaning before reaching the LTM will be detailed below.

4.1.2 Functions

Limitless and permanent, the long-term memory contains endless information comprised over long periods of time, and unlike the short-term memory, does not require constant repetition to make it last. Information stored in the LTM is **recalled** or **reconstructed**, rather than rehearsed or repeated. LTM is made up of implicit memory, information that unconsciously influences attitudes and behaviours, and explicit memory, the memories that one remembers specifically. LTM is further broken down into categories of knowledge which include **procedural knowledge**, **conditional knowledge** and **declarative knowledge**, which is then made up of **semantic and episodic memory** [1].

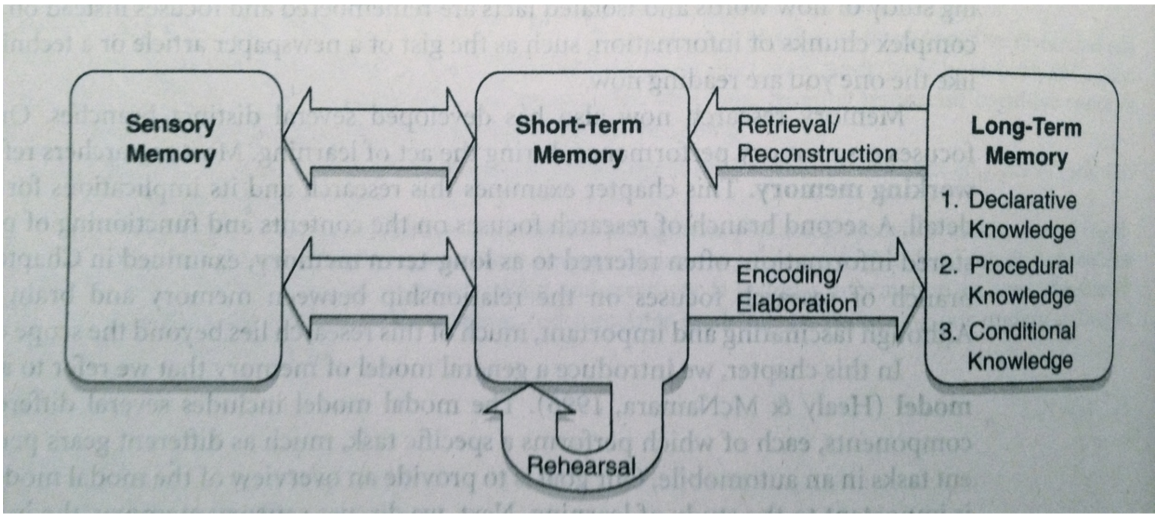


Figure 14 A depiction of the modal model, taken from *Cognitive Psychology and Instruction*

4.1.3 The Modal Model

Information, when first perceived, travels through a series of cognitive functions before it reaches the LTM. The modal model [2] is the general depiction that recent research has put together of the sequence in which information is transferred from the sensory memory to the short-term memory ending with long-term memory. Based on this model, information is assumed to be processed through each of the three "lower" memory systems, each its own separate function [3]. This model provides a significant distinction between each of the different memory functions, and the processes between each.

Length and Limitations of Short-Term Memory

Extensive research throughout history proves that the short-term memory (also referred to as working memory) usually holds up to no more than 7 chunks of information at one time [4]. This limited capacity prevents the short-term memory from overload and requires different amounts of attention per task. Referring back to the modal model, we see how sensory information gets pruned and given meaning during its transferral. Each cognitive function of the modal model is described in more detail below.

1 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
2 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
3 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
4 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

Sensory Memory

The sensory memory is the initial memory component in which incoming information is perceived and recognized [5]. Most importantly, this is the memory component in which information is given **assignment of meaning**, and then is passed on to the short-term memory. Each sense (ex. sight, sound, scent, touch and taste) has a **sensory register**, a function that allows it to temporarily retain the perceived information after it has disappeared. This function is very limited, as sensory memory rapidly decays once removed from view [6]. From here, sensory information with a newly assigned meaning passes onto the short-term memory, more commonly referred to as the working memory.

Working Memory

The second stage of the modal model, the working memory is the function which focusses on the memory process during learning [7] . There are three separate functions that make up the working memory. The **executive control system** is superior of these three components, controlling and selecting what enters the short-term memory and planning necessary strategies for processing the selected information (such as arranging a given list of numbers in numerical order) [8] . The remaining systems (sometimes called *slave systems*) are the **visual-spatial/visuospatial sketchpad** and the **articulatory/phonological loop**, which control, respectively, visuospatial and acoustic information. The visual-spatial sketchpad is also responsible for rehearsing the designated information, performing computations on images (one example is the rotating letter [insert image]) and judging spatial comparisons. The articulatory loop manages auditory rehearsal, articulation processes and holds acoustic information via rehearsal (this information typically lasts from 2-4 seconds) [9] . These three components of the working memory are theorized to be functionally separate from one another and having their own limited attentional resources [10] .

4.1.4 Significance for Learning

Though the long-term memory may seem more important towards students' learning, methods for improving short-term memory should not be overlooked. Some concepts of the short-term memory will be discussed, in regards to their significance towards learners and the possible benefit of using said strategies.

Automaticity

Automaticity is the state of a cognitive process being performed automatically, with need of fewer cognitive resources, and is only achieved through extended practice. Automatic

5 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
6 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
7 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
8 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
9 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
10 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

processes allow a student to turn more attention towards higher cognitive processes that require more of their cognitive resources, or that can allow simultaneous performance of different tasks, since the automatic processes require little to no attention [11] . Students who are able to practice automatic cognitive tasks in their learning and accrue proceduralized knowledge tend to have lesser demands on their limited resources [12] . Encouraging practice in skills such as reading, the multiplication table, or citations in higher-level academic papers to name a few, can eventually generate automaticity and grant access to more cognitive resources.

Cognitive Load Theory

Originating from Baddeley's model of working memory, the cognitive load theory is the belief that certain learning environments impose greater demands on learners than others, causing a higher information processing load taxing the working memory [13] . These greater demands may comprise of **intrinsic cognitive load**, the task's necessary cognitive resources which vary depending on its difficulty, or **extraneous cognitive load**, the cognitive resources that are spent on stimuli outside of the task [14] . While extraneous cognitive load can be changed in various ways, intrinsic cognitive load depends solely on the difficulty of the task. Students struggling with extraneous cognitive overload may benefit from changing any of the ways in which the information to be learned is presented, such as by removing oneself from a distracting environment, properly organizing the to-be-processed information, and using suitable cognitive tools. Instructors can also diminish extraneous load by providing detailed and clear learning instruction [15] .

4.1.5 Methods for Improvement and Application

Despite the limitations of the short-term memory, understanding each of its functions becomes beneficial towards using strategies for general improvement. Below are some subsequent strategies and concepts that can utilize the short-term memory best to benefit learners.

Chunking

Because the working memory can only hold up to 7 pieces of information at a time, it is theorized and suggested that to-be-learned information will be remembered better when divided up into memorable chunks. According to Miller, the short-term memory's ability to remember is sensitive only to the amount of chunks and not the size of the chunks themselves—therefore, increasing the size of chunks helps students to learn more efficiently and can allow them to remember large amounts of information at a time, with due **rehearsal** [16]

11 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
12 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
13 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
14 Woolfolk, A., Winne, P. H.. & Perry, N. E. (2016). Educational psychology (Custom ed. for Simon Fraser University). Pearson Education. 169
15 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
16 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

. However, information decays rapidly if there is too long a gap between rehearsal and retention.

Managing Cognitive Demands

Studies done by Mayer and Moreno show additional ways in which learners can benefit by managing the demands on cognitive load during learning. Having distinguished 3 different types of cognitive demands, Mayer and Moreno suggest that student concentration on **essential learning**—the cognitive demands that are necessary for understanding the information— will benefit them more than concentrating on the demands of **incidental processing** and **referential holding** [17] . Referential holding is when one holds information in memory temporarily while other information is being processed (taking notes while listening to an instructor, for example), and causes attentional resources to become overtaxed. This study suggests that students focus more of their attention and resources towards essential learning, as spending more resources on referential holding and unnecessary incidental processing tends to lead to cognitive overload and overall poorer learning performance [18] .

Attentional Filtering

According to studies done by Bengson and Luck, attentional filtering is a high influence upon storage capacity in the visual working memory [19] . Similarly to Mayer and Moreno, this study suggests that students who filter out irrelevant information to make more storage room for the necessary information in the visual working memory perform better than students who do not [20] . A subsequent experiment was performed in which 3 groups of students were shown certain visual stimuli and were tested on how well they remembered them. The first group was asked to remember everything that they saw, the second group was asked to remember only specific subsets of stimuli, while the last group was simply told to "do their best." Results showed that though the "do your best" and subset groups performed quite similarly, the group remembering everything had a much higher cognitive task to perform and were easily overwhelmed [21] . When applying the insights of this study towards instruction and learning, giving instructions that are specific and focus less on the whole and more on subset goal groups may be more beneficial towards students' cognitive loads, keeping them from being overtaxed.

17 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

18 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

19 Bengson, J. & Luck, S.. (February 2016). Effects of strategy on visual working memory capacity. Psychonomic Bulletin & Review Volume 23, Issue 1, 265-270. `http://link.springer.com.proxy.lib.sfu.ca/article/10.3758%2Fs13423-015-0891-7`

20 Bengson, J. & Luck, S.. (February 2016). Effects of strategy on visual working memory capacity. Psychonomic Bulletin & Review Volume 23, Issue 1, 265-270. `http://link.springer.com.proxy.lib.sfu.ca/article/10.3758%2Fs13423-015-0891-7`

21 Bengson, J. & Luck, S.. (February 2016). Effects of strategy on visual working memory capacity. Psychonomic Bulletin & Review Volume 23, Issue 1, 265-270. `http://link.springer.com.proxy.lib.sfu.ca/article/10.3758%2Fs13423-015-0891-7`

4.2 Encoding

Encoding is the process of transferring information from the working memory into the long-term memory, and is highly important due to its significance towards how well something is remembered. Below are some of the different encoding and processing methods that are well-known and well-used.

4.2.1 Rehearsal

Referring back to the modal model, rehearsal is the process in which information is kept in the short-term memory, usually through constant repetition. Maintenance rehearsal usually employs the process of constant repetition and recycling information, but it is considered a more shallow method of encoding as the information is usually kept active for only a short amount of time, and decays quite rapidly once repetition is ceased. Elaborative rehearsal is a more meaningful mode of encoding, in which to-be-learned information is given meaning by being related to previously learned information. Though this form of rehearsal uses more cognitive resources, it is better for long-term retention and makes use of deeper encoding activities [22] .

4.2.2 Elaboration

Several elaborative encoding strategies exist, all which make new information easier to process or remember. One well-known and most-used elaborative encoding strategy is the mnemonic, a process which engages more sophisticated coding by pairing together new information with well-known information. This strategy typically makes use of rhymes, hand gestures, acronyms, the first-letter method, and many others [23]. Other strategies include mediation, a simple strategy of connecting a new piece of information to something more meaningful, and imagery, which involves tying together a corresponding image to something to be remembered [24].

4.2.3 Levels of Processing Theory

Influential constructivist views, especially theories from Craik and Lockhart, remain significant to this day. Their levels of processing theory is most reputable. According to this theory, students benefit most from performing cognitive analyses on the to-be-learned information— memory of the information is retained naturally after these processes. However, the retention of the information is highly based on the methods in which it was processed. According to theory, the more deeply the information is processed and the more meaning is given to the information, the better it is retained, while shallower processing of more superficial details tends to make the information forgotten much faster [25]. It is theorized and widely proven that participation in more meaningful, rather than mundane tasks,

22 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
23 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
24 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
25 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

helps students to better remember the information learned. Providing students agency and choice is also beneficial towards retention, as studies done by Jacoby and many others show how having students make decisions (especially difficult ones) recall more of the task than if they made simpler decisions, or none at all [26].

4.3 Long-Term Memory and Learning

Most learning goals target the long-term memory, which is supposedly limitless and retains a significantly higher amount of information than the short-term memory. The text will now discuss concepts related to the long-term memory and their benefits towards enhancing the encoding processes of learners.

4.3.1 Higher Encoding Processes

Higher encoding processes are typically activated when one encodes more complex information, and higher encoding processes usually help more towards higher educational/learner goals [27]. As shown above, students tend to perform much better the more elaborately they encode the to-be-learned information. Through methods such as activating prior knowledge and guided peer questioning, instructors can activate relevant **schemata** in students and provide opportunities for comprehension and asking thought-provoking questions. Activating prior knowledge helps to prepare learners for new learning activities: a base of already-known information can help to guide the new to-be-learned information [28].

4.3.2 Metacognition

Introduced by Flavell in the 1970's, **metacognition** remains one of the most important and most complex cognitive processes today. Generally defined, metacognition means "thinking about thinking", but also means the ability to self-regulate, according to the knowledge of the ways in which one thinks [29]. One of the best examples of metacognition is when a learner plans, monitors and evaluates different or specific strategies according to the knowledge of which would work better for them, based on how they think [30]. Having **conditional knowledge**, the knowledge of when and why to use particular strategies, aids in the planning, monitoring and evaluation stages [31]. Metacognition is a skill that is developed over time, as research shows that younger children and preadolescents tend to lack these skills, and is different based on each individual [32].

26 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
27 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
28 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
29 Woolfolk, A., Winne, P. H.. & Perry, N. E. (2016). Educational psychology (Custom ed. for Simon Fraser University). Pearson Education. 190.
30 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
31 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education
32 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education

4.4 Implications for Instructors

Enriching students' long-term memory should be the goal of all instructors. To do that, it is beneficial for instructors to know the framework of both short and long-term memory and the best types of encoding processes between each. For short-term retention, instructors can encourage students to practice certain tasks until they gain automaticity, and can guide students in learning attention-filtering strategies, such as focussing less on extraneous information and more on the essential parts of the learning task to avoid cognitive overload [33]. For long-term retention, instructors should begin by teaching students a variety of strategies, and then encouraging metacognition. As much as possible, instructors should involve students more in their learning to encourage active, rather than passive learning.

4.5 Building Blocks of Cognition

The "building blocks of cognition" are five mental constructs hypothesized by many theorists that work together to form the foundation of all of the mental frameworks and information that is stored in the long-term memory (LTM) [34] . Although many of these concepts may, in fact, share similar features, each is slightly different than the next. The first three concepts that we will examine are linked closely to declarative knowledge, and the last two fall closely in accordance with procedural knowledge [35].

4.5.1 Concepts

What are Concepts? To begin, we will first examine **concepts**. Concepts theorized to be ways of which we break down and categorize mental structures into relatively elemental chunks and groupings with meaning that then can be used to make sense of any new incoming information [36]. They are deemed to be "conceptually coherent chunks of knowledge" that can be triggered and called upon when one is prompted to retrieve information, and they are closely related to declarative knowledge [37]. Concepts that are based off highly common/prominent events are called **prototypes** [38]. It is believed that concepts, along with the other four components of the "building blocks of cognition", work together to formulate the foundations of what we know to be long-term memory, supporting the acquisition and

33 Woolfolk, A., Winne, P. H.. & Perry, N. E. (2016). Educational psychology (Custom ed. for Simon Fraser University). Pearson Education. 169.

34 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

35 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

36 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

37 Khajah, M. M., Lindsey, R. V., & Mozer, M. C. (2014). Maximizing students' retention via spaced review: Practical guidance from computational models of memory. Topics in Cognitive Science, 6(1), 157-169. doi:10.1111/tops.12077

38 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

development of language functions, factual knowledge, and object recognition; many of the very core aspects of long-term memory [39]. doi:10.1523/JNEUROSCI.6241-11.2012

What are Concepts composed of? There are two main theories that are considered with regards to how conceptual development occurs [40]. First, some theorists believe that concepts are abstract, mental structures in the brain, which are formed separately from the sensory-motor systems from which the information in these structures is received [41]. In contrast, the other main theory, which has been supported by neuroimaging technologies (such as the **fMRI**), is that concepts are formulated in accordance with the sensory-motor component and that they are stored within long-term memory as multi-modal structures [42]. There are three widely agreed upon categories of which we sort our conceptual information into; matter, processes and mental states [43]. **Matter** refers to just that, matter. Matter is any physical object in our world that has a mass and occupies space, such as people, animals, furniture, or objects [44]. Processes are slightly more abstract. The idea of conceptual processes refers to the idea that we store mental information pertaining to a series of interrelated events that occur of which we would expect to see a particular result [45]. An example of processes would be understanding that when you drop something from any height, the forces of gravity will not allow for it to be suspended in space and will act upon it to bring it back down to the earth. Finally, concepts can be arranged into our knowledge of mental states, which is a category essentially designated for internal states and emotions, such as recognizing when you feel upset, happy, or unsure about another person or a situation.

How do we formulate Concepts? There are also three possible ways accepted by professionals pertaining as to how we develop and formulate our concepts. First is the conservative focusing strategy, proposed by Bruner et al. Individuals who use this strategy are able to select appropriate stimuli according to the relevant attributes surrounding the concept of which they are confronted with [46]. Other individuals favour the focus gambling strategy, where it is believed we gain all of the knowledge we need about a stimulus at a single period

39 Bonner, M. F., & Grossman, M. (2012). Gray matter density of auditory association cortex relates to knowledge of sound concepts in primary progressive aphasia. The Journal of Neuroscience, 32(23), 7986-7991.

40 Bonner, M. F., & Grossman, M. (2012). Gray matter density of auditory association cortex relates to knowledge of sound concepts in primary progressive aphasia. The Journal of Neuroscience, 32(23), 7986-7991. doi:10.1523/JNEUROSCI.6241-11.2012

41 Bonner, M. F., & Grossman, M. (2012). Gray matter density of auditory association cortex relates to knowledge of sound concepts in primary progressive aphasia. The Journal of Neuroscience, 32(23), 7986-7991. doi:10.1523/JNEUROSCI.6241-11.2012

42 Bonner, M. F., & Grossman, M. (2012). Gray matter density of auditory association cortex relates to knowledge of sound concepts in primary progressive aphasia. The Journal of Neuroscience, 32(23), 7986-7991. doi:10.1523/JNEUROSCI.6241-11.2012

43 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

44 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

45 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

46 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

of time, all at once [47]. Individuals who choose to follow this strategy will, in fact, take less time to attribute a stimulus than those who chose conservative focusing strategy, however, they will be more likely to make mistakes as they are making their attributions out of speed, not thoroughness [48]. The final possible strategy one can utilize is called scanning strategies, where individuals will attempt to put multiple hypotheses to the test at one given time [49]. Although this is also a time-efficient strategy for attributing stimuli, the testing of these multiple hypotheses is ultimately a greater cognitive demand than testing one at a time, and thus can detrimentally impact an individual's abilities to process and remember information [50].

4.5.2 Propositions

Propositions are the mental concepts of which most theorists widely believe that we store linguistic information and the majority of our declarative knowledge [51]. Propositions are known to be the absolute shortest statement to of which meaning can be attached, yet are inherently more complex than concepts as they build upon the preexisting concepts in order to form meaningful statements and assertions how these particular concepts are related [52]. In order to be a proposition, the statement made must be able to be judged to be either true or false (in other words, a declarative statement of knowledge) [53]. It is believed that propositions sharing common characteristics or qualities are linked together within propositional networks, that can be activated through the encoding or **retrieval** of information related to a specific proposition [54].

4.5.3 Schemata

What are schemata? Schemata's are believed to be mental representations of an individual's general cause and effect knowledge [55]. Any and all knowledge that we gain is organized in the schema, which is responsible for the subsequent encoding, storage and retrieval of

47 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

48 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

49 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

50 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

51 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

52 Remue, J., De Houwer, J., Barnes-Holmes, D., Vanderhasselt, M., & De Raedt, R. (2013). Self-esteem revisited: Performance on the implicit relational assessment procedure as a measure of self- versus ideal self-related cognitions in dysphoria. Cognition and Emotion, 27(8), 1441-1449. doi:10.1080/02699931.2013.786681

53 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

54 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

55 Jui-Pi Chien. (2014). Schemata as the primary modelling system of culture: Prospects for the study of nonverbal communication. Sign Systems Studies, 42(1), 31-41. doi:10.12697/SSS.2014.42.1.02

information [56]. Schemata's are formed through the interaction of the external conditions and the individual's own prior knowledge [57]. They have been compared to the mental equivalent of **scaffolding**-meaning the schema that we form will provide supports for us when we find ourselves in novel situations or learning new information [58].

How are schemata formed? Possessing pre-existing schematic knowledge on a certain topic has been linked to improved memory on retaining new information when attempting to recall newly encoded information [59]. This is believed to occur as it allows for new information to be more rapidly assimilated into the brain (and thus into the activated schema) [60]. The information that is encoded in our schema is sorted into what are known as slots; specific mental "categories" of sorts, into which our knowledge is encoded, stored, retrieved and ultimately how it is perceived overall [61]. When a schema has developed and has been proven to be a common occurrence of events or concepts, it will then likely become a part of our long-term memory where it will continue to serve as the foundation for our recollections and any future schematic information that may be encoded [62]. This process is termed schematic instantiation [63].

4.5.4 Productions

Productions are "if/then" statements that serve as a set of action rules, which govern all of our procedural knowledge [64]. They are instantaneous, automatic mental concepts that are learned to be second nature to humans after repetitive exposure to a common sequence of events [65]. They provide a set of production rules and expectations for these events, and, like propositions, are organized in interactive groups known as production networks [66] .

56 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

57 Le Grande, M. R., Elliott, P. C., Worcester, M. U. c., Murphy, B. M., Goble, A. J., Kugathasan, V., et al. (2012). Identifying illness perception schemata and their association with depression and quality of life in cardiac patients. Psychology, Health & Medicine, 17(6), 709-722. doi:10.1080/13548506.2012.661865

58 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

59 van Kesteren, Marlieke T. R., Rijpkema, M., Ruiter, D. J., Morris, R. G. M., & Fernàndez, G. (2014). Building on prior knowledge: Schema-dependent encoding processes relate to academic performance. Journal of Cognitive Neuroscience, 26(10), 2250-2261. doi:10.1162/jocn_a_00630

60 van Kesteren, Marlieke T. R., Rijpkema, M., Ruiter, D. J., Morris, R. G. M., & Fernàndez, G. (2014). Building on prior knowledge: Schema-dependent encoding processes relate to academic performance. Journal of Cognitive Neuroscience, 26(10), 2250-2261. doi:10.1162/jocn_a_00630

61 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

62 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

63 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

64 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

65 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

66 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

Often by activating one production, other productions will be triggered, reacting in a series of cognitive processes and actions until the ultimate goal is accomplished [67].

4.5.5 Scripts

Scripts are the mental concepts that work as the underlying framework for all our procedural knowledge [68]. It is commonly agreed that scripts are vital to our social understanding of the world around us, and largely work to provide information governing social situations and events, specifically who does what, when do they do it, to whom do they do it to and why [69]. Scripts develop over time and with continuous exposure to reoccurring events that are all essentially similar in nature [70]

4.5.6 Implications for Instruction

It is incredibly important for all educators (currently employed and future alike) to ensure that they are knowledgeable about each individual component of the building blocks of cognition, and how all of these mental concepts work together to facilitate learning, acclimation of knowledge and development, in addition to retrieval and the retrieval processes. By doing so, they can ensure that all of their students are fully utilizing these metal processes (such as by teaching "review lessons" prior to the new curriculum in order to activate pre-existing productions, schemata propositions to facilitate the encoding of the new information, as well as prepping for an easier retrieval later on) in order to reap all of the benefits out of their education. By obtaining knowledge about the inner workings of these mental processes, educators will be able to better understand how learning occurs and how best to assist their students while encoding novel stimuli and information.

4.6 Changing and Growing Theories of Memory

4.6.1 Modal Model

Before other models were developed, the **Modal Model** was the primary model used for understanding memory. This understanding compares human memory to the processing performance of a computer in its simplicity and step interpretation of memory. Understanding this model of how memories are absorbed, understood, retained and regurgitated helps to understand alternative models, as this emphasis is common among the majority of theories. Another main difference in theories will be showcased in the understanding of

67 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

68 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

69 Trillingsgaard, A. (1999). The script model in relation to autism. European Child & Adolescent Psychiatry, 8(1), 45. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=4689586&site=ehost-live

70 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

short-term and/or working memory in comparison to long-term memory; primarily in areas of storage and understanding.

The idea of short-term memory, as it is understood as memories or bits of information that is stored for a short period of time, has evolved into the idea of working memory, "the ability to internally maintain and manipulate information" [71]. This is not to say that items considered 'working memory' can not be held in long-term storage. A good example of this would be your ability to ride a bike; despite this being a working, functional knowledge after years of not riding bike, it would be uncommon for someone to hop on a bike again and simply tip over. Some obvious exceptions to this may be in the case of mental illnesses, including those that can develop like Alzheimer's and dementia, mental trauma; PTSD, and physical trauma; specifically, but not limited, to brain damage and also serious injuries including amputation.

The modal model would have you believe that everything flows neatly together, with sensory and working memory flowing neatly into long-term memories, though as we do not remember everything we have come to contact with, (seen, smelt, done, etc) it is clear that there is more going on that contributes to memory retention. Some of the other models that will be discussed in this section contain a more dynamic understanding of the memory input/output processes, though all understanding will evolve as new information is gathered and comprehended. Due to this fact, models of memory and how learning takes places are constantly being adapted and amended to new knowledge, becoming more comprehensive and flexible as concepts become more inclusive. As a note to the reader, it is important to also consider the backgrounds of the participants of any research study as this can affect what knowledge will be viewed as important but also what pre-existing schemas are involved in their learning.

4.6.2 ACT Model

Where the network model can be taken visually, the **ACT Model** is much more comprehensive. This broad framework encompasses declarative and procedural knowledge into its outline; building off the standard model of the modal model framework. The ACT model's latest revision, ACT-R uses schema and categorization structures to represent declarative knowledge, whereas procedural knowledge is categorized by 'production'. These 'production rules' specify the actions needed to complete the given goal; like an electrician who fixes a light and uses practical application along with their textbook knowledge to explain how it works. These two areas are closely related as declarative knowledge provides the situation or context and procedural knowledge provides the rules to solve it.

Some key terms to know under the ACT model are **spreading activation** and **focus units**; where spreading activation refers to activity in long-term memory, and focus units are where this activation starts, either with perception, or working memory which then activates elements that would be chunked together with that first focus unit. An example of this could be watching a weather report: despite the forecast saying sunny, related items like rain, snow and the seasons may also be activated in your memory. This functions on

71 Wei, Ziqiang, Xiao-Jing Wang, and Da-Hui Wang. "From Distributed Resources To Limited Slots In Multiple-Item Working Memory: A Spiking Network Model With Normalization." The Journal Of Neuroscience 32.33 (2012): 11228-11240. PsycINFO. Web. 1 Mar. 2016.

the basis of prior knowledge, so the more prior knowledge one has to reference could lead to more items being activated with the initial focus unit. This prior knowledge can come from long-term memories or working memory, as they have a great deal of overlap.

With this theory, **Nodes** are references as points of information, so, back to the weather example, if a student was asked about 'sunshine' this information could easily connect to a second node containing 'summer', but the connection to 'sleet' may not be immediate. To reach this node the teacher could rephrase the question or offer hints like sensory information to aid the information retrieval processes as those pathways are forming. Information that the student knows well will have more available pathways tying information together than a new subject. The stronger the node is and the more prior knowledge that exists, will lead to superior recall than without the connections made. Due to the broad scope that this model has to offer, it has been used and adapted to be used in accordance to problem solver, cognitive processing and decision making; meaning it has a greater validity that just with ideas of memory and its future application possibilities in cognitive research are varied.

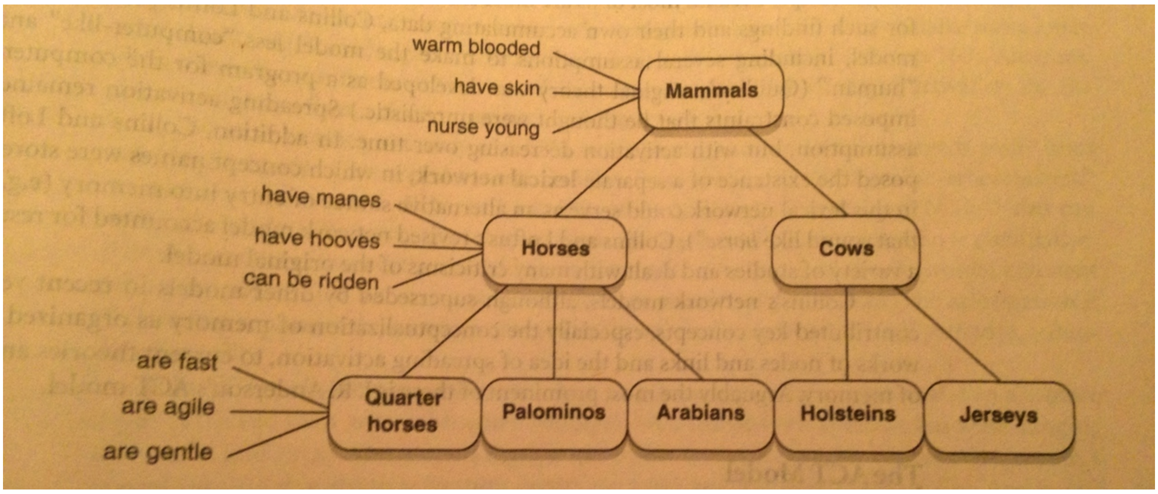


Figure 15 An example of a network model, taken from *Cognitive Psychology and Instruction*

4.6.3 Network Models

To start off the discussion of models, Network Models could be compared to mind mapping or a brain-storming web as information is represented by a web-like pattern, generally moving from the general to more specific information or categories. This would be similar to the way in which a small child would slowly differentiate between different animals that have four legs and fur, learning that a dog and cat have different classifications. Networking models are one of the more simple ways to organize small units of information when they related within the topic to other pieces. This model has been used directly in teaching, finding that "Mind mapping directed the students' attention to plan, monitor, and evaluate their learning processes, which helped them to obtain metacognitive knowledge and transfer their understanding to solve novel problems and situations” [72]

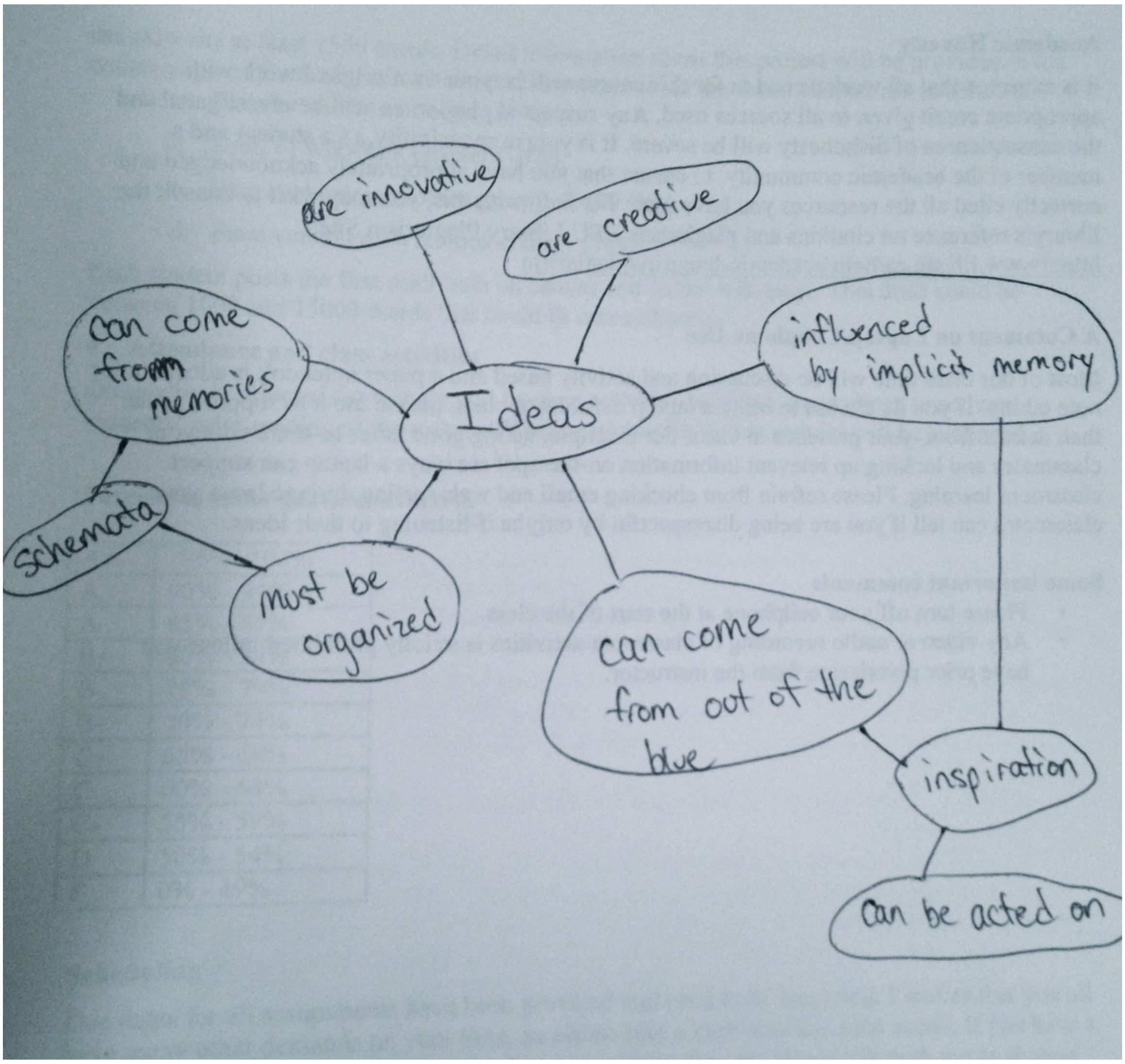


Figure 16 A general model of what a connectionist model might look like

4.6.4 The Connectionist Model

The Connectionist Model is a ‘brain metaphor’ taking on the traditional computer metaphor used for information processing, storage, and retrieval model; also referred to as the parallel distributed processing model. This model includes the concept of understanding based on context; an example of this would be having a shape with a straight line on the left, with a ‘3’ shape on the right. In the series ‘12 |3 14’ this would be seen as the number

72 Ismail, M. N., Ngah, N. A., & Umar, I. N. (2010). The effects of mind mapping with cooperative learning on programming performance, problem solving skill and metacognitive knowledge among computer science students. Journal Of Educational Computing Research, 42(1), 35-61. doi:10.2190/EC.42.1.b

thirteen, but in the sequence ‘ A |3 C’ it can be read as the letter ‘B’. It is because of the adaptability to context and ability to combined cognitive tasks with a physical attribution that the connectionist model was developed to better encompass these dynamics. This theory looks at the human thought processes from a multitude of parallels as the human brain is able to consider multiple thought directions in a time in a way that a computer wouldn’t think to compare of connect. As mentioned previously, other models have a store-retrieval aspect of recovering information where the pattern of information connections is stored and recovered when needed. Alternatively, the connectionist model theorizes that the elements of the pattern or connections are stored as their single units, along with the strength of their connections, to be retrieved and reconnected. On this topic Vickers and Lee had an important point, that “ connectionist accounts of semantic or meaningful information are based on conceiving of meaning as activation of a limited number of features, at least at the input layer” [73], stating that this theory works best if the information has depth over just memorizing facts.

4.6.5 Assessment of the functions of Long-Term Memory

Just to re-cap, long-term memories can be broken into semantic and episodic memory systems. Semantic memory is described as “memory for general concepts and principles and the associations among them” [74]. This area of memory contains simple working knowledge, like how to operate the appliances in your home, as well as how concepts and words connect. Knowing what a word means or how to get to school is all carried out by semantic memory. Episodic memory is more personal in function, as it is involved in remembering events and past experiences. These memories are associated with a specific time and/or place and are unique to the individual, meaning that even though two people were at the same party, at the same time, in the same place, they could leave with very different episodic memories of the event.

Memories gathered over a longer period of time have a greater chance of being retained long-term, but the quality of the memory is just as important as quantity. Quality can refer to sensory information being gathered by the individual during the experience, like smelling popcorn at the movie theatre, and can have a bidirectional relationship between quality components, like smelling popcorn and thinking of the movies or being at the movies and remembering the taste of popcorn. Although perceptuo-motor mechanisms have been found to be connected the quality of memory, as they are typically associated with the activation of neuronal systems that emerge from knowledge [75]. This mechanism refers to how far back centres of the brain search into prior knowledge for an answer: so, when shown a picture of tools, the brain has been proven to also activate sections containing the premotor cortex [76]

73 Vickers, Douglas, and Lee, Michael D. (1997). Towards a dynamic connectionist model of memory. Behavioral and Brain Sciences, 20, pp 40-41 doi:10.1017/S0140525X97460016

74 Bruning, R., & Schraw, G. (2011) by Bruning and Shaw. Cognitive psychology and instruction (5th ed.). Pearson Education.

75 Versace, R., Vallet, G. T., Riou, B., Lesourd, M., Labeye, E., & Brunel, L. (2014) “Act-In: An integrated view of memory mechanisms.” Journal of Cognitive Psychology Online, Volume 26, Issue 3. DOI: 10.1080/20445911.2014.89211

76 Versace, R., Vallet, G. T., Riou, B., Lesourd, M., Labeye, E., & Brunel, L. (2014) “Act-In: An integrated view of memory mechanisms.” Journal of Cognitive Psychology Online, Volume 26, Issue 3. DOI: 10.1080/20445911.2014.89211

The majority of research done in this field has to focus on self-evaluation or individual memory testing, both of which have fair parameters of error, though functional magnetic resonance imaging devices have been used to noninvasively view the activity of an individual's brain. An experiment was done, using this technique, by Anderson et al. to find the link between procedural execution, goal setting, controlled retrieval from declarative memory and image representation construct, and the brain's cortical regions. The findings of this experiment showed that each of these four areas lit up a different cortical region on the imaging device. This evidence seems to show that different areas of the brain handle these different areas, but critiques on the technique highlight that we still do not know why this activity occurs and what connections are being formed in the mind to cause the array of activity. Despite critique, experiments of this variety do give us greater insight into our brain activity than we previously had, and show just how different areas of information can stimulate different areas of the brain, so we know that it is not all active all the time.

4.7 Glossary

Assignment of meaning: When meaning is assigned to a perceived stimulus

Concepts: A way of sorting mental information into meaningful categories and structures; A "building block of cognition"

Conditional knowledge: Knowledge of different strategies and when and why to use them; The knowledge of "knowing why"

Declarative knowledge: Factual knowledge such as knowing capital cities and algebra formulas; The knowledge of "knowing what"

Episodic memory: Memory that is specific to each individual's personal experiences

Essential learning: Cognitive demands that are necessary for understanding the to-be-processed information

Extraneous cognitive load: Anything that causes cognitive load outside of the original cognitive task

fMRI: Functional magnetic resonance imaging. A neuroimaging technology that is able to monitor brain activity by detecting changes in blood flow to activated areas of the brain

Incidental processing: Cognitive demands that are useful for understanding the to-be-processed information, but not entirely necessary

Intrinsic cognitive load: The cognitive load required of any given task

Long-term memory: Memory that is developed over days, months, years and/or decades of time. The permanent accumulation of memory developed over a lifetime

Matter: Any physical object in our world that has a mass and occupies space, such as people, animals, furniture, or objects

Procedural knowledge: Knowledge of how to complete daily tasks, such as driving a car, skiing, or making coffee; The knowledge of "knowing how"

Prototype: An extremely common/prominent concept

Recall: When information previously stored in short- or long-term memory is remembered

Reconstruction: When information previously stored in short- or long-term memory is reconstructed at recall, but not remembered exactly

Referential holding: When one holds information temporarily within working memory while other information is simultaneously being processed

Rehearsal: Cognitive repetition which allows information to remain active in short- or long-term memory

Retrieval: The act of transferring information out of long-term memory and into working memory

Scaffolding: A temporary framework of supports while an object (or schemata) is "under construction" that is taken away when completed and the support is no longer needed

Schema or Schemata: Cognitive structure(s) that help organize knowledge and guide thinking, perceptions and attention

Semantic memory: Nonspecific memory of general concepts and procedures; Not related to specific individual events or experiences

Sensory register: A cognitive function within the working memory in which perceived input is stored to receive meaning

UNKNOWN TEMPLATE Bookcat

4.8 References

5 Encoding and Retrieval

Although learning is constantly happening in a multitude of settings, this text will focus on how learning can be improved in an educational context. **Learning strategies** are planned activities that a learner can engage in to learn more deeply and with better retention. Generally, a strategy is a plan of action to achieve a goal, and a learning strategy is a plan to enhance learning. In order for learning strategies to be successfully implemented, the learner must encode information in long-term memory. **Encoding** refers to the process of converting information in working memory to knowledge in long-term memory [1] Learning strategies can affect how well the learner encodes or constructs new knowledge and subsequently retrieves and uses it. In this chapter we will look at the process of encoding as well as a variety of learning strategies such as rehearsal, mnemonics, and the activation of prior knowledge.

5.1 Encoding Processes

We will discuss two key aspects of encoding. Firstly, we will look into the processes from which information is translated into memory, and secondly, the strategies which can be used to aid this process. A portion of information we attempt to learn is automatically encoded; the rest of the information (in order to be learned and stored) involves a conscious effort to transfer the information to the long-term memory. The way in which we remember information, and recall it from our memory, depends greatly on the way it was originally encoded.

5.1.1 Encoding Simple Information

The information we attempt to learn varies in complexity. Some information is simple (e.g., 'Sandra is 10 years old') while other information is more complex and requires critical thinking to be fully understood (e.g., a newspaper article about a political event). In most cases the complexity of the to-be-learned information will affect how the learner attempts to learn. Not all strategies are suitable for learning all types of information so it is important for the learner to be able to choose the right strategy. In the next section we will discuss strategies which can be used to remember simple information.

1 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.

5.1.2 Rehearsal

The first strategy, which can be applied to simple encoding, is **rehearsal**. There are several different types of rehearsal, which can be applied to different learning tasks. This concept can be perceived as students attempt to study for a test. **Maintenance rehearsal** is considered to be a shallow form of processing and is most beneficial in simple tasks such as remembering a phone number, but is generally not sufficient for remembering complex information. [2]. Maintenance rehearsal involves repeatedly focusing on a piece of information in order to keep in short term memory. It is not the most beneficial form of remembering information because during maintenance rehearsal information can be lost easily when the rehearsal process is interrupted. Since the information rehearsed often does not make it into long-term memory storage, the information cannot be recalled later on making it insufficient for encoding complex information. If the information only needs to be remembered in the present moment, maintenance rehearsal is an appropriate tactic but if the information is more complex or needs to be recalled later on, an elaborative rehearsal approach should be taken. **Elaborative rehearsal** involves relating the to be learned information to other information. Elaborative rehearsal is more successful in the encoding of complex information because it requires the learner to relate the new information to their existing knowledge, which helps build connections and strengthens understanding. Learners who relate new information to prior knowledge are more likely to remember information and be able to retrieve it later on [3]

5.1.3 Mnemonics

Mnemonics are strategies that can be applied when learning unfamiliar concepts; they can increase the probability that unfamiliar information will be encoded. Mnemonics involve pairing unfamiliar concepts with familiar concepts in an attempt to increase the chance a concept will be remembered. It involves recording information into a more easily remembered or more meaningful format. [4] Bruning et. al describes mnemonics as memory strategies that help people remember information by creating more elaborate coding of new information and stronger memory traces [5]Mnemonics can include familiar strategies such as stories, rhymes, and songs; many students have been taught to use mnemonics in their work without even being aware they are engaging in a mnemonic strategy. Common examples of mnemonics we use and learn in society include using the letters BEDMAS to remember the order of operations in completing a math equation, and ROYGBIV to remember the colours of the rainbow. These tactics are called **acronyms** and if you have ever used these words to cue your memory, you have engaged in a mnemonic strategy to aid the encoding and retrieval of simple information. Other mnemonic techniques, described in the next section, are the **keyword method**, **the pegword method**, and **acrostics**.

Although research suggests that mnemonics are widely used, theorists have questioned their value. A common criticism is that they only encourage rote memorization and do not help

2 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.
3 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.
4 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023
5 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.

with higher order skills such as comprehension or transfer order of skills. [6]There are also varying views about whether mnemonics promote long-term learning. Mnemonics prove to be useful in the memorization of simple information such as fact learning but have contradicting results whether they are useful in higher order learning skills. It is useful to note that mnemonics are purely designed to enhance recall and not facilitate higher order learning so criticisms surrounding their ability to assist in higher order learning my be irrelevant. [7]Mnemonics are designed to assist in remembering unfamiliar concepts and they are especially useful in lower level learning such as fact learning. Lower level learning in turn affects higher order concepts. Higher order learning can only be facilitated if an understanding of basic concepts is previously attained, so it is arguable that mnemonics in fact do affect higher order thinking. It can be argued that mnemonic strategies also promote long-term learning as most people remember the acronym for the colours of the rainbow for the majority or their life. Carney and Levin conducted a study to test the usefulness of mnemonic strategies through tests such as matching, recognizing and comprehension analysis measures. The results showed that the participants who used mnemonic strategies had significantly better results than students who used their own preferred methods.[8] Finally, mnemonics may have some positive non-memory side effects, such as increasing motivation to study. In one study, students reported on a survey that having acronyms on a review sheet made it easier for them to remember course content and made them start studying earlier. Other studies show that students think that some mnemonics are easier, faster, more enjoyable, and more useful than rote rehearsal and that mnemonics can reduce test anxiety. [9]Whether mnemonics strategies can be implemented to assist with long-term learning or learning past rote-memorization or not, they have some clear benefits. The next section will outline some mnemonic strategies, which can be used to aid in memory benefits.

5.1.4 1. The Keyword Method

The most popular mnemonic method is arguably the keyword method. The keyword method aids in the retention of vocabulary words, and vocabulary words in foreign languages. The keyword method involves localizing a keyword, or similar word to the foreign word in order to simplify it. Seeing the word associated word activates the unfamiliar word and primes the formation of an image in a learner's mind. The technique involves the learner focusing on a native language keyword that sounds similar to the to-be-learned word. For example, if the to-be-learned word is the Spanish word carta, the English-speaking learner could use the keyword cart and then construct a meaningful interaction between the keyword and the definition. The keyword method can be implemented by generating a sentence to link the keyword with the to-be-learned word, or by using an illustration or a visual image. [10]

6 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

7 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

8 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

9 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

10 Bakker, J., & Simpson, C. (2011). Mnemonic Strategies: Success for the Young-Adult Learner. Human Resource and Adult Learning, 7(2).

Some criticisms suggest that the keyword method might not be useful when there is not an obvious keyword [11]. On the other hand, it has been demonstrated in a study that two or three hours of training with the keyword method can lead to a 70% increase in recall with German language vocabulary; as a whole, it appears that the keyword method is very beneficial. [12]

5.1.5 2. The PegWord Method

In the pegword method, a list of concrete objects in a specific order is learned, and then visual imagery combines the to be remembered items with the peg items. Items can be retrieved by thinking of a number corresponding to a specific peg; the number can then cue the target item. An example of a way to implement the pegword method is to use words that sound like the corresponding number. One might be bun, two could be blue ect. [13] By associating information with each peg word in order, the to be learned information can be recalled later in the order of the pegs. An additional strategy of the pegword method involves correlating each letter of the alphabet with a number and using this coing system as a memory cue. [14]

5.1.6 3. Acronyms

Acronyms are a popular mnemonic strategy involving the first letters of a to be learned words list; the first letters of each word in the set are taken and put together to form a new word – called an acronym. For example, a commonly used acronym is remembering the colours of the rainbow as ROYGBIV. Each letter serves as a retrieval cue for the target items.

5.1.7 4. Acrostics

Acrostics are similar to acronyms but involve using a sentence to help remember a segment of letters rather than the other way around. The first letters of a list of words serve as the first letter in a new sentence or phrase. A commonly used acrostic is using the sentence "every good boy deserves fudge" to remember the lines of the treble clef. (E, G, B, D, F) (3)

5.1.8 Mnemonics Discussion

Despite some criticism surrounding the usefulness of mnemonics, they appear to be beneficial when applied the correct way. Mnemonics can be applied to help remember difficult concepts, but they should not be used in replace of primary study tactics. Mnemonics are

11 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

12 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

13 Spackman, C. (2011). Mnemonics and Research on Using the Keyword Method in the Classroom.

14 Spackman, C. (2011). Mnemonics and Research on Using the Keyword Method in the Classroom.

not to be implemented to help overall learning or to enhance comprehension, but strategies to aid the recall of new or difficult information. Research shows that students, including secondary and college level, remember two to three times as much factual information, maintain information over delayed recall periods, and enjoy using them. [15]In addition, the use of mnemonics with college age students might have enough potential for making learning easier and possibly more fun. Specific strategies for encoding can help in the retention of information and can possible lead to more successful comprehension. In order to encode a level of **deep processing** should be attained which will be discussed in the next section.

5.1.9 Encoding More Complex Information

Elaborative encoding uses known information and relates it to the new information being experienced. The nature of a new memory becomes dependent as much on previous information as it does on the new information. Studies have shown that the long-term retention of information is greatly improved through the use of elaborative encoding.[16]

5.1.10 Levels of Processing and Semantic Encoding

Craik and Lockhart's popular levels of deep processing theory suggest that the level to which an item is cognitively processed largely affects its memorability. [17]Their theory suggest that memory traces could be seen as records of analyses carried out for the purposes of perception and comprehension, and that deeper, more semantic, processing result in more durable traces. [18] **Semantic encoding** refers to encoding the meaning of a concept and can lead to a deeper level of understanding and a higher chance of successful encoding. Typically, items encoded using semantic operations are better remembered in a subsequent memory test than items encoded using shallow operations at any level of depth. [19] On the one hand if semantic base or meaning of the new information is the focus of processing, then the information will be stored in a semantic memory code and will be well remembered. On the other hand, if only superficial or surface aspects of the new information are analyzed, the information will be less well remembered and not deeply encoded. [20]In Craik and Lockhart's terms, memory depends on depth or processing. A typical observation in experimental as well as everyday life settings is that if we learn an item using semantic or operations, such as attending to its meaning, memory will be better than if we learn the same item using

15 Putnam, A. L. (2015). Mnemonics in education: Current research and applications. Translational Issues In Psychological Science, 1(2), 130-139. doi:10.1037/tps0000023

16 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.

17 Galli, G. (2014). What makes deeply encoded items memorable? Insights into the levels of processing framework from neuroimaging and neuromodulation. Frontiers In Psychiatry, 5doi:10.3389/fpsyt.2014.00061

18 Nyberg L. Imaging episodic memory: Implications for cognitive theories and phenomena. Memory [serial online]. September 1999;7(5-6):585-597. Available from: PsycINFO, Ipswich, MA. Accessed December 7, 2015.

19 Galli, G. (2014). What makes deeply encoded items memorable? Insights into the levels of processing framework from neuroimaging and neuromodulation. Frontiers In Psychiatry, 5doi:10.3389/fpsyt.2014.00061

20 Galli, G. (2014). What makes deeply encoded items memorable? Insights into the levels of processing framework from neuroimaging and neuromodulation. Frontiers In Psychiatry, 5doi:10.3389/fpsyt.2014.00061

more “shallow” operations, such as attending to its structural features. [21]Deep processing is seen as that processing centered on meaning. **Shallow processing** refers to keying on superficial aspects of new material. An example of a shallow processing technique is highlighting words in a passage whereas reading a passage and putting it into your own words would be practicing deep processing. Putting an essay into one’s own words requires thinking about the meaning of the content and carefully analyzing and comprehending the material. In general, theorists agree that deep encoding results in more elaborate memory traces, and that this in turn affects later memorability. [22]

5.1.11 Activating Prior Knowledge

Prior Knowledge includes the pre-existing knowledge a student possesses surrounding a particular topic. A base of prior knowledge is beneficial for successful learning because prior knowledge facilitates encoding and guides what students recall from new information. Van Blankenstein et al. reported that students who activated prior knowledge before self-study were able to recall more information after the study session was completed compared to students who did not activate prior knowledge.[23] The activation of Prior knowledge includes various methods which are designed to stimulate student’s relevant knowledge in preparation for a new learning activity. [24] The activation of prior knowledge allows students to engage in the material by relating the to-be-learned information to information they are already familiar with which allows them to make inferences and connections. Students who active prior knowledge before engaging in learning encode more information than students who activate irrelevant knowledge showing that the activation of prior knowledge improves recall of information [25] Prior knowledge is a simple and effective learning strategy because it involves any teaching procedure that helps students relate what they already to know what they are to learn. The knowledge activation can take place in the form of group discussions, experiments, review sessions or personal reflections making is a convenient and effective learning strategy. The activation of prior knowledge is successful for the learner because relating information to personal experiences heightens the possibility that the information will be remembered. Information is more likely to be elaborated or recalled in the future if the learner has made a connection to it, rather than if the learner has no previous information or understanding. Students at any age are able to engage in prior learning which makes it beneficial to the encoding and retrieval of information.

21 Galli, G. (2014). What makes deeply encoded items memorable? Insights into the levels of processing framework from neuroimaging and neuromodulation. Frontiers In Psychiatry, 5doi:10.3389/fpsyt.2014.00061

22 Galli, G. (2014). What makes deeply encoded items memorable? Insights into the levels of processing framework from neuroimaging and neuromodulation. Frontiers In Psychiatry, 5doi:10.3389/fpsyt.2014.00061

23 Van Blankenstein, F. M., Dolmans, D. M., Van der Vleuten, C. M., & Schmidt, H. G. (2013) Relevant prior knowledge moderates the effect of elaboration during small group discussion on academic achievement. Instructional Science, 41(4), 729-744. doi:10.1007/s11251-012-9252-3

24 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.

25 Van Blankenstein, F. M., Dolmans, D. M., Van der Vleuten, C. M., & Schmidt, H. G. (2013). Relevant prior knowledge moderates the effect of elaboration during small group discussion on academic achievement. Instructional Science, 41(4), 729-744. doi:10.1007/s11251-012-9252-3

5.2 Retrieval Processes

Retrieval processes are the means by which memories are recalled from long-term memory.

5.2.1 Retrieval

The process of retrieval is a complex but essential process, which involves converting memories into conscious experience.[26] Many concepts can affect the efficiency of retrieval such as the environment present at the time of retrieval and the learner's study tactics. For example, whether the learner studied information for recognition or recall plays a large part in how well information is remembered. Empirical evidence suggests that students who expect recall tests which are primarily essay based focus on the organization of information. On the other hand, students who anticipate multiple choice recognition tests focus on separating concepts from one another. [27] A theory which can improve a students retrieval efficiency is Roediger et. al's testing effect. The testing effect involves using tests related to material being studied to attempt to improve overall learning for a final test.[28] A study conducted on the benefits of retrieval practice, or the testing effect examined whether the benefits of retrieval practice could transfer to deductive inferences. The results showed that the testing condition produced better final-test recall of the content but multiple choice recognition questions showed no enhancement from the application of the testing effect. [29] Most teaching occurs through direct instruction and tests are only implemented to measure progress and determine grades. The testing effect shows that tests can be used as a learning strategy to improve encoding and retrieval of information.

5.3 KWL Comprehension Strategy

The Know-Want-Learn (KWL) strategy was first formed by Donna Ogle in 1986. Ogle first put the program together as a way of helping teachers make learning a more student guided process. The KWL was originally made to be used to increase reading comprehension, but has since been found to be helpful in many areas of study [30].

The KWL relies on constructivist theories of information activation and recall. The different steps of the strategy (Know, Want, Learned) activate students prior knowledge, help students recognize their current schemas, and links newly learned information with old, solidifying and strengthening this information. The KWL relies on students constructing their own meanings of what they know [31], and teaches them to be more interactive in their

26 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.
27 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.
28 Bruning, R., & Schraw, G. (2011). Cognitive psychology and instruction (5th ed.). Pearson Education.
29 Tran, R., Rohrer, D., & Pashler, H. (2014). Retrieval Practice: The Lack of Transfer to Deductive Inferences. Psychonomic Society. Retrieved December 1, 2015.
30 Ogle, D. (1986) K-W-L: A teaching model that develops active reading of expository text. Reading Teacher, 39(6), 564-570. http://dx.doi.org.proxy.lib.sfu.ca/10.1598/RT.39.6.11
31 Tok, S. (2013). Effects of the Know-Want-Learn strategy on students' mathematics achievement, anxiety and metacognitive skills. Metacognition and Learning, 8(2), 193-212. http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11409-013-9101-z

learning experience. The KWL also teaches students to recognize what they don't know about a topic, which is a beneficial skill for learning. Through the steps of identifying what they know, what they want to learn, and what they have learned, the KWL teaches students how to be active and take charge of their own learning.

5.3.1 Know-Want-Learn Chart

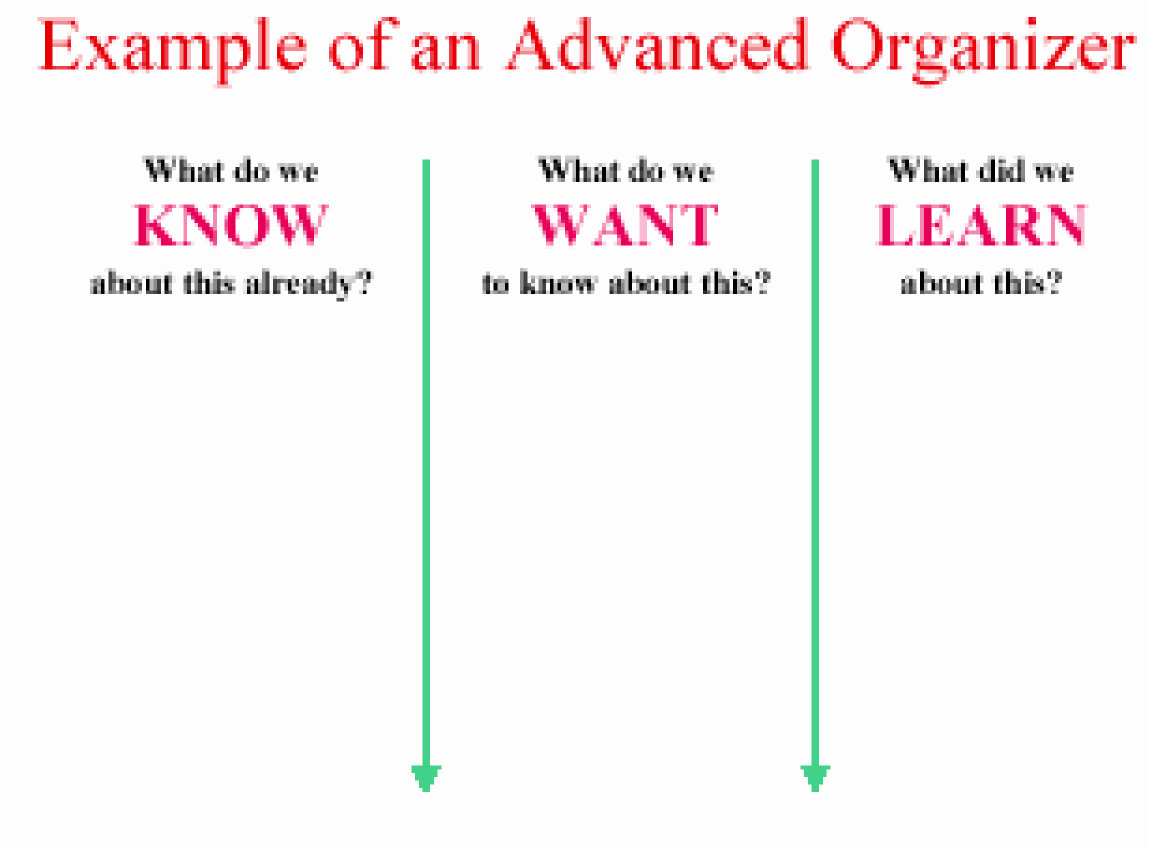


Figure 17 Kwlimage2

The KWL strategy is often represented in the form of a KWL chart. This tool is implemented and used in instruction in the form of a three step procedure:

1. "What do I know?"

The first procedure in the KWL is the "Know" phase. Before new information is brought into the classroom, students are asked to recall what they already know about a specific subject. This step is a collaborative one between the teacher and the student, in which the students brainstorm information about what they know as a group, and the teacher records this information in the first section of the chart [32]. The teacher's role in this portion of the strategy is not to correct students if what they believe they know about a subject is wrong,

32 Tok, S. (2013). Effects of the Know-Want-Learn strategy on students' mathematics achievement, anxiety and metacognitive skills. Metacognition and Learning, 8(2), 193-212. http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11409-013-9101-z

but rather to guide the brainstorm and stimulate thinking. This portion of the procedure works to activate the prior knowledge and any previous schemas students may have.

After what the students know has been recorded in the chart, they are then asked if they can organize this information into logical categories. This step works to chunk information and link ideas together. Once students learn to make information categories, this skill can be applied to all areas, aiding in their formation of schemas and reading comprehension [33].

2. "What do I want to learn?"

The second procedure in the KWL is the "Want" phase. After prior knowledge is activated, and what students already believe they know about a subject is recorded in the first section of the chart, students are then asked what they want to learn about a subject. This step furthers the brainstorming process because it requires learners to think deeper about what they know, recognize what they don't, and identify what interests them. Asking what students want to learn also acts as a way to get learners personally involved in the process. This step functions to inspire students, and spark their interest in the subject.

3. "What have I learned?"

The last step in the KWL procedure is the "Learned" phase. After the new information is presented, students are asked to think about they have learned during the lesson. This step requires students to reflect and think about the new information they have been presented with. It is in this step, when the new information that was learned is recorded in the final column of the chart, that any previous incorrect knowledge that may be contradicted by the new, is recognized and corrected by the students. By presenting all of the information visually, students are able to see and link new concepts with their prior knowledge, which aids in deepening their understanding of what they have just learned.

The KWL strategy has been found to be effective and helpful in all grades and subjects [34]. The strategy is easily adjustable to fit multiple age groups, and works effectively to reinforce new information with old. Longer, more demanding lessons can be divided and reflected upon in smaller chunks to minimize cognitive load and difficulty.

5.3.2 Research and Feedback

Although the KWL strategy was originally formatted as a learning comprehension tool, researchers have found the KWL approach to be beneficial to learning and comprehension in several different areas of study. After implementing KWL, increased academic achievement has been reported in areas of learning such as reading, math, science, language, and the development of metacognitive skills [35].

33 Ogle, D. (1986) K-W-L: A teaching model that develops active reading of expository text. Reading Teacher, 39(6), 564-570. http://dx.doi.org.proxy.lib.sfu.ca/10.1598/RT.39.6.11

34 Ogle, D. (1986) K-W-L: A teaching model that develops active reading of expository text. Reading Teacher, 39(6), 564-570. http://dx.doi.org.proxy.lib.sfu.ca/10.1598/RT.39.6.11

35 Tok, S. (2013). Effects of the Know-Want-Learn strategy on students' mathematics achievement, anxiety and metacognitive skills. Metacognition and Learning, 8(2), 193-212. http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11409-013-9101-z

When testing grade 6 math students in a research study, the data found that students who had undergone mathematic instruction with the KWL format delivered test scores with a statistically significant increase. This application of the KWL strategy resulted in increasing the academic achievement in the participants [36].

Teachers report positive effects when the KWL method is incorporated into their lesson plan. Teacher reports also include receiving notably positive feedback from the students who receive this tool [37]. Primary research continues to support the KWL as a learning comprehension strategy, and reports that it outperforms many other comprehension tools and it continues to be preferred by learners [38].

5.4 READS

READS for summer learning is a literacy reform program with the intention of enhancing child literacy. It is currently being run by the Project for Scaling Effective Literacy Reforms leader: James S. Kim, who is an Associate Professor at the Harvard Graduate School of Education.

READS addresses the problem of the literacy gap that children, especially those from lower-income families, obtain over the summer period while they are not in school [39]. READS works to minimize the development of this gap by encouraging and providing children with the opportunity to read over their summer break. READS works to motivate kids to continue reading, and therefore keep up their literacy comprehension, through the work of goals and prizes [40]. Another key component to the READS program is the involvement of parents. READS provides lessons to teach and encourage parents how to successfully scaffold their child's summer literacy journey so that positive progress is made during the program [41]. READS also relies on teachers and other mentors to provide assistance and literary intervention when they are needed.

5.4.1 READS Summer Program

Lessons

Prior to the summer program, children are provided with lessons on reading comprehension from a READS professional teacher. In these lessons, children learn how to understand

36 Tok, S. (2013). Effects of the Know-Want-Learn strategy on students' mathematics achievement, anxiety and metacognitive skills. Metacognition and Learning, 8(2), 193-212. http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11409-013-9101-z

37 Ogle, D. (1986) K-W-L: A teaching model that develops active reading of expository text. Reading Teacher, 39(6), 564-570. http://dx.doi.org.proxy.lib.sfu.ca/10.1598/RT.39.6.11

38 Tok, S. (2013). Effects of the Know-Want-Learn strategy on students' mathematics achievement, anxiety and metacognitive skills. Metacognition and Learning, 8(2), 193-212. http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11409-013-9101-z

39 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

40 Kim, J. S. (2004). Summer Reading and the Ethnic Achievement Gap. Journal of Education for Students Placed at Risk, Journal of Education for Students Placed at Risk, 9(2), 169-188.

41 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

what they are reading, and also how to find deeper meanings in what they are read. These skills are crucial for academic success. Children also establish a comprehension routine with their teacher, which they can implement over the summer.

Motivation

One of the ways READS tackles the issues of literacy among children is by addressing and inspiring the children's motivation. READS works to teach children how to have a positive relationship with books. One of the first, and important ways that children are motivated to read through the READS program is that their immediate access to books is greatly increased [42]. Children are provided with further reason to be motivated for reading during the summer when they are matched by professionals with books that are of their reading level and of their interest [43]. Supplying kids with books that are topics of interest provides **intrinsic motivation**, or personal motivation that comes from within, to continue their reading[44]. This also prevents kids from choosing books that are too easy or not the right fit for a literacy comprehension program [45].

The **extrinsic motivation**, or outside external motivation, to keep up with their summer reading is prizes. READS sends the participants 10 books to read over the summer, along with comprehension exercises to complete after the books are read. After the exercises have been filled out, they can be sent in for prizes. This works to both motivate the children to read, as well as work on practicing their comprehension skills[46].

Scaffolding

Family and teacher support is a big component of READS. Teachers help the children learn comprehension skills and routines, and parents provide their children with motivation and support throughout the summer to continue with the program. Parents are provided with scaffolding tips so that they can successfully play a role in their child's literacy efforts. Encouraging children to read, asking about the comprehension checks, engaging in conversation about the books, and sending the booklets back for prizes, are some of the ways in which the READS program teaches parents how to encourage their child [47].

5.4.2 Support and Research Findings

While the READS program claims to have found positive effects from their programs, the efficacy of these types of programs is still up for debate. Research findings for increasing reading comprehension through summer programs has been controversial. Some research

42 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

43 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

44 Kim, J. S. (2004). Summer Reading and the Ethnic Achievement Gap. Journal of Education for Students Placed at Risk, Journal of Education for Students Placed at Risk, 9(2), 169-188.

45 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

46 Kim, J. S. (2004). Summer Reading and the Ethnic Achievement Gap. Journal of Education for Students Placed at Risk, Journal of Education for Students Placed at Risk, 9(2), 169-188.

47 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

has found no difference between children who do voluntary reading, and later reading comprehension performance. Research studies have however, found a positive results from children who read and are provided scaffolding by teachers and parents, versus those who do not receive any support[48]. Other research studies have found a positive correlation between children who read during the summer, and their test scores in the fall. Increased access to books and other reading material has also been found to lead to positive reading outcomes for children [49].

48 Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

49 Kim, J. S. (2004). Summer Reading and the Ethnic Achievement Gap. Journal of Education for Students Placed at Risk, Journal of Education for Students Placed at Risk, 9(2), 169-188.

5.5 Highlighting

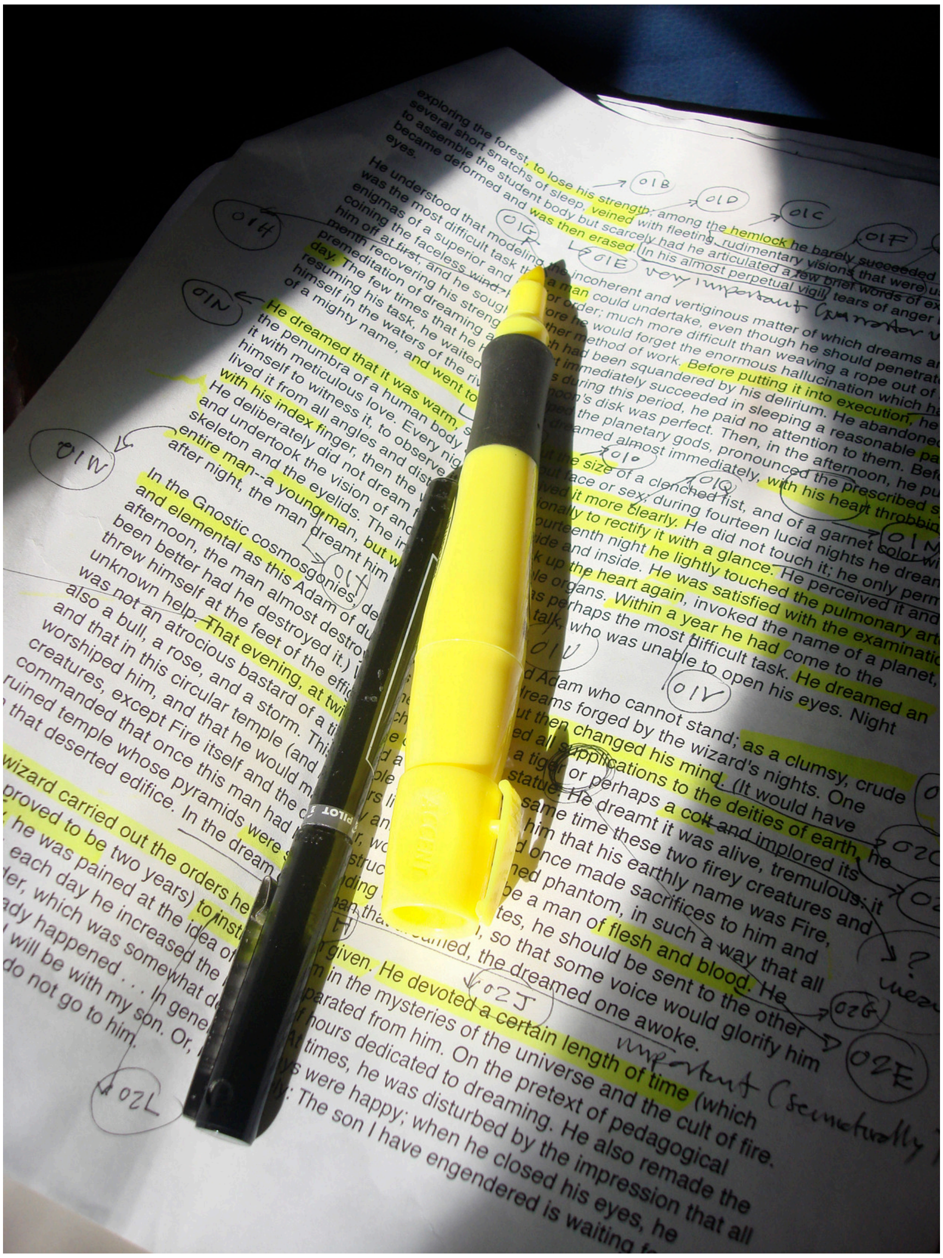


Figure 18 text highlighting

Highlighting text is one of the most common study strategies used by students. Highlighting involves selecting important text in a passage and marking it for later reference. Most of the time, when students use highlighting as a learning tactic, it is with the purpose to helping them with their future studying, when they intend to come back to the material at a later date[50].

When used appropriately, each step in the highlighting strategy can engage meaningful processing of text. Reading the text, activating prior knowledge, selecting important information out of the text, linking this information to prior knowledge and the previously read text, and constructing a representation of the text meaning all work to help better store and recall the information back later [51]. Each of these steps work to strengthen the encoding process, so that this information is more likely to be processed further in the working memory. Marking parts of sentences, or individual words, is a good way to keep the student's focus on the information that is important.

There are many different theories as to why highlighting may be beneficial to learning. The cognitive processes that are used and required when deciding which of the text should be marked amongst the text that shouldn't, could possibly result in students thinking harder about the material and using thinking strategies when evaluating it, which leads to deeper processing of the text meaning, versus just regular reading[52]. Actively choosing which text to mark, and which meanings are important in the information they are studying changes the way the student reads and re-reads the text, which can lead to it seeming more important, and therefore more memorable [53].

5.5.1 Research Findings and Opinions

While there are many hypothesis as to why the cognitive processes involved in highlighting may be beneficial to learning, research studies have shown conflicting results as to whether or not highlighting itself is helpful. Many studies have shown beneficial results from highlighting, while others have not [54].

One research study compared participants who read highlighted information with participants who read non highlighted information. The study found that the participants with highlighted information were better able to recall the information that was highlighted, as well as the information that was not highlighted, over the participants who had plain text. This finding was even stronger when participants read over the text two or more times

50 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

51 Den Elzen-Rump, V., Leopold, C., Leutner, D (2007). Self-regulated learning with a text-highlighting strategy: A training experiment. Journal of Psychology, 215(3), 174-182. `http://dx.doi.org.proxy.lib.sfu.ca/10.1027/0044-3409.215.3.174`

52 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

53 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

54 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

without delay. These findings suggest that combining highlighting with rereading may aid student's recall ability [55].

One of the research views opposing the helpfulness of highlighting argues that students do not know how to highlight information correctly, and that is why it is not beneficial to them. Because students do not know how to properly focus their attention on the text long enough to decipher what information is useful and the most meaningful, they end up highlighting information that they believe is important, but is actually not relevant [56]. This draws student's attention away from the important information, and acts more as a distraction, adding onto their cognitive load. Also, because students may be reading the information wrong and focusing on the incorrect parts, deeper processing is not possible and does not occur in a beneficial way [57].

Another view opposing the highlighting process states that highlighting may actually be a placebo effect[58]. In other words, students may believe highlighters are effective simply because they have always relied on them. This false belief can backfire when students become over confident and comfortable with highlighting, and don't give the process much thought. Students that are overconfident in their use of highlighting may also assume that they already know the information when they reread it, which can cause them to skim, resulting in a loss of deeper processing[59].

5.5.2 Application

Learning to highlight text properly requires high levels of reading comprehension, as well as other cognitive abilities such as problem solving techniques and critical thinking. Students must learn to identify what concepts are important, relevant and appropriate to the information they are learning. The process of highlighting a text should pose some difficulty to students in order to be beneficial, because by focusing your attention and thinking hard about what is important, you strengthen your chances of deeper encoding of the text meaning[60].

Five simple steps for approaching highlighting are: (1) familiarizing yourself with the general topic of the text, (2) reading each paragraph slowly and carefully, (3) identifying and mark-

55 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

56 Den Elzen-Rump, V., Leopold, C., Leutner, D (2007). Self-regulated learning with a text-highlighting strategy: A training experiment. Journal of Psychology, 215(3), 174-182. `http://dx.doi.org.proxy.lib.sfu.ca/10.1027/0044-3409.215.3.174`

57 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

58 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

59 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

60 Bjork, E., Kornell, N., Storm, B., Yue, C (2015). Highlighting and its relation to distributed study and students' metacognitive beliefs. Educational Psychology Review, 27(1), 69-78. `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s10648-014-9277-z`

ing the main points, (4) revising your understanding of the text based on the information you found, and (5) applying this information to memory[61].

5.6 Concept Mapping

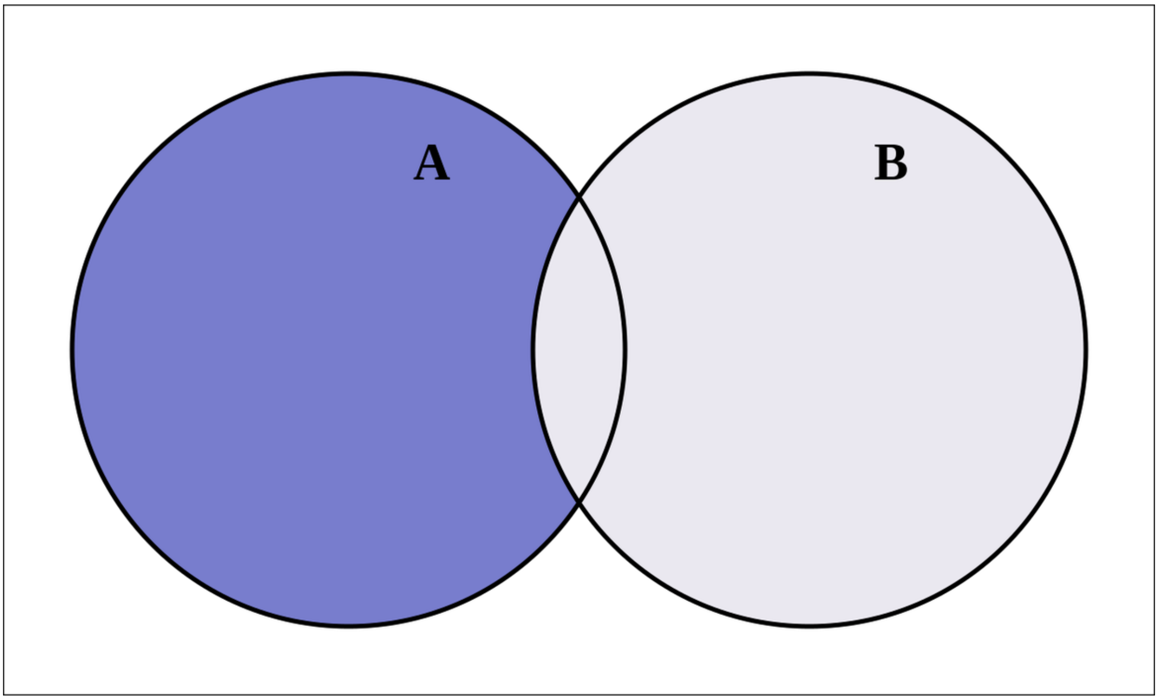


Figure 19 Venn diagram

A concept map is a method in which concepts can be organized, linked, and visually displayed. A concept map, more commonly referred to as a diagram, represents the relationships between concepts. Some more common forms of concept maps are Venn diagrams, tree diagrams, flow charts, and context diagram. Concept maps can be used and adapted to fit many different subjects of learning.

Concept maps are a useful tool for learning because they enable the student to visualize how concepts interact with each other, and what their relationships are. This enables students to encode the meanings of the concepts more deeply, and with better understanding[62].

When a student goes through the process of making a concept map and they consider the possible relationship between concepts, their prior knowledge and schemas are activated. The building of a concept map also works to add to new information to student's knowledge, by visually representing new ideas, and asking students to think critically and find logical

61 Den Elzen-Rump, V., Leopold, C., Leutner, D (2007). Self-regulated learning with a text-highlighting strategy: A training experiment. Journal of Psychology, 215(3), 174-182. `http://dx.doi.org.proxy.lib.sfu.ca/10.1027/0044-3409.215.3.174`

62 Blunt, J (2014). Learning with retrieval-based concept mapping. Journal of Educational Psychology, 106(3), 849-858. `http://dx.doi.org.proxy.lib.sfu.ca/10.1037/a0035934`

relationships between ideas. These two work together, linking new ideas to old schemas, to reinforce learning and strengthen encoding [63].

Concept maps require students to think deeply about the information they are learning, in order to identify the main points [64]. By building a concept map, students learn how to represent what they know, and how to organize information in a logical, sense making way.

5.6.1 Research Findings

Research studies show that the use of concept maps help students learn how to organize information, enhance their academic performance, and increase their knowledge retention abilities[65]. This is because the process of forming a concept map relies on encoding strengthening procedures such as deep thinking, organizing, and relating old information to new.

One study compared the retrieval effectiveness of information practiced in either concept maps or in paragraph form. As a retrieval activity, both formats gave similar results in the study, meaning that concept maps are just as effective as paragraph retrieval. Worth noting, in the study, researchers reported that the participants preferred the paragraph retrieval format.

5.6.2 Use of Concept Maps

There are many different ways that concept maps can be used academically. Students can personally make concept maps while they are learning. This would help students in their learning process. By being able to identify the key components and how they relate to each other, students would be able to grasp a deeper understanding right away.

Concept maps could also be used after students have learned. Having students fill in a blank diagram could be a way in which class understanding and comprehension of new ideas are tested and measured. Students could also use concept maps as a method of studying, as recall practice for what they need to know.

Lastly, concept maps can be used by instructors as a teaching aid. Diagrams and visual representation of new ideas are useful tools that could help teachers in communicating and clarifying information to students. Concept maps may be used most effectively of all by educators, because they have a clear understanding of the information they are trying to deliver [66].

63 Blunt, J (2014). Learning with retrieval-based concept mapping. Journal of Educational Psychology, 106(3), 849-858. http://dx.doi.org.proxy.lib.sfu.ca/10.1037/a0035934

64 Blunt, J (2014). Learning with retrieval-based concept mapping. Journal of Educational Psychology, 106(3), 849-858. http://dx.doi.org.proxy.lib.sfu.ca/10.1037/a0035934

65 Liu, P (2014). Using eye tracking to understand learners' reading process through the concept-mapping learning strategy. Computers & Education, 78, 237-249. http://dx.doi.org.proxy.lib.sfu.ca/10.1016/j.compedu.2014.05.011

66 Hung, S., Ku, D., Shih, J (2014). The integration of concept mapping in a dynamic assessment model for teaching and learning accounting. Journal of Educational Technology & Society, 17(1), 141-153.

5.7 Classroom Contexts/Strategies

This chapter will describe the ways in which you teach and the ways that your students perceive their learning environment help to affect their cognitive development as they grow. This includes the type of teaching style that you execute and how the students see you as your role as a teacher. How the classroom is built for students to develop academically and emotionally will also be a factor in this chapter. Relationships between students and teachers will be analyzed to determine the impact they have on learners.

5.7.1 Interactions in the Classroom

The relationships between teachers and students, and students and students are vital to the success of a classroom and its ability to foster a supportive learning environment. A study completed in Greece by Poulou (2014) [67]focused on student behaviours, emotions and attitudes in relation to teacher-student interactions. It heavily emphasizes the importance of Brofenbrenner's model describing the influences of our peers and adult figures. Not only does it look at teacher-student relationships, it takes into consideration student social skills and classroom context to see its influence on student behaviours and attitudes.

Discussions between students which are also facilitated by teachers are strongly supported by a study done by Danish & Saleh (2015). It shows that while student to student dialogue is advantageous, it is much more effective if there is a teacher who consistently provides support, which in this case, is context clues, for the students to continually develop their ideas.

5.7.2 Self-Regulated Learning

TheorySelf-regulated learning is a technique used in classrooms in which students are given freedom to control the pace at which they work and to evaluate their understanding of the material. They use this understanding to make judgements on their progress and to decide whether or not they will move their studies forward. In turn, this allows them to create and maintain their own learning goals and the strategies they will use to fulfill these goals. It involves metacognitive awareness in that they are aware of their own learning, such that they are able to make the aforementioned decisions as necessary. Motivation also plays a major role as it requires an individual to work independently, determining their own intrinsic or extrinsic motivations.

ResearchAlthough self-regulated learning is widely popular with educators, it is debated whether or not it is effective for all students. For that reason, this strategy in the classroom is looked at in a study done by Nelson (2015)[35] in which a variety of high school students studying history in a suburban upper mid-west neighborhood report motivation and self-regulation. Different groups of students with skill levels ranging from AP students to students in regular courses are observed as self-regulating techniques are applied and

67 Poulou, M. (2014). The effects on students' emotional and behavioural difficulties of teacher-student interactions, students' social skills and classroom context. Br Educ Res J British Educational Research Journal, Vol 40(6), 986-1004. `http://dx.doi.org.proxy.lib.sfu.ca/10.1002/berj.3131`

removed. It finds that those who are in AP courses are more highly motivated if they use self-regulatory techniques, whereas students in normal classes quickly become disinterested if they are in control of their learning. However, this article also mentions findings conclusive from another study by Cleary and Chen where self-regulated learning was more effective for students in regular classrooms than for those in AP classrooms. Because this study was based on math rather than world literature, it could be considered that self-regulated learning is important for all learners and that the effectiveness of self-regulated learning varies by subject.

5.7.3 Self-explanation

TheorySimilarly, self-explanation is another useful independent strategy where students verbalize their thoughts to facilitate clearer, conscious, and more organized understanding. For instance, if a student were to tackle a math problem using the self-explaining technique, they would work through the problem explaining each step, what they are going to do to solve each step, and why they did it. If they find that they are not able to explain why they did it, they might go back and look for an explanation from another source. In the same way that we are able to learn by teaching others, self-explanation works because you are working to break down the material to your own understanding to teach yourself.

ResearchFor further understanding, an article by Roy & Chi[68] differentiates between high quality self-explanations and low quality self-explanations. The former describes students who have shown a more critical understanding of the material by being able to demonstrate reflections of their learning through assumptions, comments and integrated statements. The latter describes students who simply restate what they've read. Being able to recognize the two is important because those who participate in high-quality self-explanations are not only able to produce better post-test results, but are also more likely to be good students as opposed to poor students (these students were tested prior and classified according to their scores). Roy & Chi also looked at another study that shows four different types of self-explanation- two that are successful and two that are unsuccessful. Principle-based explainers can connect what they learn to the principles of the topic and anticipative explainers make predictions prior to reading and connect it to relevant material from the past. Most learners in the study fall into the unsuccessful type category, which includes passive explainers and shallow explainers. They concluded that learners vary in their abilities to self-explain, and these variations can predictively estimate the quality of the results a learner produces.

ApplicationWylie and Chi[69] describe different forms of self-explanation that can be categorized by placing them under one or more of the utilized methods. One of the methods used included open ended methods, the first being one in which students are asked to further connect and ensure understanding of the material by relating it to prior knowledge and explaining what they just read aloud. Another similar open ended method used computers

68 Roy, M., & Chi, M. (2012). The Self-Explanation Principle in Multimedia Learning. The Cambridge Handbook of Multimedia Learning, 271-286. `http://dx.doi.org/10.1017/CBO9780511816819.018`

69 Wylie, R., & Chi, M. H. (2014). The self-explanation principle in multimedia learning. In R. E. Mayer, R. E. Mayer (Eds.) , The Cambridge handbook of multimedia learning (2nd ed.) (pp. 413-432). New York, NY, US: Cambridge University Press. doi:10.1017/CBO9781139547369.021

for students to express their understanding of the material rather than vocalizing it. On the other end of the spectrum were some less open ended methods that required students to pick their explanation of why they answered incorrectly off a multiple choice list. Both extremes have advantages and disadvantages, with open ended methods being too unrestrictive yet allowing students to freely assess themselves, which can allow new and different ideas. On the other hand, menu type methods can be too restrictive, but eliminate the irrelevant or incorrect explanations students can make.

5.7.4 Scaffolding Instruction

Scaffolding learning is another classroom technique that is very popular with educators. It involves a step by step process in which the educator continually provides support for individual students as they progress in their understanding of the topic. The teacher works around the pace of the students to further their knowledge development. There are implications to this, which includes the lack of time and far too large classroom sizes for this to be a feasible task. With that said, given enough time and small enough classroom sizes, providing scaffolding instruction could yield extremely effective learning outcomes.

In an article by Kabat-Zinn (2015) [70], he discusses the downfalls of scaffolding. While scaffolding, in the moment, can be a great way to support students, it may become detrimental eventually as students may become dependent on the support they have received thus far. In other cases, scaffolding instruction does not carry the burden of leaving a sense of dependency. In a study done by Ukrainetz (2015)[71], students who struggled with reading comprehension participated in a text comprehension program in which they were given practical and explicit strategies to improve their skills. It discusses ways in which students successfully transition from being supported by their speech language pathologists to being supported by their own knowledge.

5.8 Studying

There are many types of studying strategies that are taught to students- although often times, students tend not to use strategies at all. In this chapter, different strategies will be looked at along with the population they work best with. It will analyze and study students as individual groups in relation to the study techniques they use. **Motivation** and social support from peers and adults including teachers, tutors and parents will also be seen as a factor in the effectiveness of various study techniques. We will look at studying in relation to individual groups rather than studying as a whole. Additionally, study techniques can be broken up and categorized according to different subjects and different forms of testing.

70 Kabat-Zinn, J. (2015). On Lineage and the Uses and Limitations of Scaffolding. Mindfulness, 6(5), 1222-1225. doi:On lineage and the uses and limitations of scaffolding.

71 Ukrainetz, T. (2015). Improving Text Comprehension: Scaffolding Adolescents into Strategic Reading. Semin Speech Lang Seminars in Speech and Language, 36(1), 17-30. `http://dx.doi.org.proxy.lib.sfu.ca/10.1055/s-0034-1396443`

5.8.1 Peer Tutoring

Theory

Peer tutoring is a method of learning in which classmates teach and learn from each other through one-on-one direct instruction. Many schools, particularly secondary schools, have implemented this strategy as whole classes. Its intentions are directed at students to be able to process material deeply enough to be able to teach it, and for tutees to be able to learn in an environment without pressure. Typically, tutors are better performing students, likely those who have previously taken the class that they are tutoring. Some of the challenges of peer tutoring, as stated in an article by Mynard & Almarzouqi[72] include the fact that students, especially those in high school, may not necessarily get along and thus coordination of all the students becomes difficult. Additionally, there are no guarantees that tutors and tutees will consistently show up for class. There is also a fear among professional educators that students don't possess adequate information or ability to effectively teach another one of their peers.

ResearchOne study by Korner & Hopf[73] looked specifically at cross-age peer tutoring in physics, in which the tutors were in grade 8 and the tutees were in grade 5. Using a pre-test post-test design, they had three main groups in which each consisted of tutors, tutees or tutors and tutees, and two mentoring groups that would guide them through the material prior to tutoring. Results saw that no matter which group was tutoring which, all groups showed positive effects on tutors, mentors and tutees, particularly when the students took part in the active role of tutoring. In their review of literature, they also consider past studies where "They emphasized positive effects concerning students' achievements, attitudes toward the subject matter, and self-concepts not only for the tutoring students, but for the tutees as well[74]." Peer tutoring increased a variety of interpersonal skills such as teamwork and taking on a leadership role. In the same way, another study found that peer tutoring benefitted vulnerable minority students who came from low income and/or poor socioeconomic families more so than if they were to adhere to traditional means of teaching. The difference is that peer tutors and tutees are able to form relationships that students and teachers cannot. The impact, given that the system is organized, structured and clearly understood, is most likely to be positive on both tutor and tutee's sense of academic achievement and self-efficacy.

Application

Being a fairly new method of learning, peer tutoring is still somewhat in its initial stages of development. School systems vary among a variety of factors including different levels of schooling, private and public schools, different countries, and so forth. For this reason, there are a variety of ways peer tutoring can be implemented in classrooms.

72 Mynard, J., & Almarzouqi, I. (2006). Investigating peer tutoring. ELT Journal, 60(1), 13-22. doi:10.1093/elt/cci077

73 Korner, M., & Hopf, M. (2014). Cross-Age Peer Tutoring in Physics: Tutors, Tutees, and Achievement in Electricity. Int J of Sci and Math Educ International Journal of Science and Mathematics Education, 13(5), 1039-1063. doi:10.1007/s10763-014-9539-8

74 Korner, M., & Hopf, M. (2014). Cross-Age Peer Tutoring in Physics: Tutors, Tutees, and Achievement in Electricity. Int J of Sci and Math Educ International Journal of Science and Mathematics Education, 13(5), 1039-1063. doi:10.1007/s10763-014-9539-8

An article by Ayvazo & Aljideff[75] discusses Classwide peer tutoring (CWPT) and its structure in inner-city elementary and secondary schools. The first step in CWPT is to train the tutors. Teachers first instruct the tutors in their expertise, and the tutors are to then practice tutoring what they have learned. As this is happening, teachers will move from student to student, assessing them and providing critique to allow students to correct themselves. Next, they are given a performance record sheet to check off the skills that they have done well, and cross off the skills they need to continue to work on. Throughout this, students continue to learn lessons about interpersonal growth, such as how to appropriately receive and give feedback to their peers. Following this, students become ready to undertake their roles as they take on being both the tutee and tutor. This turn taking is advantageous because it allows the students to reap benefits from both roles, as they also learn to become better learners and teachers. It also eliminates feelings of inferiority or superiority, as all students are given the opportunity to teach each other, rather than deeming some students more qualified than others to teach.

In universities, a study by Brandt & Dimmit[76] utilizes writing centers at school to be a setting for peer tutors who are separated by their specific studies. Tutors go through a screening process in which they must complete a number of specific, selected courses, have at least a 3.5 GPA., and fulfillment of other criteria stated by the university. As tutors, they are taught to teach by scaffolding the learners, rather than straightforward direction. They teach a student-centered approach and encourage tutors to understand why these methodologies are used. The methods used at these writing centers seemed to be well organized in terms of their hired tutors and study formats. The beliefs that the writing centers had to ensure that tutors were genuine in their use of student-centered approaches greatly facilitated the success to this program. A peer tutoring system does not simply work when it's implemented; it must be planned thoroughly and made clear to all participants what its intentions are. The effects of this peer tutoring method depended on approach and clear guidelines being followed.

It's apparent that peer tutoring techniques fare especially well in schools with at-risk students, for it allows these students to work with peers whom they most likely have more valuable and meaningful relationships with. Additionally, for antisocial students, it creates a starting point of interaction- which can often times be the most difficult part of making friends. Given that an effective method of peer tutoring is used, it is unlikely that it will have a negative effect on students and likely that it will create a positive impact on students' self-confidence, academic achievement, peer relationships, and interpersonal skills.

5.8.2 Note Taking, Summarizing, and Rereading

TheoryBecause strategies while studying are dependent on the motivation and effort of an individual, rather than their peers and teachers, they play a major role in the development and academic achievement of a student. Habits and perceptions on studying that students pick up in their younger years are likely to carry on throughout their lives. The effects of note

75 Ayvazo, S., & Aljadeff-Abergel, E. (2014). Classwide peer tutoring for elementary and high school students at risk: Listening to students' voices. Support for Learning, 29(1), 76-92. doi:10.1111/1467-9604.12047

76 Brandt, C. & Dimmitt, N. (2015). Transfer of learning in the development of peer tutor competence. Learning and Teaching in Higher Education: Gulf Perspectives, 12(2). `http://lthe.zu.ac.ae`

taking can differ as it can occur during lectures or while reading. Similarly, summarizing material may have different outcomes, dependent on whether you are recalling material or directly referring to the material as you summarize. The effectiveness of these strategies, including note taking, summarizing, rereading and highlighting, depends on a number of different factors, some of which will be looked at as we analyze the literature.

ResearchA study by Dyer & Ryley[77] looks at the effects of note taking, summarizing, and rereading individually and collaboratively as study strategies. Each student is given an envelope with instructions along with a passage, telling them that they are to do a random combination of taking notes, reading, summarizing, and/or doing an unrelated task. Students who were able to spend more time reviewing and studying the passage through note taking or rereading had better post-test results than those who summarized the material by recall without reference to the material. On the other hand, those who did an unrelated task after reading had the lowest performance scores. A meta-analysis by Ludas (1980) focused on the accumulated studies on note taking and the effect it has on recalling information. Previous studies have shown note taking to be either positive, or having no difference, but never negative in results. Note taking is optimal in suitable environments, such as lectures that are slower-paced, as opposed to note taking during videos. During quick-paced lectures, one might simply write exactly what they hear, rather than thinking about what they're writing. Time is also a factor when looking at the efficiency of note taking- in that 15 minutes is the proximal time for one to effectively listen and take notes that are remembered.

ApplicationNote taking, summarizing and re-reading are strategies many students use as they are often the first things taught about studying. They are very much self-explanatory, although it is important to mention the impact that technology has on these strategies, as they can all be done on laptops, computers and tablets. All in all, it is evident that activities that allow more review of the material taught result in better sustainment of what is learned. Note taking requires rereading and comprehending text in order to understand what we are reading in our own words, thus it requires constant review. Note taking in lectures provides students material that is written to their understanding to review, given that the class provides an optimal environment for note taking.

5.9 Glossary

Learning strategies:tactics, which the learner can apply to material in order to remember it more efficiently

Encoding:the process of transferring information from short- term memory for storage in the long-term memory of the learner

Retrieval:the process of re-accessing information once it has been encoded in the brain

Maintenance rehearsal: Information is repeatedly rehearsed in order to keep it active in short-term memory

77 Dyer, J., Riley, J., & Yekovich, F. (1979). An Analysis of Three Study Skills: Notetaking, Summarizing, and Rereading 1. The Journal of Educational Research, 73, 3-7.

Elaborative rehearsal: Relating the to be learned information to other information

Mnemonics: Study tactics, which aid learners in the retention and retrieval of information

The Keyword method:A two- stage procedure for remembering materials that have an associative component

Prior Knowledge: The pre-existing knowledge a student possesses surrounding a particular topic

Zone of Proximal Development The time in which students are most likely and able to learn material and as they move further from this time, it will become harder to learn

ScaffoldingA process first put forward by Lev Vygotsky, in which learners are supported step by step at their own pace to reach their learning goals

Self-Regulated Learning Learning that gives the learner freedom to control their own pace

MotivationBehaviours and thoughts that drive individuals to perform

Intrinsic MotivationA drive to complete a task based on personal interest or belief

Extrinsic Motivation A drive to complete a task based on outside factors such as prizes and rewards

5.10 Recommended Readings

The self-explanation principle in multimedia learning.

Wylie, R., & Chi, M. H. (2014). The self-explanation principle in multimedia learning. In R. E. Mayer, R. E. Mayer (Eds.) , The Cambridge handbook of multimedia learning (2nd ed.) (pp. 413-432). New York, NY, US: Cambridge University Press. doi:10.1017/CBO9781139547369.021 Siegler

The effects on students' emotional and behavioural difficulties of teacher-student interactions, students' social skills and classroom

Poulou, M. (2014). The effects on students' emotional and behavioural difficulties of teacher-student interactions, students' social skills and classroom context. Br Educ Res J British Educational Research Journal, Vol 40(6), 986-1004. http://dx.doi.org.proxy.lib.sfu.ca/10.1002/berj.3131

Mayer, R. E. (1980). Elaboration techniques that increase the meaningfulness of technical text: An experimental test of the learning strategy hypothesis. Journal Of Educational Psychology, 72(6), 770-784. doi:10.1037/0022-0663.72.6.770

K-W-L: A teaching model that develops active reading of expository text.

Ogle, D. (1986) K-W-L: A teaching model that develops active reading of expository text. Reading Teacher, 39(6), 564-570. http://dx.doi.org.proxy.lib.sfu.ca/10.1598/RT.39.6.11

Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study.

Kim, J. S., & White, T. G. (2008). Scaffolding Voluntary Summer Reading for Children in Grades 3 to 5: An Experimental Study. Scientific Studies of Reading, Scientific Studies of Reading, 12(1), 1-23.

While encoding processes store new information into long-term memory, retrieval processes access previously stored information in long-term memory and place it into our conscious awareness

6 Encoding Processes

Before we are able to decode information, it must first be placed in to our long-term memory, which is referred to as encoding [1]. There are several strategies that students can use in order to successfully encode the information that is being learned. When encoding simple information, three distinct strategies can be used. Elaborative rehearsal, defined as "any form of rehearsal in which the to-be-remembered information is related to other information", is a deeper encoding strategy than maintenance rehearsal, which is simple repetition of information [2]. Mediation is a simple elaborative encoding strategy that involves relating information that is difficult to remember with something meaningful [3]. Another commonly used strategy is mnemonics, in which new information is paired with already learned information. This gives meaning to the new information, which allows it to be more memorable [4].

In order to encode more complex information one may use other strategies, such as activating prior knowledge, using guided questioning, or using the levels of processing approach [5].

1 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
2 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
3 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
4 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
5 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

7 Reconstruction of Memories and Information

7.1 Definition and examples

In previous chapters, we have learned about the encoding process and its role in constructing memories. In this chapter we look at the retrieval process and its use of reconstructive memory. When information is taken into the brain during encoding, only selected key elements of the situation are stored in long-term memory.[1] This storage is aided with the structural help of **schemata**, mental frameworks that help organize knowledge.[2] Think of how you recognize that a dog is a dog. Your schema for "dog" may include, four legs, barks, has a tail, and so on. Some people may include in there schema for "dog" that they are pets, while other may include that they can be dangerous and can bite. The individual componets that make up a schema work together in constructing one's perceptive of that schema. When we want to retrieve certain information for recall, the schemata will be activated and the stored pieces of information will be combined with general knowledge, thereby reconstructing the memory into a whole. Therefore, **reconstructive memory** can be defined as the way in which the recall process reassembles information by building upon the basis of limited key details held in long-term memory with the general and domain specific knowledge in one's repertoire. The reconstruction of memory allows our minds to deal with fragments of information, which is far easier to handle than taking on every piece of information we come into contact with all at once. The reconstruction of memory is not a fully accurate system of retrieval; mistakes can arise out of the reconstruction process that can distort the original information. This section will focus on reconstruction of memories and information, give specific examples and definitions, provide an insight into the research in this field, and examine the errors that can arise during the process of memory reconstruction.

To give a basic image of the concept behind reconstruction, think of a jigsaw puzzle and the box that holds its pieces. The individual puzzle pieces come together in creating a unified image, but are stored as individual units within the box. When the pieces are reconstructed in a meaningful way, starting with one piece and it being connected to another piece and so on, the entire image comes together as a whole image. The completed puzzle is now a single entity and now too big to fit into the box. In order to have the puzzle stored properly in the box, it needs to be deconstructed and have its individual pieces put back into their original container. The idea here is that memories and information are deconstructed for

1 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5$^{\text{th}}$ ed.
2 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5$^{\text{th}}$ ed.

easy storage, yet have the ability to be reconstructed in collaboration with general and domain specific knowledge in order to become a single unit of meaningful information.[3]

7.2 Bartlett's Research on Memory Reconstruction

The nature of memory recall has been under debate for many years, with the question: is recalling information from memory a reproductive process or a reconstructive process?[4] After several experiments regarding memory reconstruction, many cognitive psychologists agree that remembering is a reconstructive process.[5] One experiment that widely impacted this debate was done by British psychologist Frederic Bartlett and was expressed in his book *Remembering:A Study in Experimental and social psychology*.[6] The experiment involved a group of students who read a short story from an entirely different culture; the fact that the story was from a different culture was to ensure that the material as not too familiar to the students. At various lengths of time since the original reading, students were asked to reproduce the story to the best of their abilities. Two years after the original reading, one student was asked to reproduce the original story. The only pieces of information the student could reproduce were the names of the two main characters in the story, *Egulac* and *Calama*. After some thinking, the student was able to connect several other aspects of the story to the vivid names that she originally remembered; although these aspects did not match the original story exactly, it was clear that they were inspired by the original content. This experiment shows that remembering can be an active process that combines key points of interests that are stored in long-term memory with prior knowledge in order to produce a whole product that closely matches the original. This experiment supports the reconstructive nature of memory because the student started with a main point of reference, then actively tried to make connections, ultimately reconstructing the original story, or at least a story that resembles the original).[7]

7.3 Errors in Reconstruction

The work done by Bartlett sets the stage for addressing the errors that can arise during memory reconstruction. As stated earlier in section 1.2, the student in Bartlett's experiment was able to reconstruct her memory of the story, but the reconstructed memory did not exactly match the original content. Bartlett was able to show not only that remembering is a reconstructive process, but also that this process is vulnerable to errors and is not fully reliable in reproducing completely accurate copies of the original experience. There are two main topics related to memory reconstruction errors: confabulation and selective memory.

3 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.
4 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.
5 Bruning, R., & Schraw, G., & Norby, M., (2011). Cognitive Psychology and Instruction, 5th ed.
6 Bordignon, S., Giulini, E., Trentini, C.M., & Bosa, C.A. (2015). Memory in children and adolescents with autism spectrum disorder: a systematic literature review. *Psychology and Neuroscience, 8, 211-245.*
7 Bordignon, S., Giulini, E., Trentini, C.M., & Bosa, C.A. (2015). Memory in children and adolescents with autism spectrum disorder: a systematic literature review. *Psychology and Neuroscience, 8, 211-245.*

Confabulation is one error that arises out of memory reconstruction. **Confabulation** is the unintentional fabrication of events displayed as real memories in one's cognition. It is a common problem that can affect those who have suffered from a brain injuries or psychological diseases. Confabulation occurs when the key pieces of information in long-term memory that starts the reconstruction process of producing the memory is lost; this loss can be caused from brain trauma. The brain makes up for this loss of information by coming up with new information that seems right, resulting in the invention of a confused memory. Confabulation can present itself in a wide degree of severity, depending on the individual and their medical condition.[8]

Selective memory is the active repression of negative memories, or it can be seen as the active focus on positive memories. This causes errors in the reconstruction of memories because the recall process is disturbed. When a person actively represses negative memories, those memories will be forgotten. The forgotten material will not be recalled because even the proper cues will not connect to the repressed material.[9]

8 Nalbantian, edited by Suzanne; Matthews,, Paul M., McClelland, James L. (2010). *The memory process : neuroscientific and humanistic perspectives.* Cambridge, Mass.: MIT Press. ISBN 978-0-262-01457-1.

9 Waulhauser, G. (2011, July 11). Selective memory does exist. The Telegraph.

8 Recalling Specific Events

While reconstruction of memories occurs when people try to retrieve memories from a general information and memory storage, retrieval of specific bits of information- like specific life events- occurs under a slightly different process [1]. In this section the recalling of specific events will be looked at. We will discuss the role that episodic memory has and how this type of memory functions. We will also examine a phenomenon known as flashbulb memories and how it works.

8.1 The Role of Episodic Memory

Episodic memory is defined as the "storage and retrieval of personally dated, autobiographical experiences" [2]. Appropriately named, this type of memory focuses on life events, like recalling childhood events, where you vacationed last summer, and even what you had for breakfast last Sunday. These types of memories are retrieved with the help of associations that link the event to a specific time or place [3]. Robin, Wynn, and Moscovitch studied the effects of spatial context on the recall of specific events [4]. These researchers were interested in whether actually being in the context or simply hearing auditory cues about the context will enable the recall of events [5]. Robin and colleagues found that locations, compared to people, served as a better tool for recall when participants were asked to either imagine or recall an event- although both were better when they were highly familiar [6]. It is interesting to note that Robin et al. [7] found that even when there was no location specified for the scenarios provided, the participants were much more likely to generate a spatial context than a person. The researchers state that "participants spontaneously added

1 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
2 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
3 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.
4 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.
5 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.
6 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.
7 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.

location information to the person-cued events when none was specified" [8]. Furthermore, when spatial cued events were compared against person cued events, it was discovered that the recall of memories was much more vivid and detailed [9]. Thus, the researchers concluded that spatial cues were much more effective for accurately recalling specific events [10]. This study portrayed how the location and time of various events is a salient factor for retrieval of episodic memories.

There is an ongoing debate among psychologists whether episodic memory and **semantic memory**, which is defined as a "memory of general concepts and principles and associations among them", are different types of memory [11]. Researchers are investigating brain activity in people with amnesia who are no longer able to retrieve episodic memories [12]. A study on individuals with **Alzheimer's Disease**, a type of dementia characterized by progressive degeneration of the brain, found that people with amnesia have significant impairments in all domains of episodic memory [13]. The greatest impairments were evident in acquisition of memory, delayed recall and associative memory [14].

Research on people with amnesia inspired many psychologists to investigate the functions of **implicit memory**; this type of memory is an automatic and unconscious way of memory retention [15]. It is interesting to note that often times our memories are not available to our conscious mind for recall, but can still influence our behaviour due to a previous event [16]. Early theorists believed that the "inability of such individuals to transfer verbal materials from [short-term memory] to [long term memory] played a critical role in their amnesia" [17]. However, this view was not adequate, as it became evident that individuals suffering from amnesia were not impaired in all kinds of long-term verbal memory [18]. Further studies have revealed that individuals with amnesia have the ability to use implicit memory when

8 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.

9 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.

10 Robin, J., Wynn, J., & Moscovitch, M. (2016). The spatial scaffold: The effects of spatial context on memory for events. *Journal Of Experimental Psychology: Learning, Memory, And Cognition*, *42*(2), 308-315.

11 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

12 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

13 Irish, M., Lawlor, B. A., Coen, R. F., & O'Mara, S. M. (2011). Everyday episodic memory in amnestic mild cognitive impairment: A preliminary investigation. *BMC Neuroscience*, *12*doi:10.1186/1471-2202-12-80

14 Irish, M., Lawlor, B. A., Coen, R. F., & O'Mara, S. M. (2011). Everyday episodic memory in amnestic mild cognitive impairment: A preliminary investigation. *BMC Neuroscience*, *12*doi:10.1186/1471-2202-12-80

15 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

16 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

17 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

18 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

completing various tasks, like spelling, suggesting that there is no division between semantic memory and episodic memory [19].

8.2 Flashbulb Memories

Moving forward, flashbulb memories are another type of memory for recalling specific events. This type of memory is of an incredibly specific nature and is tied to events with an emotional relevance to the individual [20]. For example, individuals may experience flashbulb memories when remembering the 9/11 terrorist attacks on New York City. Although flashbulb memories may be considered to be perfect accounts of the event or events that have occurred, research has discovered something quite on the contrary. It has been found that flashbulb memories are not actually as accurate as previously assumed [21]. This gives rise to the debate on whether flashbulb memories are a "special class of emotional memories," or whether they should be categorized as ordinary autobiographical memories [22].

19 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

20 Lanciano, T., Curci, A., Mastandrea, S., & Sartori, G. (2013). Do automatic mental associations detect a flashbulb memory?. *Memory*, *21*(4), 482-493.

21 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

22 Lanciano, T., Curci, A., Mastandrea, S., & Sartori, G. (2013). Do automatic mental associations detect a flashbulb memory?. *Memory*, *21*(4), 482-493.

9 Relearning

Relearning is a process of acquiring of once lost information, while using much less time compared to the initial attempt of learning the same material. It provides an accurate demonstration of how memory can store the smallest traces of information without us realising that we remember anything about it. Proof to that is how much faster we can relearn seemingly lost information compared to first tries of learning it[1]. A good example would be the case when a learner memorizes meaningless set of words and then after some time, when it is impossible to recall any of it, he or she repeats the process. The comparison between the amount of time that was needed to memorize the words for the first and the second time would demonstrate that the second attempt was shorter in duration. Next section demonstrates how similar experiments were done by prominent researches in the past.

9.1 History of Research on Relearning Method

Hermann Ebbinghaus was one of the first researchers who examined relearning method in his work. He practiced it by memorizing nonsense syllables to the point when he could repeat them without an error[2]. After some time, when the memory of it was completely gone, he relearned the same set of syllables and compared the number of attempts made during the initial and subsequent sessions. The fact that the second try required less time to succeed in recalling suggested that some information retained after initial session[3].

However, relearning method stays underused in modern memory research and more widespread approaches like recall tests took its place[4]. One reason for that is an apparent insufficiency in measuring any visible savings while relearning complex materials, which usually require deeper understanding alongside the sheer memorization[5].

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1 de Jonge, M., Tabbers, H. K., & Rikers, R. P. (2014). Retention beyond the threshold: Test-enhanced relearning of forgotten information. *Journal Of Cognitive Psychology*, 26(1), 58-64. doi:10.1080/20445911.2013.858721

2 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

3 Schraw, G., & McCrudden, M. (2013), Information Processing Theory. Retrieved from www.education.com/reference/article/information-processing-theory.html

4 de Jonge, M., Tabbers, H. K., & Rikers, R. P. (2014). Retention beyond the threshold: Test-enhanced relearning of forgotten information. *Journal Of Cognitive Psychology*, 26(1), 58-64. doi:10.1080/20445911.2013.858721

5 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

9.2 Distributed versus Massed Practice

Although it is unclear how exactly relearning occurs, research indicates that the way in which learners practice their studies has a major impact on both learning and relearning. There are two ways of practice that can cause quite different learning outcomes. One is **distributed practice** - a certain amount of study sessions which take place regularly over time (e.g., working on improving a skill for several weeks or years). The opposite is **massed practice**, where learners make one-time intensive effort of working on a task (e.g., preparing for a test overnight)[6].

Subsequent retention of information proves to be more successful when using distributed practice method. At the same time, if the goal of a studying is to pass a test or just use certain knowledge once or twice, massed practice might be a better choice[7]. Thus, the purpose of the learning activity could influence which of these practices learners adopt in a given activity.

A number of non-experimental studies had examined the effect of distributed practice on mathematical knowledge retention. In particular Bahrick and Hall (1991) analyzed how much the subjects remember from school algebra and geometry classes after 1 to 50 years later. Results of the study indicated that the more different-level classes of the same subject student took in school (which means that he or she was exposed to certain amount of repetition of the same material), the better student's memory of the subject was[8].

Massed practice can be beneficial too, in particular while meeting two conditions. First case is when the goal is not understanding, but particular behaviour, which would generate stimulus-response linkages. Second example is when it is used by an expert who already holds sufficient amount of knowledge in the field[9].

9.3 Relearning after Brain Injury

Another interesting domain, where relearning occurs as a necessity, is the cases of people forgetting sometimes not only declarative, but even simple procedural knowledge that we all have been trained to perform since early childhood. When brain injury results in dysfunction between different parts of the brain, motor and cognitive functioning suffers. In that case, damage can cause problems in performing even regular every-day behaviour. Observational learning appears to be one of the most useful relearning tactics for individuals with such injuries. When watching others performing a needed activity, patients form a mental representation of it[10]. If accompanying by a proper reinforcement, such practice

6 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

7 Rohrer, D., & Taylor, K. (2006). The effects of overlearning and distributed practise on the retention of mathematics knowledge. *Applied Cognitive Psychology*, 20(9), 1209-1224. doi:10.1002/acp.1266

8 Rohrer, D., & Taylor, K. (2006). The effects of overlearning and distributed practise on the retention of mathematics knowledge. *Applied Cognitive Psychology*, 20(9), 1209-1224. doi:10.1002/acp.1266

9 Mumford, M. D., & Constanza, D. P. (1994). Influence of abilities on performance during practice: Effects of massed and distributed practice. *Journal Of Educational Psychology*, 86(1), 134.

10 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: `https://explorable.com/nature-vs-nurture-debate`

can produce positive results for patients who is capable of focusing their attention on the object, can plan and execute their own behaviour[11].

11 Sarah Mae Sincero (2012). Nature and Nurture Debate. Retrieved Apr 05, 2016 from Explorable.com: https://explorable.com/nature-vs-nurture-debate

10 Testing as Retrieval Practice

When thinking of a test, most students will only consider its outcomes in the form of a grade or a conclusive estimation of their abilities and knowledge, while research proves that testing can be a solid learning tool itself. Depending on the desirable outcomes, tests can be designed and implemented into the curriculum in much more useful ways than just for assessment purposes.

10.1 Testing Effect

The principle of the **testing effect** states that if being tested during the time of study by undergoing smaller tests and quizzes on the material, students will perform better on their final test[1].

Under certain conditions tests can provide much more positive impact on students' future retrieval of information, than spending the same amount of time on rereading the material. That standard tends to be confirmed even if no feedback follows the test and performance on the test itself is not perfect. Thereby, after initial studying of the material, it would be more beneficial to undergo some tests on it, than rereading the text again[2].

However, better effect takes place if detailed feedback for the test is provided or if performance on it was successful. Research indicated that the number of successful tries increases long-term retrieval effect respectively. Even better conditions are provided when those testing practices are distributed across several days and take place repeatedly[3].

Several reasons form the basis of tests providing more positive impact on students' retrieval outcomes than simple rereading of study material. One of such reasons is practice on the retrieval, when learners have an opportunity to work on their abilities to find and extract needed material out of their memory under small pressure of a challenge. Also, if there is a resemblance between practice and final tests, such actions will put retrieval processes into right context, which provides additional connections between encoding and decoding conditions[4].

1 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

2 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

3 Rawson, K., Dunlosky, J., & Sciartelli, S. (2013). The Power of Successive Relearning: Improving Performance on Course Exams and Long-Term Retention. *Educational Psychology Review*, 25(4), 523-548. doi:10.1007/s10648-013-9240-4

4 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

10.2 Research on Testing for Retrieval

Despite the fact that students usually assume that primary goal of being tested is to be evaluated afterwards, cognitive psychologists have been aware of tests' ability to enhance retrieval for a long time. Several research methods were used to verify it. First, it required the students to learn new material and then take or don't take a test on it before the final exam. Results proved that those who took the additional test performed better on the final one. With such a method some researchers have questioned whether positive results depended on test itself or they were caused by additional reminders about the material in the test. Due to that additional type of research was conducted and it required students to either take a test after initial learning or restudy the material without taking a test. Final tests again showed that student who took additional test performed better on the final one. As for the nature of the material being tested, equally beneficial results were found for remembering words, texts or illustrations. Overall, there were conducted numerous studies which proved tests to reinforce learning outcomes[5].

5 Rawson, K., & Dunlosky, J. (2012). When Is Practice Testing Most Effective for Improving the Durability and Efficiency of Student Learning?. *Educational Psychology Review*, 24(3), 419-435. doi:10.1007/s10648-012-9203-1

11 Glossary

Alzheimer's Disease: A type of dementia characterized by progressive degeneration of the brain.

Confabulation: The unintentional fabrication of events displayed as real memories in one's cognition.

Distributed Practice: a certain amount of study sessions which take place regularly over time (e.g., working on improving a skill for several weeks or years).

Episodic Memory: Storage and retrieval of personally dated, autobiographical experiences.

Implicit Memory: An automatic and unconscious way of memory retention.

Massed Practice: practice, where learners make one-time intensive effort of working on a task (e.g., preparing for a test overnight).

Reconstructive Memory: The way in which the recall process reassembles information by building upon the basis of limited key details held in longterm memory with the gerneral and domain specific knowledge in one's repetoire.

Schemata: Mental frameworks that help organize knowledge.

Selective Memory: The active repression of negative memories, or the active focus on positive memories.

Semantic Memory: Memory of general concepts and principles and associations among them.

Testing Effect: the influence that taking tests makes on learning and retention of information.

12 Suggested Readings

Bartlett, R.H. (1932). *Remembering: A Studyin Experimental and Social Psycology.* Cambridge University Press.

Irish, M., Lawlor, B. A., Coen, R. F., & O'Mara, S. M. (2011). Everyday episodic memory in amnestic mild cognitive impairment: A preliminary investigation. BMC Neuroscience, 12doi:10.1186/1471-2202-12-80

Lanciano, T., Curci, A., Mastandrea, S., & Sartori, G. (2013). Do automatic mental associations detect a flashbulb memory?. Memory, 21(4), 482-493.

12.1 References

13 Sociocognitive Learning

13.1 Social Cognitive Theory

Figure 20

Albert Bandura's social cognitive theory views learning as occurring within a social context and regards humans as self-organizing, proactive, self-reflecting and self-regulating.[1] Social cognitive theory categorizes the factors in human development as environmental, behavioral, and cognitive. It portrays development as emerging from the dynamic interplay of these three types of factors. Building on Bandura's earlier focus on observation and modeling as a source of learning, social cognitive theory describes how the belief in one's competence to succeed at a task, known as self-efficacy, strongly affects learning outcome.[2]

1 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Prentice-Hall, Inc.
2 Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. Psychological review, 84(2), 191.

13.1.1 Reciprocal Determinism

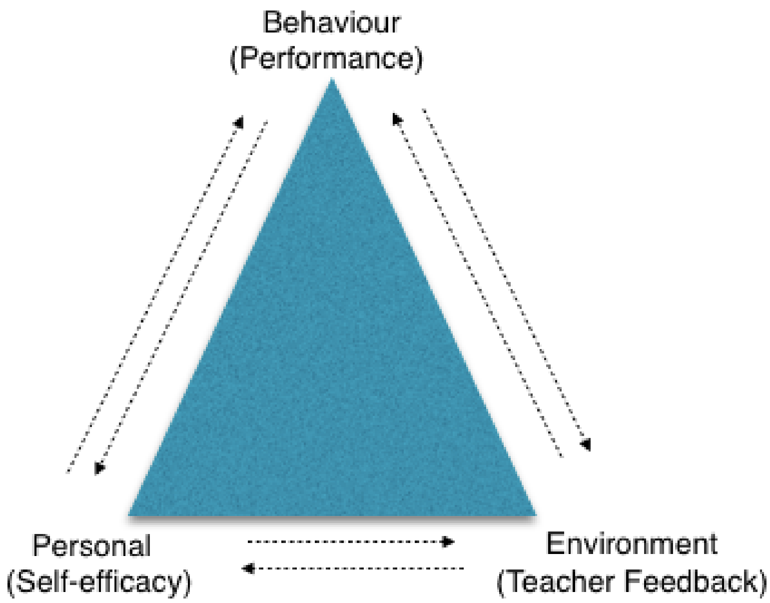

Figure 21

Bandura considers his model of **reciprocal determinism** as a way to explain how an individual's behavior both influences and is influenced by both personal characteristics and the social world. Bandura's reciprocal determinism model also explains that learning is the result of interacting variables. His model involves three components, personal, behavioral, and environmental factors that interact and influence each other. These three components are considered to function as interdependent rather than autonomous determinants, thus maintaining the fact that the they are conditional of each other. Personal factors include beliefs and attitudes of the individual. To apply this to a learning environment, one would say that the personal beliefs and attitudes of the learner would affect their own learning. If they were previously rewarded for a certain behavior in a certain situation, for instance, they are more likely to repeat that scenario. The behavioral component of learning can consist of responses one makes in a given situation such as one's response to a low test score with either frustration or an increased effort. Finally, environmental factors such as roles played by parents, teachers and peers can have an effect on an individual's behavior and self-beliefs, which consequently impact their learning. Given the importance of this three components of Bandura's model, we focus on the personal factors such beliefs about the self, and how it can affect behaviors and the interpretation of environmental cues. The model of reciprocal determinism will thus be considered in each section of this chapter.

13.1.2 Self-efficacy

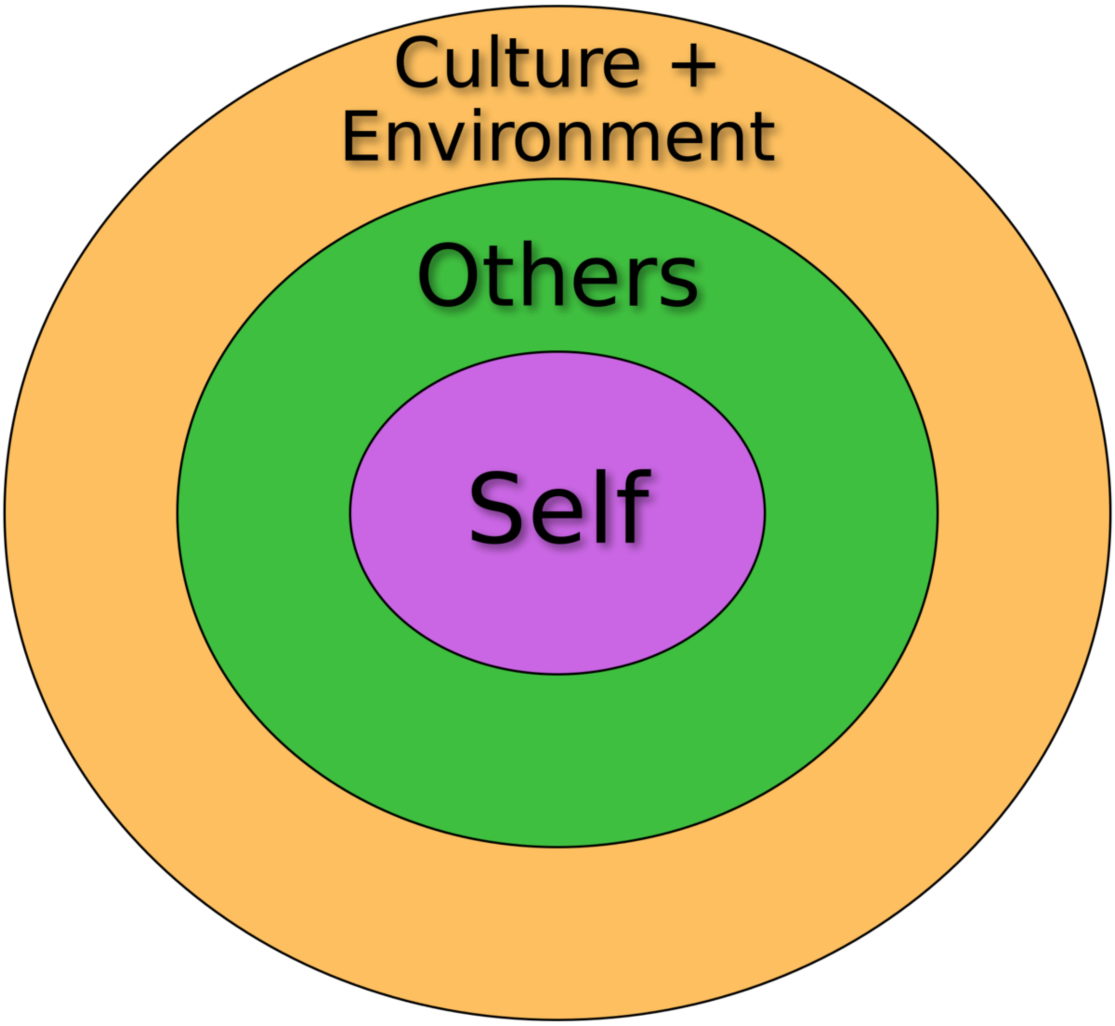

Figure 22 self efficacy factors

Since self-concept and self-efficacy, though distinct constructs, are related in their conception and in their effects on student achievement, consideration is given first to the literature on self-concept as a basis for observations on self-efficacy. **Self-concept** is generally viewed as an assessment of self-worth deriving from comparisons with the past performance of self and the performance of others.[34] Self-efficacy tends to be conceptualized as a context-specific assessment of one's competence to perform a specific task. Self-efficacy theory suggests that feelings of self-efficacy have their origins in experiences of success or failure that arise through attempts to master actual tasks. In brief, Self-efficacy is how the individual perceives ones own abilities and the level of confidence for achieving goals from

3 Marsh, H. W. (1986). Global self-esteem: Its relation to specific facets of self-concept and their importance. Journal of personality and social psychology, 51(6), 1224.

4 Bandura, A. (1978). Reflections on self-efficacy. Advances in behaviour research and therapy, 1(4), 237-269.

the perceived abilities. There are three domains of self-efficacy that differentiates in: task difficulty, generality of one's self-efficacy (self-efficacy in one domain is not consistent with self-efficacy in another domain), strength of one's efficacy judgments. Within those three domains, there are four factors that Bandura stated to effect self-efficacy. These factors are enactive mastery, vicarious experience, verbal persuasion, and physiological and effective state. Enactive mastery is related to the knowledge that an individual has obtained from pervious experience. For example, if an individual has achieved mastery in math they are more likely to have a high self-efficacy. Achieving mastery contributes to the individual's perception of ones ability in completing a task. Vicarious experience is watching others and learning from what was watched[5]. For example, if an individual watches a classmate or teacher demonstrate an equation on the board they may feel their ability to the problem on their own has increased. There will be more discussion related to this in the section entitled enactive and vicarious learning. Another factor is verbal persuasion which is having an individual convince another that they are capable of completing a task. Having another person or classmate tell another that they have the ability to do well on a task or encourage them, might boost their confidence and their perception of their ability on a task. The final factor, physiological state, can effect the individual's self-efficacy. For example, if an individual is tired due to a lack of sleep, their perception of their ability to complete a math task might be low. Even though they normally have high self-efficacy in math. These four factors as well as others affect the individual's self-efficacy.[6][7] As self-efficacy is closely related to the concept of reciprocal determinism in ways that the personal, environmental, social aspects influence self-efficacy and vice versa, this part of the chapter will look closely at the different aspects and implications of self-efficacy and factors that will correlate with each other.

13.1.3 Agency

Agency refers to simply the capacity of a person to act in any given environment. When it comes to learning, agency and performance are closely related, since agency involves the individual's willingness to engage in academic tasks. Agency is characterized by number of core features that operate within human consciousness and influences the nature and quality of one's life and learning. Social cognitive theory distinguishes among three modes of agency: direct personal agency, proxy agency that relies on others to act on one's behest to secure desired outcomes, and collective agency which is exercised through socially coordinated and interdependent effort.[8] As defined by Bandura, efficacy beliefs form the foundation of human agency as people need to believe that they can produce results by their own actions, individuals who have agency are intrinsically motivated to perform and may need very little or no external incentives; Bandura (2007)[9] refers to this subjective

5 Phan, H. P., & Ngu, B. (2014). Factorial equivalence of social cognitive theory: Educational levels × time differences. Educational Psychology, 34(6), 697-729. doi:10.1080/01443410.2013.814190

6 Seijts, G. H., Latham, G. P., & Whyte, G. (2000). Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

7 Phan, H. P., & Ngu, B. (2014). Factorial equivalence of social cognitive theory: Educational levels × time differences. Educational Psychology, 34(6), 697-729. doi:10.1080/01443410.2013.814190

8 Bandura, A. (1989). Human agency in social cognitive theory. American psychologist, 44(9), 1175.

9 Bandura, A. (2007). Much ado over a faulty conception of perceived self-efficacy grounded in faulty experimentation. Journal of Social and Clinical Psychology, 26(6), 641-658.

operative capabilities. For example, a person with high self-efficacy would be confident in his/her ability to perform a given task successfully. In order to fulfill and maintain the condfidence, the person would exert greater effort in completing a difficult goal-related tasks if he/she feels confident that the task would be successfully completed. Individuals with high self-efficacy, need to believe that challenges can be met and overcome. Self-efficacy beliefs usually affect cognitive functioning through the joint influence of motivational and information-processing operations. For example, this dual influence is illustrated in studies of different sources of variation in memory performance. The stronger people's beliefs in their memory capacities, the more effort they devote to cognitive processing of memory tasks, which, in turn, enhances their memory performances. However, efficacy in dealing with one's environment is not a fixed act or simply a matter of knowing what to do. People are neither autonomous agents nor simply mechanical conveyers of the environmental influences. Rather, they make causal contribution to their own motivation and action, which involves a generative capability in which cognitive, social, and behavioral skills must be organized into integrated action. Perceived self-efficacy helps to account for such diverse phenomena such as changes in coping behavior produced by different modes of influence. The stronger their perceived self-efficacy, the higher the goals people set for themselves and the firmer their commitment. These include the temporal extension of agency through intentions and thought, self-regulation, and self-reflection about one's capabilities, quality of abilities, and the meaning and purpose of one's life pursuits. In causal tests, the higher the level of induced self-efficacy, the higher the performance accomplishments and the lower the emotional arousal.[10] Among the mechanisms of personal agency, none is more central or pervasive than people's beliefs about their capabilities to exercise control over events that affect their lives. Self-efficacy beliefs function as an important set of proximal determinants of human motivation, affect, and action. So far, the discussion has centered on efficacy activated processes that enable people to create beneficial environments and to exercise control over them. Judgments of personal efficacy also affect selection of environments. People tend to avoid activities and situations they believe exceed their coping capabilities, but they readily undertake challenging activities and select social environments they judge themselves capable of handling. They operate on action through motivational, cognitive, and affective intervening processes. Some of these processes, such as affective arousal and thinking patterns, are of considerable interest in their own right and not just as intervening influencers of action.[11] Those who argue that people do not exercise any control over their motivation and action usually emphasize that external events influence judgments and actions, but neglect the portion of causation showing that the environmental events are partially shaped by people's actions. In the model of reciprocal causation, people partly determine the nature of their environment and are influenced by it. Self-regulatory functions are personally constructed from varied experiences and not simply environmentally implanted. Among the mechanisms of human agency, beliefs of personal efficacy is also very pervasive and other factors serve more as guides and motivators, as they are rooted in the core belief that one has the power to produce what one desires. Do beliefs of personal efficacy contribute to human functioning? If it was otherwise people would have little incentive or motivation to act or to persevere in the face of difficulties. This core belief affect whether individuals think in self-enhancing or self-debilitating ways, how well they motivate themselves and persevere in the face of difficulties, the quality of their emotional well-being

10 Bandura, A. (1982). Self-efficacy mechanism in human agency. American psychologist, 37(2), 122.
11 Bandura, A. (1982). Self-efficacy mechanism in human agency. American psychologist, 37(2), 122.

and their vulnerability to stress and depression, and the choices they make at important decisional points. The critique for this theory comes from this aspect since self-efficacy beliefs operate in concert with goal systems of self-regulation in contrast to the focus of control theory on discrepancy reduction. As evaluated by 9 meta-analyses for the effect sizes of self-efficacy beliefs and by the vast body of research on goal setting, contradicts findings that belief in one's capabilities and personal goals is self-debilitating. [12]

13.1.4 Outcome Expectation

Figure 23 thumbnail

12 Vancouver, J. B., Thompson, C. M., Tischner, E. C., & Putka, D. J. (2002). Two studies examining the negative effect of self-efficacy on performance. Journal of Applied Psychology, 87(3), 506.

Studies of the relationship between self-beliefs and performance tend to draw on this or related theories and usually endorse the notion of reciprocal determinism at a theoretical level which can also set the basis for self-efficacy level. However, attempts to model this mutual influence of self-beliefs and performance are few and are focused on the relationship between self-concept and performance. Comparisons are made between those who overestimate how well they will perform (over-estimators), those who underestimate their level of performance (under-estimators) and those who have an accurate perception of their performance level (accurate estimators) to determine how the three groups differ.[13] If differences exist then recommendations can be made to improve the accuracy of self-estimates, and thereby improve the efficacy of such measures. A key consideration is what differentiates those that are able to accurately self-assess from those that produce erroneous self-assessments. Feedback is also a very important factor in building outcome expectation and self-efficacy. Athanasou (2005) identified three key sources of feedback used by people in deriving self-estimates: social messages, personal factors and situational factors. Social messages were sources of information derived from interaction with others. Three types of social messages influenced self-evaluation: comparisons we make of ourselves with others, feedback we receive from others, and the social and cultural stereotypes.[14] Results from the above study indicated four main areas of feedback sources, and a positive relationship between ability and accuracy of self-estimates. Learning goal orientation and use of feedback were positively related; however their effects on accuracy of self-assessment were contrary to those hypothesized. Analyses indicated a positive relationship between ability and accuracy of self-assessments. However, over-estimators recorded higher levels of confidence, learning goal orientation and usefulness of feedback than the other groups.Most studies report the relationship between estimates of ability and actual ability to be only moderate.[15] Thus the reciprocal determinism of self-efficacy and performance seems to be without direct empirical support, probably because the longitudinal, repeated-measures data often considered necessary for this purpose are not available. It is possible, though, to model reciprocal effects with cross-sectional data. In the analyses reported in an article, the authors achieved this using a structural model in which the mutual influence of self-efficacy and performance in mathematics is represented as a feedback loop. This model was estimated in each of 33 nations on the basis of data on the mathematics self-efficacy and mathematics achievement of 15-year-olds. First, the reciprocal determinism of mathematics self-efficacy and achievement was supported in 26 of the 30 nations, providing empirical support for this proposition as an explanation for the observed relationship between mathematics self-efficacy and achievement. The model was a good fit to the data in 30 nations and was supportive of reciprocal determinism in 24 of these, suggesting a fundamental psychological process that transcends national and cultural boundaries. Such evidence can suggest the link between culture which is an example of environmental factors correlated to self-efficacy and performance. [16] Taken together, these findings provide persuasive support for Bandura's contention that self-beliefs and per-

13 Ng, J. R., & Earl, J. K. (2008). Accuracy in self-assessment: the role of ability, feedback, self-efficacy and goal orientation. Australian Journal of Career Development, 17(3), 39-50.

14 Athanasou, J. A. (2005). Self-Evaluations in Adult Education and Training.Australian Journal of Adult Learning, 45(3), 290-303.

15 Ng, J. R., & Earl, J. K. (2008). Accuracy in self-assessment: the role of ability, feedback, self-efficacy and goal orientation. Australian Journal of Career Development, 17(3), 39-50.

16 Williams, T., & Williams, K. (2010). Self-efficacy and performance in mathematics: Reciprocal determinism in 33 nations. Journal of educational Psychology, 102(2), 453.

formance iteratively modify each other until the individual comes to a realistic appraisal of his or her self-worth or competence relative to the (mathematics) tasks at hand.

13.1.5 Goal Orientation

According to Locke and Latham (2002), 'A goal is the object or aim of an action, for example, to attain a specific standard of proficiency, usually within a specified time limit'.[17] Elliot (1997) sees goals as cognitive representations that guide individual behaviour by focusing on specific outcomes. These definitions have a common thread that they suggest goal-setting is based on purposeful conscious human behavior.[18] Thus, a goal is that which an individual hopes to reach or attain through purposeful behavior. **Goal orientation** refers to the mental framework that influences how people approach situations of achievement in terms of interpreting the situation and motivation to achieve. Past research suggests that goal orientation may be treated as either an individual trait or a situational characteristic. Button, Mathieu and Zajac (1996) claimed that goal orientation has both the dispositional and situational components.[19] College students who hold a strong learning goal orientation are more likely to pursue challenging activities and to exert greater effort when presented with a difficult class, topic, or activity. this mastery pattern is adaptive in an academic setting and leads to a higher level of achievement.[20] There are two types of goal orientation: performance orientation, where the aim of completing a task is to gain favorable judgments of one's performance; and learning orientation, where the aim is to gain knowledge. Theoretically these orientations produce different behaviors. Individuals with a performance orientation are more likely to avoid challenges and pressure because that might increase the likelihood of failure and consequently be judged negatively by others. For people with performance orientation, their aim is on the performance and external reinforcement components such as positive feedback and judgment on their work or grades in school and taking risks that will result in negative feedback or bad grades lower their motivation to challenge tasks. In contrast individuals with a learning orientation seek out challenges and maintain their motivation even under difficult conditions, for them, failure is also a form of useful feedback. For learners with learning orientation, the process itself is also reward for learning and the result of succeeding or not does not effect them very much because they are more focused on gaining the knowledge which ironically often results in good external feedback and results as well.[21] Button et al., (1996) concluded from their investigations that learning and performance goal orientations were not mutually exclusive, each goal orientation represent a different end of a continuum. Self-efficacious students are better goal setters, because of their willingness to set "close" rather than "distant" goals and the ability to set one's own goals; also it has been shown that these students have an enhance self-efficacy. This also

17 Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. American psychologist, 57(9), 705.

18 Elliot, A. J., & Church, M. A. (1997). A hierarchical model of approach and avoidance achievement motivation. Journal of personality and social psychology, 72(1), 218.

19 Button, S. B., Mathieu, J. E., & Zajac, D. M. (1996). Goal orientation in organizational research: A conceptual and empirical foundation. Organizational behavior and human decision processes, 67(1), 26-48.

20 Vieira Jr, E. T., & Grantham, S. (2011). University students setting goals in the context of autonomy, self-efficacy and important goal-related task engagement. Educational Psychology, 31(2), 141-156.

21 Ng, J. R., & Earl, J. K. (2008). Accuracy in self-assessment: the role of ability, feedback, self-efficacy and goal orientation. Australian Journal of Career Development, 17(3), 39-50.

implies that student-initiated goals and related achievement can be important to the subsequent establishment of challenging goals being applied to complex situations. In other words, perceptions of higher levels of control and goal commitment (self-efficacy beliefs and a willingness to engage in important goal tasks) influence an individual's willingness to set difficult goals[11].

13.1.6 Task Engagement

Self-efficacy is linked with the initial task engagement, persistence of task engagement, and successful performance. In self-efficacy, first setting the goal from the level of self-perceived performance expectation leads to how the student will approach and engage in a task. There seems to be two aspects to task engagement: the first is the willingness or the level of motivation to engage in a given tasks and the second aspect would be the actual attitude and behavior of engaging in the certain tasks. One's ability and willingness to establish challenging yet achievable goals is necessary to evaluate options, make decisions, plan and achieve meaningful accomplishments. A willingness to take on important goal-related tasks and have positive self-efficacy beliefs were associated with those who reported a readiness to set difficult goals. This suggests that an individual, who experiences a general sense of autonomy, may likely extend this perspective to specific situations. Inversely, an individual who experiences a low general sense of autonomy may perceive less autonomy in specific situations. A sense of having autonomy, for example, through the opportunity to choose, is related to confidence in one's ability to complete a task successfully.[22] Individuals, who perceive a margin of control in their lives, might take on difficult goal-related tasks, since they likely feel confident in affecting outcomes. An individual's sense of having some control in life as supported by choice is positively related to a sense of self-efficacy and a willingness to engage in important goal tasks. By its very nature, goal-setting invokes task effort that may include planning in order to increase the probability of success. Goal-setting is thus a key component in self-regulation (Locke & Latham, 2002) and can facilitate learning. Results suggest that before males engage in challenging goal attainment they must perceive themselves as self-efficacious, whereas females are inspired by tasks that are important to them. If the tasks are important, so are the goals, regardless of their difficult nature. One's ability and willingness to establish challenging yet achievable goals is necessary to evaluate options, make decisions, plan and achieve meaningful accomplishments. For example, in two studies, one with undergraduate university students and the other with high school students, Sideridis (2001) found the important task of maintaining a high GPA contributed to normative beliefs in the goal, importance of effort, intention to achieve the goal and positive study behaviors such as organizing and planning, which resulted in satisfaction over the long term.[23] These studies suggest the saliency of goal-setting and self-efficacy in academic achievement. They also imply that student-initiated goals and related achievement can be important to the subsequent establishment of challenging goals being applied to complex situations. The literature indicates that an individual's sense of having some control in life as supported by choice is positively related to a sense of self-efficacy and a willingness to engage in important goal tasks.

22 Bandura, A. (1982). Self-efficacy mechanism in human agency. American psychologist, 37(2), 122.

23 Sideridis, G. D. (2001). The causal role of goal importance for the explanation of student study behaviour: Cross-validation with multiple samples. Educational Psychology, 21(3), 277-298.

13.1.7 Persistence

Persistence is defined as the act of perseverance in spite of obstacles and frustrations. Although the persistence of an individual can be respective to a variety of factors, it is found that the level of self-efficacy in an individual amounts to the extent of persistence in an individual. As self-efficacy refers to the degree of confidence of one's ability to succeed at a task, the strength of one's perceived efficacy accompanied by motivation highly corresponds to the extent to which they persist in a given task. In an observational study made by Hackett and Betz (1981), it was hypothesized that efficacy expectations are associated to the degree of persistence that lead to success in an educational setting. Their study ultimately found that both level and strength of self-efficacy for educational requirements were generally related to persistence and successful academic outcome in students [24]. Motivation is another determining factor that contributes to an individual's persistence. A logistic regression analyses and general linear modelling approach was applied to predicting persistence and academic success in students. In both cases of academic motivation on persistence and academic success, it was proven that amotivation was the single significant motivational predictor in the final models [25]. These results are associated with the level of self-efficacy of the participants as the level of their motivation also seems to branch from the level of their self-efficacy.

Case Study: In another study done by Taylor and Betz (1983), self-efficacy was measured in relation to the tasks required in career decision making. This study was aimed to investigate the theory of self-efficacy beliefs tied with academic success and persistence in students who were considering careers in the science and engineering field. It was discovered that college students' efficacy expectations were dependent on the degree of their career indecision; students who were indecisive about their career path were less confident in their ability to complete the tasks required to make career decisions, and those who had decided on their career path experienced the reverse. The expectations of self-efficacy in completing their education for their specific technical/scientific careers were acquired at the beginning, at the end, and two months following a ten week academic course in career planning. The strengths of individual self-efficacy was then assessed by having students give an estimate of their level of confidence in ability to complete these requirements and duties for career performance. Other correlations that were used to measure the relationship between self-efficacy and academic success included the individual's Math PSAT scores and high school rank and it was found that self-efficacy for technical/scientific educational requirements appeared to be related to objective measures of mathematical aptitude and high school academic achievement. According to Bandura, performance accomplishments are hypothesized to be an influential factor in self-efficacy; based on this notion, the subjects' knowledge of their previous academic performance and aptitude test scores may have had a part in determining their efficacy expectations [26]. On the other hand, the relationship between measured and perceived ability did not correlate, which in turn suggests that the appeal of studying both efficacy expectation and objective ability as they can contribute to the understanding of career-relevant outcomes. Further work can be done in determining a causal connection

24 Lent, R. (1984). Relation of Self-Efficacy Expectations to Academic Achievement and Persistence. University of Minnesota.
25 Lent, R. (1984). Relation of Self-Efficacy Expectations to Academic Achievement and Persistence. University of Minnesota.
26 Bandera, A. (1977). Self-efficacy: Toward a Unifying Theory of Behavioral Change, 84(2), 191-215

between self-efficacy and particular academic behaviors with factors such as objective ability and incentive for performance can be considered in this context.

As much of previous studies on self-efficacy were based on the examination of targets problems, such as phobias, and performance criteria, like behavioral avoidance tests, this particular investigation looked at self-efficacy in various different levels and sets of academic behaviors. The expectations were not confined to an educational setting, but branched out into the consideration of occupational fields titles. The fact that significant relations were found with such variable and nonspecific factors suggests that "self-efficacy may be a relatively robust and flexible model that may help to explain complex as well as relatively discrete behaviors" [27]. Overall, this study resulted in the confirmation of the strength of efficacy expectations in relation to persistence and success in major choice.

13.1.8 Strategy use

Strategy use is a significant factor in determining the level of self-efficacy in individuals and vice versa. The use of strategy enables students to regulate their behavior and and be in control of their learning environment, thus putting a significance on self-regulation in establishing a connection to successful uses of strategy with positive outcomes. Furthermore, the different strategies used by an individual is strongly dependent on their perception of academic efficacy as well as some factors of reciprocal feedback through teachers. According to Zimmerman, students use strategies to regulate three foundational aspects for learning: their personal functioning, academic behavioral performance, and their learning environments [28]. Personal regulation are strategies such as organization, rehearsal, memorizing, goal setting and planning; strategies that are geared towards enhancing behavioral functioning are things such as self-evaluation and self-consequating; and finally, strategies that include students to seek information, keep records and seeking assistance can improve students' immediate learning environment. For those students who are successful in self-regulation seem to have a general understanding of the environment on themselves and hold the ability to improve that environment through the use of strategy. To better understand students' use of these self-regulated learning strategies and the factors that affect motivation for strategy use, we can take a look at Zimmerman and Martinez-Pons' study conducted in 1986. This study was aimed at measuring students' self-regulated learning strategies through the Self-Regulated Learning Interview Schedule (SLRIS). The results found that the measures of strategy use were highly correlated with students' academic achievement [29]; additionally, perceptions of self-efficacy also acted as a determinant of strategy use.

Case Study: The SLRIS that Zimmerman and Martinez-Pon used in their study measured strategy use by asking students to report the methods they used in various learning contexts. Two multiple regression analyses were conducted in order to determine students' perception of academic efficacy in relation to **self-regulated learning strategies**. These learning strategies were then used to predict both verbal and mathematical efficacy, where verbal

27 Lent, R. (1984). Relation of Self-Efficacy Expectations to Academic Achievement and Persistence. University of Minnesota.

28 Zimmerman, B., & Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex. and giftedness to self-efficacy and strategy use. Estados Unidos: American Psychological Association.

29 Zimmerman, B., & Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex. and giftedness to self-efficacy and strategy use. Estados Unidos: American Psychological Association.

self-efficacy was related to the individual's use of strategies such as organization, reviewing notes and seeking peer assistance and mathematical self-efficacy had similar results, with the exception of seeking adult assistance which was negatively correlated. Final results on the strategy use of students indicate that "the achievement of these students in school indicates that a triadic model of self-regulation may have merit for training students to become more effective learners" [30].

In providing individuals with the necessary tools for efficient strategy use, Zimmerman proposes an academic self-regulation model called the SRL model. The theory behind this model outlines how teachers can aid students in becoming more engaged in their learning and lead to improvement in academic performance. The SRL model makes use of an feedback cycle consisting of three phases: planning, practice, and evaluation. In the planning phase, students will have a chance to carefully assess their academic environment and pick a strategy that can most efficiently address their learning goals. During the practice phase, students can implement their chosen strategy and make ongoing adjustments to the plan as they go, also giving them the opportunity to self-monitor their progress. Finally, in the evaluation phase, students can evaluate the effective of each strategy that was used to help obtain their learning goals. This model can be useful in to providing individuals with the necessary techniques to regulate their academic behaviors and control their learning environment.

13.1.9 Effort

Self-regulation strategies alongside self-efficacy successively help maintain the level of effort put forth by an individual. Volition is represented in effort regulation which describes one's willingness towards a given task. Zimmerman and Martinez-Pons (1990) reported that individuals who demonstrate the successful use of self-regulation strategies and hold a high degree of self-efficacy were likely to succeed academically; this demonstrates that self-efficacy helps maintain **volition** and those who are successful in doing so consequently appear to promote the use of self-regulation strategies [31]. Zimmerman's Model of of Self-Regulatory Process explains that learners regulate and maintain their concentration, attention and motivation so that they can learn efficiently and achieve their determined goal [32]. Based on this, there exists a three stage model of self-regulation that includes three cyclical phases involved in the self-relation process: a forethought phase, a volitional or performance control phase, and a self-reflection phase. When a student is engaged in a task, their learning behavior is supported by volitional/performance control. They then regulate themselves by strategies such as maintaining concentration, attention and motivation. The last stage to this model is the reflection on learning outcomes. This reflection helps individuals in maintaining the motivation needed to maintain and improve on their performance for future academic success.

30 Zimmerman, B., & Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex. and giftedness to self-efficacy and strategy use. Estados Unidos: American Psychological Association.

31 Onoda, S. (2014). Examining the relationships between self-efficacy, effort regulation strategy use, and English vocabulary skills. Studies in Self-Access Learning Journal, 5(4), 357-371.

32 Zimmerman, B., & Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex. and giftedness to self-efficacy and strategy use. Estados Unidos: American Psychological Association

Throughout the three stages mentioned, the phase of volition and performance control is a significant factor in looking at effort. When individuals set an initial learning goal in the stage of forethought they are then needed to regulate themselves and use strategies that can allow them to reach their goal. One of the learning strategies used includes effort regulation which is then represented through volition. Furthermore, as motivation is associated with effort and volition, it can then be seen as an essential construct of self-efficacy which ultimately fosters effort regulation. Zimmerman suggests that it is crucial for educators to understand the importance of learners developing self-efficacy because this can positively affect effort regulation strategy use; in order to promote self-efficacy teachers can help learners experience personal mastery experiences such as observing peers, repeated successful experiences and positive feedback that will allow them to improve their effort regulation strategies as manifested by volition [33]. In addition to these ideas, Onoda's results of examining the relationship between self-efficacy and effort regulation strategy use determined that self-efficacy indeed significantly influenced effort regulation strategy use [34]. Through a series of questions based on the Motivated Strategies for Learning Questionnaire created by Pintrich, Smith, Garcia, & McKeachie (1993), it was discovered that self-efficacy developed through previous learning experiences was a determining factor in employing effort regulation as well as their ability to control their learning behavior for successful learning.

13.1.10 Enactive and Vicarious learning

Enactive and vicarious learning represent two different ways of acquiring knowledge [35]. Enactive learning occurs when one learn something by doing it; and vicarious learning refers to the learning that occurs when one observes others perform a task. Enactive learning, because it involves active engagement on a task, may appear to be most important because students can learn the steps to perform a task successfully; however it can also lead to a trial and error cycle if the student do not possess the knowledge required to perform the task. On the other hand, vicarious learning might seem more time effective because one does not actively perform the task and therefore there is no risk for errors, but at the same time it requires students to use more cognitive abilities such as focusing attention on the model that is being observed, and retaining the information intended to be learned. [36] In spite of these differences, much of the learning happens enactively and vicariously; in mathematics for example, students first need to learn the theoretical knowledge of how to

33 Zimmerman, B., & Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex. and giftedness to self-efficacy and strategy use. Estados Unidos: American Psychological Association

34 Onoda, S. (2014). Examining the relationships between self-efficacy, effort regulation strategy use, and English vocabulary skills. Studies in Self-Access Learning Journal, 5(4), 357-371

35 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

36 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

solve a problem before they attend to do it. In fact when both types of knowledge are used, the chances for errors is significantly reduced.[37]

When discussing vicarious learning it is important to distinguish between learning and performance. Although learning might occur by observing a model, performance on a task might depend in several other factors such as motivation, interest, confidence, and several other factors. Self-efficacy might also play an important role in performance of a task that was previously learned by observation. As previously mentioned, self–efficacy is a judgement of one's ability to perform a task in a specific domain. [38] A student who has high levels of self-efficacy, is more likely to perform a task that was learned vicariously. One important question to ask is whether observational learning can improve the self-efficacy of students. Braaksma. M. H and his colleagues claim that indeed the relation between observational learning and self-efficacy can be influenced by the perceive similarities between a student and the model; this means that students who can identify with a model are more likely to learn from observation and increase their self-efficacy. [39]

Because self-efficacy is domain-specific, Braaksma. M. H and his colleagues (2002) [40] examined whether if students could learn more efficiently when observing a model that has more share similarities to them compared to models that are more different. The study involved a written task where participants observed peer models write argumentative texts. The authors separated the participants into three conditions: participants who observed a competent model, those who observed a non-competitive model, and a control group where participants just did the written task without observing any model. Results from this study show that students who were weak at writing benefit more from observing the writing of non-competent models, and strong students benefit more from observing competent models. The results from this study show that perceived model identification is important. The author offer several reasons for this results, perhaps the results can be explained better by individual's need for social comparison and identification. [41] It might be the case that participants who were stronger writers identify more with competent writers since both have more things in common, such as writing style and error recognition. [42]

37 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

38 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

39 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

40 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

41 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

42 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

Another interesting finding from this study is that participants who were considered strong writers benefit from both observation and performance of the written task. According to the authors, strong writers possessed previous information about writing and are probably able to divide their attention between learning and performing. In contrast weak writers, since they might not possess enough information about the task, were unable to do this. Hoover, J. D., Giambatista, R. C., & Belkin, L. Y. (2012) [43] offer some further support for this finding. In their study participants were divided into two conditions: observation-performance, and performance only. The task in this study was a more complicated one compared to the study previously described; it involved negotiation between a buyer and a seller. Participants in the observation-performance condition were able to solve the negotiation problem more effectively than the performance alone condition. Together these findings point out that Vicarious or observation learning can increase performance and consequently raise the self-efficacy of students.

The results from both of these studies described above may have important implications for learning. On the one hand, Braaksma, M. H., et al study (2002) [44]. show the importance of share similarities between models and students. In classrooms, teachers might enhance the learning of their students by asking a student to perform a task infront of his other peers. In math learning for example, a teacher may ask someone who seem to understand the procedures of solving a specific problem to come to the blackboard and solve the problem so everyone could see. By observing peers solving a math problem, students might feel more identified with the model since both share similar characteristics such as level of intelligence, student roles, and even physical characteristics. On the other hand, Hoover, J. D., et al (2012) [45] study show that learning can be enhanced when observation and performance are combined. in classrooms, teachers might ask volunteers to try to solve a similar problem after observing the performance of other students. Observation, can also be important in the classroom because students might also get motivated to try to solve a task after observing one of their peers performance.

13.1.11 Modelling

The results from the studies described above suggest that modeling plays an essential role in learning; in a classroom for instance, students can learn from the performance of teachers and peers on a math problems; However not all models are the same; In Braaksma. M. .H; et al (2002) [46] study, Strong writers benefit more from observing competent models and weaker writer from observing non-competent models. These results suggest that observational

43 Hoover, J. D., Giambatista, R. C., & Belkin, L. Y. (2012). Eyes on, hands on: Vicarious observational learning as an enhancement of direct experience. Academy Of Management Learning & Education, 11(4), 591-608. doi:10.5465/amle.2010.0102

44 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

45 Hoover, J. D., Giambatista, R. C., & Belkin, L. Y. (2012). Eyes on, hands on: Vicarious observational learning as an enhancement of direct experience. Academy Of Management Learning & Education, 11(4), 591-608. doi:10.5465/amle.2010.0102

46 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). **Observational learning** and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

learning might depend somehow on specific characteristics of the model. These results also suggest that similarities between learners and models can be essential for learning. For instance in schools, students might learn more effectively from the performance of peers on a math problem. As it was mentioned in the previous section,there are several explanations for the fact that students are more likely to learn from other students compared to less similar models such as teachers or older peers; one reason is **identification**; students recognize and identify with the characteristics they share with a peer model. Another reason is **social comparison** where students compare themselves to peer models; and a final reason might be related to**Self-evaluation**, that is when students use others as a standard to evaluate themselves. [47] Similarly modelling also serve different functions; according to Bandura (as cited by Schunk, H, D; 2012) [48] there are three main functions of modeling: to facilitate responses, disinhibit student's responses, and provide observational learning. In a classroom students might feel more motivated to participate in a discussion when they see other peers doing the same, and might feel more confident to do so.

Another function of modelling is that it provides the necessary strategies that enhance learning such as active engagement and participation [49]. Improving Classroom Learning by simultaneously Observing Human Tutoring Videos while Problem Solving might be more effective than either watching a video or solving a problem alone [50]; furthermore it is important to encourage students to ask questions, discuss, and use examples to self-explain the material, in oth words it is important o actively involve students in their learning. Craig et al (2009) [51] emphasize the importance of active observation in learning. **Active observation** refers to observing that facilitates engagement with the material so as to facilitate deeper processing (Chi et al; 2008 as cited in Craig et al; 2009) [52]. In a study intended to explore the impact of collaboration on learning, Participants were divided into two conditions; the **collaborative observing tutoring** where students watch a video of a tutor teaching a student how to solve a problem, and a **worked example** where students watch a video of a tutor giving and performing the instructions of how to solve a problem. Participants were given a physics problem to solve right after they watch the videos and again 26 days after they watch the video. The results show no difference in score in the immediate post-test, but students in the collaborative observing tutoring score higher when

47 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

48 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

49 Craig, S. D., Chi, M. H., & VanLehn, K. (2009). In a classroom, Learning can be enhanced by Collaboratively Observing Human Tutoring Videos While Problem Solving. Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

50 Craig, S. D., Chi, M. H., & VanLehn, K. (2009) Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

51 Craig, S. D., Chi, M. H., & VanLehn, K. (2009). Improving Classroom Learning by Collaboratively Observing Human Tutoring Videos While Problem Solving. Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

52 Craig, S. D., Chi, M. H., & VanLehn, K. (2009). Improving Classroom Learning by Collaboratively Observing Human Tutoring Videos While Problem Solving. Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

the task was applied 26 days later. These results suggest that modelling provides essential strategies for effective learning such scaffolding and explanations in order to promote long-term retention of knowledge. [53]

Results of this studies can be easily applied to classrooms. As mentioned in the previous section, teachers can not only enhanced immediate learning by assigning a student to demonstrate how a problem is solved in front of the classroom, but also encourage retention of knowledge. Given that perceived similarities depend on specific characteristics of a model, students might be more complying to look at other students as an extension of their own capabilities. When a student is more skillful at solving a particular problem than another, perceived similarities may play an important role since, a less skill individual might feel more motivated to perform at the same level as the hihly-skill peer. In contrast when a model is perceived to be less similar, such as teaches or older peers,the student's motivation to achieve at the same level might suffer Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002)[54].

13.1.12 Teacher efficacy

In classrooms, teachers and students are equally affected by beliefs about their own abilities to perform a task. In the case of teachers, the beliefs are about their own capability to teach [55] **Teacher efficacy** can be influenced by several factors such as classroom experiences, relation with colleagues, and even school settings. [56] Knoblauch, D., & Chase, M. A. (2015) show that teachers have lower sense of efficacy in urban areas, tAhis was perhaps because of the challenges that urban teaching represent. Teacher efficacy has a great impact on student's learning. [57] Teacher efficacy is associated with effective classroom management, efficient teaching methods, and greater student's achievements. [58] Teachers with high self-efficacy can influence student's performance in several ways; they can encourage **mastery experiences**, provide **verbal persuasion**, and give **informational feedback** (Holzberger, D., et al 2015) [59] In summary, at schools, teachers with high self-

53 Craig, S. D., Chi, M. H., & VanLehn, K. (2009). Improving Classroom Learning by Collaboratively Observing Human Tutoring Videos While Problem Solving. Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

54 Braaksma, M. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. Journal Of Educational Psychology, 94(2), 405-415. doi:10.1037/0022-0663.94.2.405

55 Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. Journal Of Educational Psychology, 105(3), 774-786. doi:10.1037/a0032198

56 Knoblauch, D., & Chase, M. A. (2015). Rural, suburban, and urban schools: The impact of school setting on the efficacy beliefs and attributions of student teachers. Teaching And Teacher Education 45104-114. doi:10.1016/j.tate.2014.10.001

57 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

58 Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. Journal Of Educational Psychology, 105(3), 774-786. doi:10.1037/a0032198

59 Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. Journal Of Educational Psychology, 105(3), 774-786. doi:10.1037/a0032198

efficacy can be fabulous models for students since they can not only raise their academic success but also enhance their learning by providing effective instructions.

In one longitudinal study conducted by Holzberger, D., et al (2015) [60] intended to explore the relation between teacher efficacy and the quality of instructions, students and teachers complete some test intended to measure teacher efficacy (social interaction with kids, and coping with job stress) and quality of instructions (cognitive activation, and mastery experiences). The tests were applied at the end of grade 9 and then again at the end of grade ten in order to measure changes in teacher efficacy or quality of instructions. Results show that scores in teacher efficacy measures change over the course of a year, it either improve or decrease depending on external variables such as student's achievement and curriculum changes. Regarding quality of instructions, scores did not change between time 1 and time 2 suggesting that teacher efficacy and instructional quality are independent of each other and might be explained by other variables such as motivation to keep their jobs. It is important to notice that these results do not imply that teacher efficacy is irrelevant to learning. Even though this study might not show a relation between teacher efficacy and instructional quality, teacher efficacy is associated with other strategies that can enhance learning such as verbal persuasion and provision of feedback Schunk, H, D; 2012) [61].

Another interesting feature that characterized teachers with high levels of self efficacy is related to agency. As previously mentioned, agency is the willingness of a person to act in any given environment. Because at schools, often, there are situations that teachers can control such as classroom management, and situations that teachers cannot control like curriculum demands, teacher efficacy involve the ability to act on those features that can be control. At the begginning of this section, it was established that teacher efficacy is related to effective classroom management, and efficient study methods, these are features that are under the control of teachers. Teachers with high levels of efficacy focus on the things they can control while being aware of the situations that are out of their control (the figure shown below state some other situations that teachers can an cannot control).

According to Bandura (as cited in Woolfolk, A. E., & Hoy, W. K. 1990) [62] the motivation of teachers to manage the classroom and use efficient teaching strategies depend on two factors: outcome expectation and efficacy factors. Efficacy factors refer to individual beliefs that one is capable to perform effectively on a task; in contrast, Outcome expectation refers to individual's judgement about the likelyhood that a positive or negative outcome might happen. Teacher efficacy is a combination of these two factors, for instance a teacher who believe that she can greatly impact the learning of her students (personal efficacy), is more likely to believe that her effort s will result in a positive outcome (outcome expectation).

In a study, Woolfolk, A. E., & Hoy, W. K. (1990) intended to explore the relation between personal efficacy, outcome expectation, and classroom management. Participants in the

60 Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. Journal Of Educational Psychology, 105(3), 774-786. doi:10.1037/a0032198

61 Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

62 Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teachers' sense of efficacy and beliefs about control. Journal Of Educational Psychology, 82(1), 81-91. doi:10.1037/0022-0663.82.1.81

study did a bunch of questionnaires intended to measure personal efficacy, teachers' outcome expectation, and strategies for classroom management. The results show a complex relation between these variables; overall, the results show that teachers who have higher personal efficacy tend to have positive views about outcomes and therefore use more humanistic strategies such as coperative interactions and direct experiences. In contrast, teachers with a lower sense of personal efficacy tend to hold negative predictions about outcomes, and use more rigid and highly control environments in order to manage the classroom. Similarly, teachers with high personal efficacy have more positive views about teaching than teachers with lower efficacy, and therefore spend more effort to encourage intrinsic motivation on their students whereas teachers with lower efficacy tend to use rigid control strategies to elicit specific behaviors on their students [63] The results from this study clearly show that teacher efficacy is a complex construct that involve a combination of personal efficacy and the general beliefs about teaching. these results can serve to explain the findings from Holzberger, D., et al (2015) [64] study. The fact instructional quality can remains the same overtime regardless of teachers'level of efficacy can result from a change in individuals beliefs about teaching but not in the beliefs about personal efficacy. teachers may still belief that they are capable of teaching because of the extrinsic rewards and therefore adopt more controlling strategies; but on the other hand, their intrinsic motivation to teach might be affected.

13.1.13 Collective Efficacy

So far we have discussed self-efficacy, enactive and vicarious learning, teacher-efficacy and how they are related to the reciprocal determinism. This part of the chapter is going to explore the concept of group efficacy. First there is a distinction that needs to be made between collective efficacy and group efficacy. **Collective efficacy** is each individual group member's perception of how well the group will do on the task[65]. Thus each group member could have a different collective efficacy based on their perception of the groups ability. Whereas **group efficacy** is the whole group's perception of how well the group will do on the task[66]. This would include each group member holding the same efficacy This difference is small but is important when interpreting data results. The following discussion will look at collective efficacy, performance goals, group performance, group cohesion, social lofting and school efficacy.

Bandura argued that collective efficacy is related to self-efficacy. He suggested that the four factors that influence self-efficacy also influence collective efficacy. These factors are enactive mastery, vicarious experience, verbal persuasion, and physiological and effective state. He also emphasized social comparison, social influences, mix of knowledge, and past group performance which influence more specifically collective efficacy. Making references to reciprocal determinism these factors each fall under either personal, behavioural or envi-

63 Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teachers' sense of efficacy and beliefs about control. Journal of Educational Psychology, 82(1), 81-91. doi:10.1037/0022-0663.82.1.81

64 Holzberger, D., Philipp, A., & Kunter, M. (2013). How teachers' self-efficacy is related to instructional quality: A longitudinal analysis. Journal Of Educational Psychology, 105(3), 774-786. doi:10.1037/a0032198

65 Mulvey, P. W., & Klein, H. J. (1998)

66 Mulvey, P. W., & Klein, H. J. (1998)

ronmental [67]. Enactive mastery and mix of knowledge are personal factors. They are both related to knowledge that the individual already has which contributes to their feeling of being competent to complete a group task. Vicarious and social comparison are related to modelling which was discussed earlier. These behavioural factors influence collective efficacy. Verbal persuasion, physiological and affect states, and social influences are all related to environmental factors. Socially, these affect how the individual perceives his/her capability to complete a group task. Each of these factors contribute to collective efficacy. Each of these factors interact with one another and together affect collective and group efficacy.

13.1.14 Group Performance/ Performance Goals

Collective efficacy, group performance and performance goals are important aspects to examine. Collectively, research has shown that collective efficacy is related to group performance [68] A higher sense of collective efficacy produces better performance on the task. Those students who perform well on group tasks often have higher collective efficacy than those who do not [69]. For example, if a group is given the task to create a board game, and they have a high collective efficacy they are more likely to perform well. If the performance was done well it would be reflected in the grade or assessment that took place after the project. A way to improve collective efficacy and performance is through setting goals. In addition to group performance, the goals that a group sets are important, too. Research shows that when there are specific goals; overall performance and efficacy is higher than when there are no goals or they are non specific [70]. For example, a teacher might divide the students up into teams and get them to build the highest tower. Here the teacher has set a specific goal which is to build the highest tower. Since students are given a specific goal they should perform well overall than if they were given the instruction to "do your best" when building a tower. As well as making the goals specific it is also important to make them challenging. However, making them too difficult and too easy was negatively correlated with group performance [71] Thus, teachers need to take into consideration of the level of the students and their capabilities when setting group goals. For example, giving kindergarteners the task of designing a science experiment is too difficult for them, but giving the same task to fourth graders would be more appropriate. Once group goals are set, the group needs to make a commitment to these goals. Research shows that if a group has high

67 Seijts, G. H., Latham, G. P., & Whyte, G. (2000). Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

68 Mulvey, P. W., & Klein, H. J. (1998). The impact of perceived loafing and collective efficacy in group goal processes and group performance. Organizational Behavior And Human Decision Processes, 74(1), 62-87. doi:10.1006/obhd.1998.2753

69 Stajkovic, A. D., Lee, D., & Nyberg, A. J. (2009). Collective efficacy, group potency, and group performance: Meta-analyses of their relationships, and test of a mediation model. Journal Of Applied Psychology, 94(3), 814-828. doi:10.1037/a0015659

70 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

71 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

efficacy they are more likely to commit to their goals [72]. This makes sense considering that if the students perceive that the task needs to be attended to, has specific goals, and feels that they are capable of completing the project, they are more likely to be committed to the project. Higher commitment is also shown to correlate with persisting when difficulties arise in the project[73]. Further discussion on persistence was discussed earlier in the chapter. Students need specific, challenging goals, and to make a commitment to these goals in order to achieve high collective efficacy and high group performance.

Another aspect is whether a task requires high interdependence or low interdependence. If a task has high interdependence, the group members are more likely to rely on one another and develop a higher group efficacy [74]An example of this would be a group project that consists of performing a skit. The members have to rely one on another to perform the skit and all members have to be present when performing the skit. Whereas, a group that has low interdependence are more likely to not rely on group members and will have a lower group efficacy. An example of a group project would be the creation of this Wiki book. Although each of us are in a group and each group is creating a chapter we must likely divide the chapters up. This allows for each member to do their own part and not have to rely on other group members. In addition, at the end of the project we are getting marked individually. This project overall promote lower group efficacy.

13.1.15 Group Cohesion

Another way to increase collective efficacy is making sure the group has cohesion.**Group's cohesion**,is defined as an attraction to group members and each group member wants to work with the others[75]. It can also be defined as group members who are interested in the same subject or have a collective mind. Higher group cohesiveness is an important predictor of group performance [76]. Thus the more cohesive the group, the better they will perform, and the higher the collective efficacy they will have. In order to achieve group cohesion a teacher should allow students to pick their groups. This would address the aspect of each group member wanting to work together. However, it should be emphasized the group's goals and the expectation of the group this will promote commitment and collective efficacy. In addition, one of the downfalls of group work is that the students get off task. A study that observed high school adolescents found that they were able to complete group work while staying on task, whereas elementary school children were more likely to become off task. This could be due to the seating arrangements. In elementary school they are more likely to sit in groups, and have a lot of opportunity to interact with each other in informal

72 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

73 Goncalo, J. A., Polman, E., & Maslach, C. (2010). Can confidence come too soon? Collective efficacy, conflict and group performance over time. Organizational Behavior And Human Decision Processes, 113(1), 13-24. doi:10.1016/j.obhdp.2010.05.001

74 Seijts, G. H., Latham, G. P., & Whyte, G. (2000). Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

75 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

76 Huang, C., (2009). Knowledge sharing and group cohesiveness on performance: An empirical study of technology R&D teams in Taiwan. Technovation, 29(11), 786-797. doi:10.1016/j.technovation.2009.04.003

situations thus making it easier for them to go off topic. Whereas high school students are more likely to sit in rows or individually so when they were put into groups they were only in groups to complete a task. This association with being in a group and completing a task makes it more likely they will stay on task.[77] Further, research has shown that it takes up to seven weeks to fully develop group cohesiveness. These seven weeks allow the group time to work together, and develop their collective efficacy [78]. If the group sees that they are able to perform well on previous tasks, this will increase their collective efficacy. Thus it is important for teachers to let the child work with the same group for longer periods of time. However, there is research that contradicts this assumption. Research conducted by Goncalo, Polman, and Maslach shows that having a high sense of collective efficacy right at the beginning of a project can be detrimental to the group's overall performance. Having a high sense of efficacy can reduce the beneficial forms of conflict that is essential to group work[79]. Even though previous research has suggested that it takes seven weeks for a group to develop collective efficacy some groups may develop it early[80]. In addition, one group may develop high group efficacy from working with each other previously. It is uncertain if a group who has worked together previously and has a high group efficacy, will miss out on the beneficial forms of conflict. Beneficial forms of conflict include disagreeing on how to carry out the project, and reconstructing the information through discussion, evaluation, and consensus. For example, take this Wikibook project, if I had worked with my group members previously and we received a favourable performance outcome and had developed a high collective efficacy we might have gone about the project in a different way. At the beginning of the project we might not have changed our outline because in the past we had done well. As well, when we were in the final stages of editing we might not have put in as much time and effort because in the previous task we had done well. Our group discussed ways to improve our project, which included using more examples, adding pictures, and how to make the project flow better. Once again we might not have talked about it at such length if we had already established high collective efficacy. In conclusion, it may not be as beneficial as once thought for students to work together on multiple projects; there needs to be more research to further support this assumption[81]. Another important note to be made is that self-efficacy is normally discussed as being domain specific, as was mentioned earlier in this chapter. This can also be used in relation to collective efficacy[82]. Children should be placed in different groups for different subjects. To further illustrate this point, a baseball

77 S., Howe, C., & Boyle, J. (2012). Exploring the characteristics of small groups within science and English secondary classrooms. Cambridge Journal Of Education, 42(4), 527-546. doi:10.1080/0305764X.2012.73334

78 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

79 Goncalo, J. A., Polman, E., & Maslach, C. (2010). Can confidence come too soon? Collective efficacy, conflict and group performance over time. Organizational Behavior And Human Decision Processes, 113(1), 13-24. doi:10.1016/j.obhdp.2010.05.001

80 Klein H. J., Mulvey P. W., (1995) Two Investigations of the Relationships among Group Goals, Goal Commitment, Cohesion, and Performance. Organizational Behaviour and Human Decision Processes, 61(1), 44-53. doi:10.1006/obhd.1995.1004

81 Goncalo, J. A., Polman, E., & Maslach, C. (2010). Can confidence come too soon? Collective efficacy, conflict and group performance over time. Organizational Behavior And Human Decision Processes, 113(1), 13-24. doi:10.1016/j.obhdp.2010.05.001

82 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

team might have high collective efficacy while playing baseball but they may not have a high sense of collective efficacy in completing a science experiment. Thus, they should be put in another group when performing different tasks of task to allow each member the opportunity to achieve collective efficacy. Some groups can be picked based on who the children want to be with and other groups could be picked based on interest. A group's cohesion, is related to the environmental aspect of the reciprocal determinism. The other group members are the environmental aspect that influences group cohesion and collective efficacy. Another aspect of the environmental reciprocal determinism, is the size of the group.

The size of groups affects group performance and group efficacy. A research study showed that groups of three had higher group efficacy than those in groups of seven [83]. In addition, group members in smaller groups are more likely to stay on topic and complete the task[84].The article suggested that the lack of group efficacy was due to the difficulty communicating within larger groups and multiple personal interest took over group goals. However, it was mentioned that the key to group size depends on the type of task at hand. Even though the article suggested that groups of three are good for multi motive tasks other tasks might produce higher group efficacy in larger groups[85]. This would explain why sports teams work together well even though they consist of a larger group of people. Thus, if you are getting students in the class to build a tower this is best done in small groups to reduce the lack of communication. However, activities such as trivia would be better suited to larger groups. This is because each child in a group will have different knowledge which will lead to better performance and higher group efficacy. Cohesion and group size are important aspects of a groups performance outcomes and efficacy.

13.1.16 Social Loafing

Figure 24

83 Seijts, G. H., Latham, G. P., & Whyte, G. (2000). Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

84 S., Howe, C., & Boyle, J. (2012). Exploring the characteristics of small groups within science and English secondary classrooms. Cambridge Journal Of Education, 42(4), 527-546. doi:10.1080/0305764X.2012.73334

85 Seijts, G. H., Latham, G. P., & Whyte, G. (2000). Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

The discussion so far has been about how to improve collective efficacy through specific and difficult goals, making groups interdependent, group cohesion, and adequate number of group members. One pitfall of group work is **social loafing** ***'which is an environmental factor. This occurs when a group member or members do not pull their weight in a group project [86]. Ideally teachers would like to think that when they put students in groups that each one will contribute equally to the project. However, this is not the case as many students have experienced. There is always the one person in the group who never pulls their weight which has negative consequences for the other group members. Research has shown that when there is a group member that is not pulling their weight other group members put less effort into the project. This leads to a lower group performance and collective efficacy [87]. A way teachers can avoid this is to make specific and challenging goals, promote each group's interdependence, group cohesion and use adequate number of students in each group. In addition to making sure that there is an evaluation at the end of the project that includes what contribution each person made to the project. This evaluation is best done with the other group members not present in order to make each member feel more comfortable about saying what each member truly contributed to the project. This type of evaluation will lead to the social loafer getting the grade he or she should receive for their contribution. This should also help with the other members still putting in adequate effort despite having a member who is a social loafer.***

13.1.17 School efficacy

We have addressed three different efficacy's in this chapter. Although they each have their own defining characteristics they are also similar. **School efficacy** is the belief of the school that the students can perform well, and this includes the students and the teachers. Research has found that if a school collectively feels incapable of improving the learning of the students both the students and the teachers efficacy decreased. In context, students who have high self-efficacy because they have done academically well before is related positively to school efficacy. Some factors that contributed specifically to school efficacy are the SES status of the students and the stability of the students. Students who come from low SES status and do not show up to class often affects the school efficacy negatively [88]. In order to promote a higher school efficacy both the students and the teachers efficacy need to improve. There are suggestions as to how to improve efficacy in previous sections.

Collective efficacy stems from self-efficacy and has similar factors that affect it. Those factors include enactive mastery, vicarious experience, verbal persuasion, physiological and effective state, performance goals and persistence. However, collective efficacy is associated with being in a group and thus has some different factors that affect an individuals collective

86 Mulvey, P. W., & Klein, H. J. (1998). The impact of perceived loafing and collective efficacy in group goal processes and group performance. Organizational Behavior And Human Decision Processes, 74(1), 62-87. doi:10.1006/obhd.1998.2753

87 Mulvey, P. W., & Klein, H. J. (1998). The impact of perceived loafing and collective efficacy in group goal processes and group performance. Organizational Behavior And Human Decision Processes, 74(1), 62-87. doi:10.1006/obhd.1998.2753

88 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

efficacy. These include group cohesion, interdependence of the group task, group size and the phenomena of social lofting.

13.1.18 Implications for Instruction

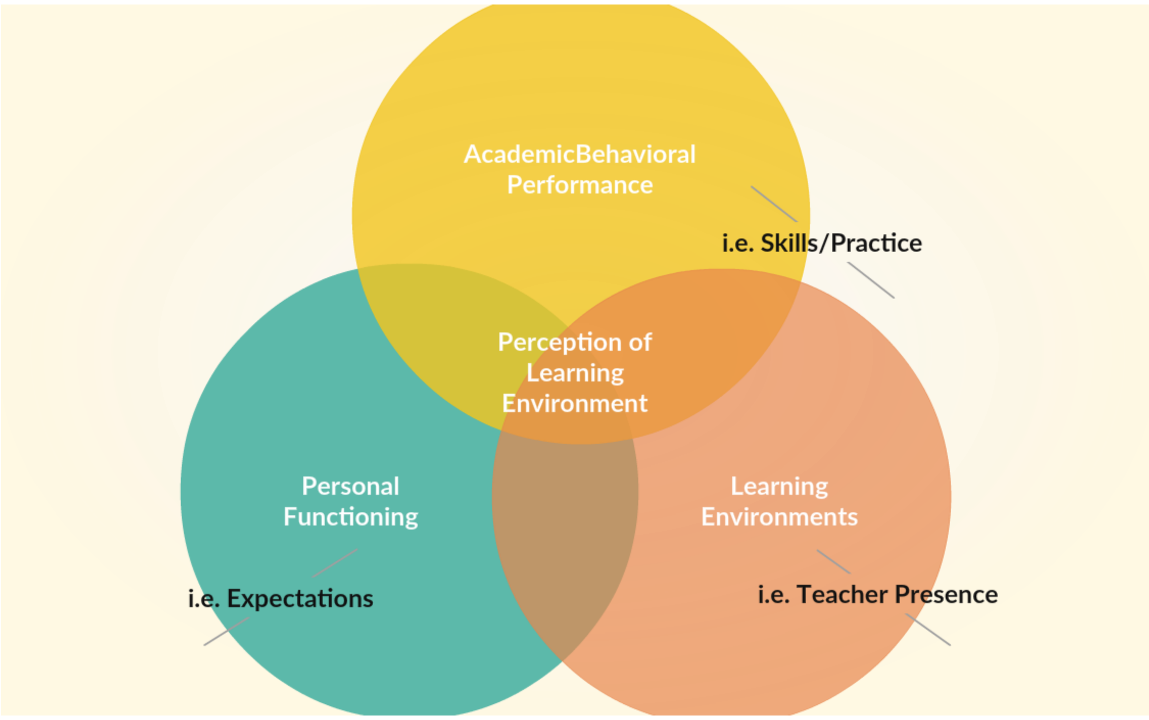

Figure 25 Self-Efficacy - Teaching Presence

Self-efficacy stands as a significant factor in fostering self-regulation in students and have proven to enhance the quality of their learning. This leads to its implications within a classroom that demands the consideration of other factors, such as teachers. One of the most significant drivers of a learning environment are the teachers themselves. It has been shown that an individual's own perception of self-efficacy was the final determinant of their success and in addition to having successfully acquired the motivation and effort to use self-regulated learning strategies, a teacher may incorporate constructivist learning environments to encourage or enhance these behaviors. As shown in the venn diagram below, personal factors, academic behavioral performance and learning environments interrelate with one another, showing how one factor affects another. Adopting a student-centred approach to learning and teaching can lead to an increase in student involvement; exerting a positive influence on students' affective and cognitive domains, as well as their perception of the learning environment [89]

Implications for teaching from the above discussed theories of especially task engagement and goal orientation suggest that team-based learning is very successful when students take

89 Ning, H., & Downing, K. (2012). Influence of student learning experience on academic performance: The mediator and moderator effects of self-regulation and motivation (2nd ed., Vol. 38, pp. 219-237). British Educational Research Journal.

ownership of a complex problem, and engage the problem in a collaborative and systematic manner. Team-based learning environments provide students with opportunities to solve complex problems resulting in their developing greater self-confidence in their abilities. Understanding the relationship of goal-setting in the learning process can facilitate a positive team effort experience for students through a learning and iterative process. Students, who successfully learned through collaboration, might be intrinsically motivated and self-efficacious when placed in other team-based learning settings. However, students who are inexperienced in this environment or who do not have sufficient knowledge of the subject might require additional guidance in order to have a satisfying experience. If this guidance is not provided, the experience could be not very satisfying, and thus have a negative effect on intrinsic motivation, self-efficacy beliefs and team-based learning in general. So, it might be more effective to expose upper class undergraduate students to collaborative learning projects, where it is assumed that they possess the minimum required subject knowledge so that they can successfully apply what they know to the experience: participate in collaborative activities involving critical thinking, and formulate creative and innovative solutions by setting goals.

Teacher efficacy can offer learning strategies that could be beneficial for students; Even though Craig's et al (2009) [90] study found no relation between teacher efficacy and instructional quality, Teachers with high sense of efficacy can contribute to learning by providing other means to enhance learning such as providing constructive feedback. Teachers can be an important model for students, especially when they incorporate the individual needs of students.Teachers can encourage students to use both enactive and vicarious learning in order to enhance the learning process. Apparently, the most effective way of learning involves learning occurs when students can observe teachers performance, and have some opportunity to apply the learned skills on a similar task. For example, in a math problem, students might benefit from observing a teacher or peer solve a problem, as well as by solving the problem themselves; this allows students to apply the knowledge they learn by vicariously.

In order to promote collective efficacy in group settings teachers should make sure their performance goals are clear, specific and challenging. Making sure the students know exactly what is expected of them for specific tasks allows the students to develop collective efficacy.

Allowing for group cohesion with the right amount of members in the group allows for better performance and overall higher collective efficacy. Group cohesion can be achieved by allowing students to pick their groups and let them work in their groups throughout the school year. In addition, making sure the groups are appropriate for the task at hand is essential. Smaller groups should be used for more intimate projects, larger groups should be used when vast knowledge is needed to complete the task, or in group sports the necessary amount of players needed in order to play the sport.

90 Craig, S. D., Chi, M. H., & VanLehn, K. (2009). Improving Classroom Learning by Collaboratively Observing Human Tutoring Videos While Problem Solving. Journal Of Educational Psychology, 101(4), 779-789. doi:10.1037/a0016601

13.1.19 Conclusion

Social cognitive theory provides a framework for the constant changing of human behavior. In order to be able to understand and predict such behaviors, it is important to consider the variables that interact amongst each other and how those interacting factors are determined. The essence of social cognitive theory based on the theory that learning is the product of observation. It also considers these foundational interacting variables that come together to explain Bandura's concept of reciprocal determinism as the basics for the theory of social cognition. Our chapter outlines three different elements that contribute to the social cognitive theory as well as cognition and instruction. Within these elements include self-efficacy, enactive and vicarious learning, and collective efficacy. Self efficacy determines how an individual perceives their own abilities and the level of confidence they have for achieving their goals and well as their abilities. Drawing from self-efficacy, we move on to enactive and vicarious learning that represents the ways we acquire knowledge. Enactive learning refers to the way an individual learns something by doing it, and vicarious learning occurs through observation of others performing the given task. Both learning styles are used in different cases, but the use of both are proven to be the most successful. In relation to self-efficacy, learning through observation - vicarious learning - can improve self-efficacy as it gives individuals a chance to identify with a model and lead to self-regulation. Furthermore, collective efficacy explains the individual perception of success of the group. Bandura argues that collective efficacy greatly relates to self-efficacy as there are factors that influence both efficacies. These factors come back down to the influence of personal, behavioral and environmental components of the reciprocal determinism model.

It is said that environments and social systems are greater influencers of human behavior; thus, the social cognitive theory justifies that different factors do not affect individual behavior in a direct manner, but instead affect them to a degree that influence other factors such as one's aspirations, self-efficacy beliefs, personal standards, emotional states, and other self-regulatory influences (Pajares, 2002). Our chapter determines how these different influences and factors co-exist and affect the basic components of Bandura's reciprocal determinism theory.

13.2 Suggested Readings

Burney, V. H. (2008). Applications of social cognitive theory to gifted education. Roeper Review, 30(2), 130-139. Effect of self- and group efficacy on group performance in a mixed-motive situation. Human Performance, 13(3), 279-298. doi:10.1207/S15327043HUP1303_3

Phan, H. P., & Ngu, B. (2014). Factorial equivalence of social cognitive theory: Educational levels × time differences. Educational Psychology, 34(6), 697-729. doi:10.1080/01443410.2013.814190

Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, T. Urdan, C. B. McCormick, G. M. Sinatra, J. Sweller, J. Sweller (Eds.) , APA educational psychology handbook, Vol 1: Theories, constructs, and critical issues (pp. 101-123). Washington, DC, US: American Psychological Association doi:10.1037/13273-005

13.3 Glossary

'**Active observation:** Observation that facilitates engagement with the material

Agency: capacity of a person to act in any given environment

Collaborative observing tutoring: Ovservation of the teaching interaction between a teacher and a student

Collective efficacy: This type of efficacy refers to the individual's perspective of how well the group can accomplish their task.

Enactive learning: Learning by doing performing a task

Group Cohesion: Is an attraction to group members as well as group members who are interested in the same subject or have a collective mind.

Group efficacy: This type of efficacy refers to the group's perspective as a whole in how well the group can accomplish their task

Goal Orientation: refers to the mental framework that influences how people approach situations of achievement in terms of interpreting the situation and motivation to achieve

Identification: Feeling close to a person that has similar characteristics as yours

Informational feedback: Feedback that helps improve performance

Learning: Act of acquiring new knowledge

Learning Orientation: aim of completing a task is to gain knowledge

Mastery experience: performance that leads to learning

Performance: Process of completing an action

Performance Orientation: aim of completing a task is to gain favorable judgments of one's performance

Persistence Continuing in a course of action despite difficulties

Reciprocal determinism: term coined by Bandura to describe the foundation of his theory of social cognition— psychological functioning involves a continuous reciprocal interaction among behavioral, cognitive, and environmental influences

School efficacy: This type of efficacy refers to the school as a whole in relation to how they can effectively promote learning in their school. It is closely related to student and teacher efficacy.

Self-efficacy: how the individual perceives ones own abilities and the level of confidence for achieving goals from the perceived abilities

Self evaluation: Evaluating one self according to a standard

Self-regulated Learning Strategies Uses of students' strategies that regulate individual behaviour

Social comparison: Determine self worth by comparing ourselves to others

Social Lofting: This happens when one person in the group does less work than the other members in the group

Subjective operative capability: the concept that efficacy beliefs form the foundation of human agency as people need to believe that they can produce results by their actions in order or else the incentive or the reinforcement to act is very little

Teacher efficacy : teacher's own belief about their teaching skills

Verbal persuasion:convince someone to do a task by using verbal communication skills

Vicarious learning: Learning by observing others

Worked examples: Explanation of how to solve a problem

Volition Cognitive process that allows one to decide on committing to a course of action.

13.4 Reference

Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teachers' sense of efficacy and beliefs about control. Journal Of Educational Psychology, 82(1), 81-91. doi:10.1037/0022-0663.82.1.81

13.5 Social Contexts of Learning

This chapter discusses beliefs about the social contexts of cognition, and how social and cultural factors can influence a child's development of mind (thoughts). In the subsequent sections of this chapter, we will discuss social cognition, situated cognition, Bronfenbenner's ecological model, the child in culture, social interaction/cognitive tools, socio-cultural contexts of learning, implications for instruction, and individual contextual differences. Situated cognition theory identifies features of the environment relevant to immediate conversational contexts, interpersonal relationships, and social group memberships. It also increases our understanding about how these features shape thoughts and actions. We also look into Bronfenbenner's ecological model and it's influence on a child's learning environment. In the socio-cultural context, Vygotsky theorized that human development was inseparable from cultural and social development and that these social interactions help children to develop cognitive tools. These cognitive tools develop skills specifically tied to an individual's personal culture and social experiences and include language/speech and cultural production. As time progresses, these skills become internalized in the zone of proximal development. In relation to instructional implications, placed based, culturally based, and cooperative learning techniques are discussed. It will help future educators use this theory and research effectively, and apply it to a practical classroom setting. Individual Contextual Differences have various influences on our cognitive development. It encompasses both Bronfenbrenner's theory about the influence of the microsystem and macrosystem in regards to child development and Vygotsky's theory on social and cultural factors being essential to cognitive development. Therefore, we look at how differences in societal, classroom and institutional settings have an effect on a child's cognitive development. The social context in which cognitive processes take place are highly influential in the development of mind.

13.5.1 Social Cognition

Social cognition focuses on the theory of mind. Theory of mind is a broad concept, encompassing and understanding the full range of mental states, as well as the antecedents and consequences of such understanding.The social context is made up not only of our relationships with specific others but also the groups we identify. As we continue to develop and associate with certain social groups, this becomes a part of our “social identity”[1]. These social groups establish norms, or standards for correct and appropriate beliefs, opinions, and behaviors. For example, it may be the ”norm” to use inappropriate language with your friends, but not with your parents or family members . Such norms influence our behavior all the time, whether other members of the social groups are physically present or not. This social identity is activated by situational reminders of our social group membership or by our own intentional thought. Once this identity is activated, we tend to conform to that group’s norms. [1].

Social identities serve as behavioral guides for appropriate behavior. This can have some negative effects. If define social identity by our social group membership that we share with some people but not others, it divides the world into ‘us’ and ‘them.’ Shaping how we think about and behave toward other people. People on the ‘us’ side of the line, are considered group members and are therefore better liked.[2] In a school context, children can often become victims of bullying if they do not identify with a popular social group, and adopt a social identity that suits their peers ”cultural norms”.

In order to understand the development of social cognition and social identity, we must examine situated cognition. Cognition almost invariably occurs in the context of other people. It refers to the web of face-to-face encounters, personal relationships, and social group memberships that make us who we are. Not only do these social entities very frequently constitute the content of our thoughts and feelings, but they fundamentally shape the processes underlying our thinking and behavior as well. To detail some of the evidence for this broad claim, this chapter describes the interface of situated cognition, the ecological model of development, and the child in culture. The social context of cognitive development has to do with our thoughts and beliefs about the social world. It also refers to our beliefs about others, the self, people in general, specific aspects of people (e.g., thoughts, desires, emotions), social groups and social institutions[3]. Situated Cognition

Situated cognition is centered on the idea that knowing is “inseparable” from actually doing and highlights the importance of learning within context[4]. The Situated Cognition Theory is based upon principles related to the fields of anthropology, sociology, and cognitive sciences. Its main argument is that all knowledge that a learner acquires is somehow situated within activities that are social, physically or culturally-based. The Situated Cognition Theory mainly supports, that the acquisition of knowledge cannot be separated from the context in which this knowledge is collected. Therefore, a learner must grasp the concepts and skills that are being taught in the context in which they will eventually be utilized. As a result, instructors who are trying to apply this theory in their classes are encouraged to create an environment of full immersion, wherein students must be able to learn skills, as well as new ideas and behaviors that are taught in the context in which they will be used at a later time. Collins, Brown, & Duguid are creators of the situated cognition model, and believed that learning culture played a major role in education, and that learning by doing was an often overlooked approach[4].

Situated cognitive learning emphasizes that learning in the real world is not like studying in school. It is often describe as acculturation or adapting the norm, behavior, skills, belief, language, and attitudes of a particular community. This community might be mathematicians, gang member, writers, and students of any group that has particular ways of thinking and doing. Knowledge is seen not as individual cognitive structures but as a creation of the community over time. The practices of the community, the way of interacting and getting things done, as well as the tools the community has created constitute the knowledge of that community. Thus learning means becoming more able to participate in those practices and using the tools. Situated cognitive learning emphasizes the idea that much of what is learned is specific to the situation in which it is learned[3]. However, situated cognitive learning says that knowledge and skills can be applied across contexts, even if the context is different from the initial learning situation. For example, when you use your ability to read and calculate (which you learned in school), to complete your income taxes, even though learning how to do your taxes was not part of your original high school curriculum[5]. In this situation, the student would be applying their mathematics and reading skills which they learned in the classroom, to the real world. Demonstrating how situational learning can be applied across different contexts.

Situated cognition offers the key insight that cognition is for adaptive action, our minds evolved under the demands of survival rather than for detached puzzle-solving or abstract cognition. This principle implies the existence of close connections between cognition, motivation, and action. Cognition is generally not neutral and detached, but is biased by the individual's motives and goals, with motives shaping our thoughts. Consider a person's understanding of the meaning of traits (such as reliable, honest, or intelligent), which are basic components of our impressions of other people as well as ourselves[2]. Research shows that our definitions of such traits are not objective and invariant, but are shaped in self-serving ways by our own perceived understandings of those traits. Also the fundamental human need to belong shapes our social cognition. People experiencing a heightened need to belong, after a social rejection; tune their attention and cognition to process social information in the environment more carefully and thoroughly. This example of biases in cognition caused by the perceives motivational concerns effectively illustrate how social cognition serves the needs of adaptive action important in determining the course of cognition [6]. There is evidence that social-cognitive development and learning recognizes that individuals develop through reciprocal interactions, in which people contribute to an individuals development. These social interactions, are rooted in the situation in which it occurs. Research on reciprocal transactions between organisms and the environment is a basic feature of Brenfenbenner's ecological theory.[7] Social-cognitive learning states that a child's personality functioning differs among individuals. Personality is understood by reference to basic cognitive and effective structures and processes. These personality variables develop through experiences with one's sociocultural environment. Social-cognitive development differentiates among a number of distinct cognitive capacities contributing to personality functioning. These include cognitive mechanisms that underlie skills and social competencies, knowledge structures through which people interpret or "encode" situations, self-reflective processes through which people develop beliefs about themselves and their relation to the social environment, and self-regulatory processes through which people establish personal goals and standards for performance and motivate themselves to reach desired ends[8]. In the next section, Bronfenbrenner's theory divides the community in which a child grows up into four systems. The community in which a child develops, will ultimately effect the situation in which the child learns, a child's interpersonal relationships and who they associate with. As previously mentioned, social cognition and situational cognition explain the development of a child's mind, but both can be largely influenced by a child's environmental context. Bronfenbrenner outlines some of these social contextual influences in his ecological model.

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13.5.2 Ecological Model

Bronfenbenner's Ecological Model

Ecological Model.gif

Bronfenbrenner provides an ecological model for understanding human development. He explains that children's development within the socio-cultural context of the family, community, broader society and the educational setting. All have an impact on the developing child, because all the various contexts are interrelated. For example, even a child in a supportive, loving family within a healthy, strong community is affected by the biases of the larger society, such as racism, sexism or violence, and may show the effects of negative discrimination and stereotyping. Bronfenbrenner's ecological context of child development and learning can be depicted as a series of concentric rings as with each system influencing and being influenced by the others[7] for example:

Microsystem

Bronfenbenner's theory: The microsystem is the system closest to the person and the one in which they have direct contact. Some examples would be home, school, daycare, or work. A microsystem typically includes family, peers, or caregivers. Relationships in a microsystem are bi-directional. In other words, your reactions to the people in your microsystem will affect how they treat you in return. This is the most influential level of the ecological systems theory.

Let's look at the microsystem in Marian lives. The first part of his microsystem is her home environment. This includes his interactions with her parents and little sister. Marian's school is also part of her microsystem. Her regular school interactions are with her kindergarten teacher and the other children in his class[9].

Mesosystem

The next level of ecological systems theory is the mesosystem. The mesosystem consists of the interactions between the different parts of a person's microsystem. The mesosystem is where a person's individual microsystems do not function independently, but are interconnected and assert influence upon one another. These interactions have an indirect impact on the individual.

One aspect of Marian's mesosystem would be the relationship between her parents and her teacher. Her parents take an active role in her school, such as attending parent/teacher conferences and volunteering in her classroom. This has a positive impact on her development because the different elements of her microsystem are working together. Marian's development could be affected in a negative way if the different elements of her microsystem were working against one another[9].

Exosystem

The exosystem is the next level we will examine. The exosystem refers to a setting that does not involve the person as an active participant, but still affects them. This includes decisions that have bearing on the person, but in which they have no participation in the decision-making process. An example would be a child being affected by a parent receiving a promotion at work or losing their job.

One part of Marian's exosystem would be his father's workplace. Marian's father is in the Navy. This often takes her away from the family, and she sometimes does not see her father for months at a time. This situation impacts Marian, and she becomes anxious when her father leaves. Marian's anxiety has an effect on his development in other areas such as school, even though she has no interaction with her father's work or say in the decision making process, but this may have impact her learning environment[9].

Macrosystem

The fourth level of ecological systems theory is the macrosystem. The macrosystem encompasses the cultural environment in which the person lives and all other systems that affect them. Examples could include the economy, cultural values, and political system. The macrosystem can have either a positive or a negative effect on a person's development. For an example, consider the different effects on the development of a child growing up in a third-world economy versus that of the United States.

Ecological theorists such as Bronfenbrenner[7] point to the importance of the settings and circumstances in which students live for understanding children's behavior and establishing productive programs and policies to promote the development of children and youth. Teachers make many decisions that can be informed by an understanding of the context in which children live. These decisions include curricular and instructional decisions about materials and methods used in the classroom. Teachers' guidance of children's classroom learning can be fostered by understanding how the knowledge, practices, and language socialization patterns within children's families and communities contribute to children's ability to function in the classroom how to communicate and work with children's families,[7] as well as how to promote children's participation and positive social relations in the classroom influence by cultural and social context. The Child-in-Culture

The child in culture, it is important for teachers to learn about the culture of the majority of the children they serve if that culture differs from their own. Recognizing that learning and development are influenced by cultural and social context, it would be an impossible task to expect teachers/caregivers to understand all the nuances of every cultural group they may encounter in their practice. It is more important for teachers/caregivers to become sensitive to the knowledge of how their own cultural experience shapes their perspective and to realize that multiple perspectives must be considered in decisions about children's learning and development, in addition to their own. Children have the learning ability and capability to function simultaneously in more than one cultural context. However, if teachers/caregivers set too low or too high expectations for children based on their home language and culture, children cannot learn and develop optimally and reach their full potential. The ideal would be for example, that children whose primary language is not

English should be able to learn English without forcing them to give up their home language and to get a teacher/caregiver to translate or teach in both languages. Likewise, children who speak only English benefit from learning another language. The goal is that all children learn to function well in the society or even community as a whole and move comfortably among groups of people who come from both the same and different backgrounds[10]

In understanding the mind of the child (learner), teachers must also understand that each student is an individual who is developing a sense of self and relationships in a variety of contexts, notably the family, school, and community.[9] Hence, teachers considered themselves least knowledgeable about issues concerning diversity and schooling effects on students. This perception exists despite major efforts made at the national level to provide guidelines for preparing teachers to teach culturally diverse students.[11] Research suggests that there is both cause for concern and hope for improvement. For example, Hollingsworth,[12] indicate that novice teachers' views of children are often inaccurate because they assume that their students possess learning styles, aptitudes, interests, and problems that are similar to their own.[12] Furthermore, recent research suggests that prospective teachers hold simplistic views of student differences have little knowledge about different cultural groups, may have negative attitudes toward those groups, they Teachers) may view diverse backgrounds of students as a problem, and have lower expectations for the learning of ethnic minority students.[12]

For some children, these points of difference may not have much effect. But for others, the mismatch between parental or community expectations and the expectations of the formal learning environment may leave the child feeling as if he or she is straddling two distinct worlds. How we think about child in culture can help us move toward greater sensitivity or, alternatively, can create additional roadblocks to our ability to engage and work with families. Early calls for cultural competency sometimes put forward a list of observed parenting traits of minority cultures with little explanation of how these aspects of culture may be part of a whole and with little understanding of the cultural participants' intention behind these actions. This type of thinking, though well-meaning, can solidify stereotypes instead of helping us penetrate them. Educators, open to embracing the diverse cultures represented in their classrooms, had little guidance in how to achieve this sensitivity in more than just a superficial way. One observation notes that ironically, teachers may conscientiously try to create culturally sensitive environments for their students (e.g., through multicultural displays and activities) while simultaneously structuring classroom interaction patterns that violate invisible cultural norms of various non-dominant groups. Teachers may also inadvertently criticize parents for adhering to a different set of ideals about children, families and parenting[13].

Research have shown that in many content domains when children are asked to learn or solve problems based upon materials with which they are familiar, or in ways that make "human sense" they learn more rapidly. These relations between culture and learning do not fade away, but become even more pronounced as children move from early into middle childhood and adolescence. Consequently, those concerned with leveraging the power of culture to promote learning should take care to pay as much attention to the cultural enrichment of children as to their health and physical well-being, all of which play an especially important role during this period of extraordinarily rapid developmental change[13]. Cognitive Tools and Social Interaction

The previous sections have mentioned how a community influences cognition by determining the context in which a child learns about the social and cultural rules around them[5]. This community also determines the situation in which learning and cognitive development takes place. For example, a child who grows up in a rural town in Saskatchewan is going to have grown up in a very different community, when compared to a child who grew up in New York City. Their learning will have taken place in a classroom with different socio-cultural ”norms”. Although these skills can be transferred across situations, each child is going to develop a different set of cognitive tools that reflects the cultural and social environment they grew up in. Cognitive tools are specialized, and designed to guide a learner in following the ”norm” behaviors dictated by a particular community[5].

In a community, there are many social interactions and processes. As time goes by, these social interactions define our patterns of thought and cognition. This social cognition refers to the information processing of social situations. Once this information is encoded, it is used in all other social interactions and applied to people. Due to this fact, early interactions will shape and serve as a template for future pro-social behaviors. These early interactions also influence our ways of thinking, and shape how we view the world. This type of situated cognition, refers to knowledge that is learned and developed through authentic activity [4]. Social interaction can serve as an important conceptual tool. They relfect the collective knowledge and wisdom of the culture in which they are used, and connect the insights and experiences of individuals[4]. These tools are understood through repeated use, and by interacting with others. Over time, these tools become implicit knowledge and shape your view of the world. Allowing you to adopt the belief system of the culture they are learned in. For example, Vygotsky states language is a cognitive tool produced through social interaction[14]. Language is tied to culture, and different languages have different semantic meanings, leading to differences in speech and cognition. These differences in socio-cultural acquisition influences an individuals thought patterns and beliefs[14]. In this way, social interaction creates cognitive skills, specifically tied to an individuals personal cultural and social experiences. In the following sections, we define Vygotsky’s socio-cultural contexts, and explain how these contexts produce cognitive tools such as language, speech, and cultural production, and how these tools are learned through more knowledgeable others in the ZPD. Socio-Cultural Contexts of Learning

In the 1930’s, psychologist Lev Vygotsky developed a new socio-cultural theory of learning and development. His theory was conceived decades before Bronfenbenner’s ecological model, although both psychologists emphasized the social and cultural context. At the time, Vygotsky’s theory contrasted that of the popular child development theorist, Jean Piaget[14]. For his era, Vygotsky’s theory of development was revolutionary. He stated that human development was inseparable from cultural and social development[14]. These social and cultural interactions lead to the development of higher cognitive processes such as language, and attention[14]. Vygotsky developed four basic principles of learning and knowledge. These are: knowledge is constructed, development cannot be separate from the social/cultural context, language plays a central role in mental development, and learning is facilitated through collaboration by working with ”more knowledgeable others” [14].

The learning of these socio-cultural processes occurs through the cultural inventions of a society. Thus, development of conscious cognition is the result of social and cultural influences[14]. Vygotsky defined specific aspects of these social interactions as specialized cognitive tools. These tools become internalized as a learner progresses through the ZPD, and shape our thought patterns. Specifically, Vygotsky emphasized language, speech, and cultural production as highly influential cognitive tools produced through socio-cultural interaction. Vygotsky also stated, that these cognitive tools are learned and enforced through more knowledgeable others in the ZPD[14]. These concepts will be broken down, and explained in detail in the subsequent sections. Language and Speech

The development of cognitive processes, are shaped through communicative interactions in specific social situations of development[15]. Vygotsky, emphasized that speaking and thinking are unified, with two basic functions: revealing reality, and communicating meaning in social interactions. Through language, an individual's cultural identity is formed, because children acquire knowledge in a specific cultural setting through familial and institutional influences[16]. As Bronfenbenner suggested, the ecological community in which learning takes place, influences developmental processes like language and speech[7]. Language initially serves as means of communication between the child, and people in the immediate environment[16]. However, upon conversion to internal speech, it affects how a child organizes his/her thoughts. It becomes an internal mental function[16]. For example, a child that grows up in an English western family, has a different dialect and system of values and beliefs compared to a child that grows up in rural India[15]. These differences can manifest in differing writing styles. This is because, each child has their own set of deliberate semantics, and words can have different meanings[15]. This is also known as, dialectic contradictions, which are historically accumulated structural tensions in a language[15]. These differences in the cultural context of language acquisition, manifest themselves in differing thought processes resulting in different cognitive and communicative interactions. This process of language/speech acquisition, can also be referred to as acculturation[4]. In this way, language is a cognitive tool as it has the ability to influence our patterns of thought.

13.5.3 Cultural Production

In previous sections, culture was defined as acculturation[5], or the process where a child learns and adopts the "norm" beliefs and values of a community. Each child learns these norms in different situational contexts and interactions. After repeated use, these norms become a part of a child's social identity, and determines the character of a child and future patterns of behavior and thought[5]. Culture can be produced through language and speech, the learning of cultural norms from elders of a group with mastery social skills (ZPD), and by a community[4].

Culture plays a dominant role in shaping social interactions, and the development of cognitive processes. It is a tool that is changeable, and created during a child's early social lives[14]. Cultural production can occur at two levels: institutional (macrosystem), and intrapersonal (microsystem). In an institutional setting, this refers to the larger social context such as school settings, political context etc. An interpersonal setting would refer to interactions between each other , such as peer to peer interactions[14]. An individuals overall cultural history, is responsible for producing useful cognitive tools that are accumulated over time [14]. Eventually, this leads to the internalization of culturally valued skills and behaviors, making these cognitive processes automatic[14]. A culture creates special forms of behaviors, which are specific to a specific cultural history[15]. These structures affect problem solving capacities, and patterns of social interactions. To examine these differences, psychologists can conduct cross-cultural studies. An example of a cross-cultural study, could include investigating how some cultures don't believe in displaying knowledge overtly, compared to cultures where that is considered a good thing. Vygotsky states that culture is developed and produced through processes of social interactions, and through active agents in the immediate development context.

13.5.4 Zone of Proximal Development (ZPD)

Vygotsky theorized that learning largely occurs in a child's ZPD. It mostly takes place in Bronfenbrenner's microsystem level of the ecological model. He defined this as "the distance between the actual developmental level, as determined by actual problem solving, and the level of potential development under adult guidance or in collaboration with a more capable peer[17] ." This form of social interaction occurring between the student and "more knowledgeable others," serves as a cognitive tool for developing higher learning processes[17]. In a classroom setting, a more knowledgeable other includes any active agents such as teachers, supervising adults, or peers[17] . There are three levels of a learners developmental progress in the ZPD over time (see figure 2 [17]). These three levels are the actual level, potential level and realized level[17]. The actual level refers to what a learner is able to accomplish without assistance. It refers to the actual base level of knowledge a student possesses on their own[17]. Whereas, the potential level is how well a learners performs with assistance by a more knowledgeable other[17]. A student has the capability to achieve this potential level of knowledge through collaboration. For example, a tutor is helping a grade two student learn grade three level mathematics. On their own, the student is able to readily solve grade two mathematics problems. Since this student possesses a strong actual level of mathematics, the student can be taught grade three level mathematics by collaborating with a more knowledgeable tutor. Eventually, through rehearsal and practise, the student is able to complete grade three mathematics problems on their own. This is referred to as their realized level of knowledge. Three Stages of ZPD Progression

Figure 2.[17] Adapted from "The Mediation of learning in the Zone of Proximal Development through a Co-Constructed Writing Activity," by Thompson, 2013 Research In The Teaching Of English, 47(3), p.259

Essential to this theory, is that the level of knowledge being learned must be more advanced than what the student currently knows [17]. Teachers can also use scaffolding, which uses a student's prior knowledge to help give students a base level of information They can use this to build more complex concepts[17]. Like in the example, the tutor built off the students prior knowledge of grade two mathematics, and made sure the material was more advanced than what the student currently knew. Before a student attempts to master a new skill, they can be given supplemental information to introduce them to the new material. This can include artifacts such as: books, videos, textbooks, and computer technology[17]. These artifacts act as priming agents for learners, and ease the learning transition to more complex concepts. By using the ZPD as a cognitive tool, instructor's can approach mastery of more difficult skills through collaborative classroom strategies. See figure two for further explanation learning through the ZPD[17].

Learning in the ZPD.jpg

Figure 3[17]. Stages of Learning in ZPD. Adapted from "The Mediation of learning in the Zone of Proximal Development through a Co-Constructed Writing Activity," by Thompson, 2013 Research In The Teaching Of English, 47(3), p.257 Implications for Instruction

The social lives of school children, can have many instructional effects. As previously mentioned, the situation in which information is learned, level of difficulty, collaboration with more knowledgeable others, level of social cognition/competency, and cultural production, all have differing instructional effects in the classroom. Each student has a different cultural history, that influences their patterns of thinking, and how they approach solving problems in the classroom. Teaching should incorporate the situation and use conceptual tools[4]. Learning should involve, the activity, concept, and culture. For example, teaching children the definition of words. It is simply not enough to have them write out definitions from the dictionary, in an abstract way[15]. Learning words, must take place in an authentic way, and relate to the cultural situation in which the word is defined and used in speech[4]. The next section will discuss how some of the previous social and cultural factors can be mediated through instructional methods. Some useful pedagogies for instructors that will be discussed are place based and cooperative learning strategies.

13.5.5 Place Based Instruction

One way of taking otherwise abstract concepts and rooting them in culturally meaningful pedagogy, is a method known as place based instruction. It uses both ideas about situated cognition and Vygotsky's socio-cultural theory. The environment in which we learn and situation in which the learning takes place, is responsible for co-creating our knowledge. A place based learning approach is suited for the multi-cultural classroom. If focuses on transforming the traditional classroom environment, into a place that engaging for all types of learners[18]. At its core, it links place to cultural struggles, and aims to empower diverse learners through the integration of local cultural knowledge[18].

Main Focuses of Place Based Pedagogy[18]:

1. Support thinking about a system using the "bigger picture"
2. Connect students to lived experiences- creating meaning through place based instruction
3. Foster Reflexive Inquiry
4. Regulate and Control How Ethnically Diverse Learners Organize their Identity

One way this pedagogy can be implemented in the classroom is by creating a community garden. It is a creative way of incorporating language, culture, and environment by increasing feelings of interconnectedness[18]. A community garden is open to all, and provides a green space for children in urban areas. It creates a setting for social interactions to take place through the cooperative planning, designing, and execution of a garden and all its elements[18]. The garden is a great way of creating conversation between students about local and self-cultural identity[18]. Students can research herbs related to their cultural background, and report to the class the various cultural ways in which the herb is used culturally like in, cuisine, medicine, or religion[18]. They can then plant these herbs in the garden, tying place with the construction of their knowledge. This also allows for peers to create conversations about cultural differences, fostering reflexive inquiry [18].

The place based framework, examines how a culture and local environment makes up the community and culture of the school. This method also allows ethnically diverse learners to, self-identify their cultural values, and decide what they want to share. This control and the self-regulation of their own identity, can help grow self-regulated learning as well[18].

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Culture-Based Education and Its Relationship to Student Outcomes
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Adapted from: Kana'iaupuni, S., Ledward, B., & Jensen, U. (2010). Culture-based education and its relationship to student outcomes. EDUCATION.

Figure 4. "Hawaiian Cultural Influences in Education Study Model[19]"

In a study by Kana'iaupuni[19], they explored the kinds of teaching strategies being used in Hawaiian classrooms and investigated the impact of teachers' use of culturally based education strategies (CBE), on student socio-emotional development and educational outcomes. Cultural relevance in education was shown to have direct effects on student socio emotional factors such as self-worth, cultural identity, and community/family relationships. It was also shown to have direct and indirect effects on educational outcomes, such as student engagement, achievement, and behaviour[19] (Kana'iaupuni, 2010). In Figure 1, it shows the reciprocal interelating relationship between CBE, educational outcomes, and socio-emotional development. Adapted from: Kana'iaupuni, S., Ledward, B., & Jensen, U. (2010). Culture-based education and its relationship to student outcomes. EDUCATION.

Figure 5: "School Engagement Among Hawaiian Students By Teacher CBE Use[19]"

The results of the of the study show (see figure 5[19]) that teachers who use CBE methods in the classroom have higher levels of student self-efficacy and trust, than students with Low CBE Teachers. Students exposed to high levels of CBE by their teachers are also more likely to be engaged in schooling than others, by putting cultural skills to use in their communities and forming trusting relationships with teachers and staff[19]. In the study, they used methodology involved in place based pedagogy[18]. They took into account the local environment and interwove it into the curriculum. Students took part in classes teaching Hawaiian culture, and and/environmental stewardship[18]. The study illustrates how place based pedagogy can significantly improve students rates of self-efficacy and trust in the classroom when teachers use a high amount of CBE/place based curriculum[19]. Cooperative Learning

In Vygotsky's zone of proximal development, he emphasized the importance and role of peer collaboration and learning. Cooperative based learning refers to intentional learning activities, where group members work towards a shared learning goal[20]. It is different from classroom "group work," as group work does not always guarantee actual learning will take place . The goal of cooperative based learning is to understand that each learner brings their own particular set of skills to the table[20]. If differs from collaborative learning, because students are not trying to improve a weak skill, but rather identify the skills they excel in and use them to help the group.For example, Amy may struggle with abstract concepts like mathematics, but has a great imagination (Also, see figure 3[20]). She is grouped together with students who excel with abstract concepts, but struggle thinking imaginatively. This way, students are able to share their skills, and teach each other. This is known as reciprocal teaching, where learners are able to teach other members of their group[20]. By working towards achieving their common learning goal, students must combine their different skill sets to solve the problem. It can help students see different perspectives on how to approach problem solving activities[20].

The Five Steps to Achieve Cooperative Learning in the Classroom[20]

1. Give Specific Learning Objectives

2. Plan out learning strategies, and composition of groups

3. Explain the learning objective

4. "monitor-observe" the students

5. Assess the achievement and cooperation of students

Some examples of cooperative learning strategies for the classroom are the jigsaw method and group investigation method[20]. In the jigsaw method, students are divided into groups. Then, one member from each group is sent to a special group to learn about a specific course topic. Once students individually read the material, they discuss and reflect upon the material as a group, making note of its key points[20]. Lastly, each student returns to their original groups. After their peers read the material, the student sent to the special group leads their group discussion, reflecting on the topics key points. The premise of this strategy is to have the students in each group teach each other, and become better self-regulatory learners[20]. In the group investigation method, students are first divided into groups. They are then given information about a specific course topic, and read through the material individually, and are asked to make note of its key points[20]. After this, the group discusses the material collectively, reflecting on its key points, and could be asked to prepare a presentation for the class.This strategy promotes group dialogue and aims at cultivating social interaction skills. Cooperative learning, is a strategy that instructors can use in the classroom to promote social cognitive growth, and increase student's performance[20]. In the next section, we discuss how social cognitive processes are affected by macrosystem influences, such as individual contextual differences in societal, classroom, and institutional settings. Individual Contextual Differences

The cognitive development process can be differed individually. Lots of aspects of social context can have varies of influences on our cognitive development, Such as: intelligence, environment factors, learning opportunities, economics status, family and society. As previously mentioned, the social and cultural context in which learning takes place, greatly affects our cognitive growth. Theories like situated cognition, Bronfenbenner's ecological model, and Vygotsky' scocio-cultural theory, discuss how macrosystem influences such as the cultural environment, make up our implicit views on the world. In this section, we will look into how different classrooms, different institution and society can affect our cognition and how do we do to improve this development. Society

"We have no obligation to make history.

We have no obligation to make art.

We have no obligation to make a statement.

To make money is our only objective."

-- Michael Eisner, former CEO of Walt Disney

The problem of boys having lower graduation rates, greater worries about intimacy and relationships are touched upon to suggest some reasons behind it. Using the internet and accessing pornography are acting as arousal addictions that have negative effect on social life of boys. Lots of documents shows the problems of women getting misrepresented, objectified and sexuality are evident in our societies' status quo. The society and media is often portraying women as object for sex and beauty, demising women's actual capabilities. We should advocate the need to value women's capabilities and encourage them to discover their true power.. Simply put, media is any device or system that we humans use to accomplish our goals. The wheel, an oar, an abacus, a hammer, a toothpick, and a TV set are various examples[21].

These influences heavily affect development of the authentic self for both males and females negatively. Being authentic self is being who you really are, knowing your personal why, discovering your capabilities and expressing your inner self to others. These are real, genuine and authentic which comes from your heart. The problem with the media is that they are portraying cognition of what it means to be ideal women or men that are accepted by the society. Often, these perfect images of beauty, success and satisfaction are falsely created by media often to get more people's attention and money. Thus, people start to take in what the media tells them to be rather than finding their own true beauty, capabilities, and values that are truly meaningful for themselves. For that reason, the media exposure simply makes us to seek what is ideal in our society instead of genuine values that are found within self-discovery so lots of people are developing a wrong cognition because of that. In order to sustain the authentic life, we need to have a clear sense of values and define our view of life that comes from inner self. Our own clear vision, belief, goal, and mind act as a firm pillar that support from being impressionable person who easily get swayed by society and media influence. Therefore, we can prevent ourselves from following other people's values.When movies and television first appeared predictions were made that they would replace most, if not all, classroom instruction[21]

The notion that these media companies are "giving us what the public want" is concerning because they're actually just giving us what the media companies and advertisers want, and manipulating viewers in believing that it is our fault for the brainless content that's being produced. It's also a problem that men make up the majority of the board of these reputable media companies because the way women are represented is inaccurate and are often times exploited through the views of white, capitalist male elites who take no interest in genuine women empowerment. On the other hand, although men aren't as demonized via media as women are, they still do struggle with radical stereotypes, biases, and discrimination. In Demise of Guys, Atherton mentions that men are constantly exposed to explicit content such as pornography, creating an "arousal addiction[22]." Men are also constantly shown "ideal" images of masculinity where there is a lack of emotional representation and here, problems in intimacy and relationships will start to manifest.

These media influences affect the development of the authentic self for both females and males in a sense that when they are exposed to inaccurate representations without knowledge on the corporate strategy behind it, they will be easily manipulated into believing that who they are and how they look isn't good enough. Especially for girls and boys who are exposed to explicit and exploitative content at a young age, they will start to believe that what they see on media is their reality. When in reality, everyone is different – we come in all shapes, sizes, and color – and it's important to base your beauty from within rather than from the physical.Educators increasingly are aware of media's potential for changing how learning and teaching take place. Even though education continues to lag behind other segments of society in using media[21]. Media likes to hyper-sexualize women and pit them against each other while romanticizing the male character for their strength and independence. Although some women and men might prefer to play that role in reality, we would possibly live in a different society if we focused on issues such as gender equality, health and fitness, and educated viewers on the reality of the world instead of the dream. Classroom

We should value children's competencies in learning, focusing on self-directed learning approach.We should value children's competencies in learning, focusing on self-directed learning approach. Rather than simply throwing information and knowledge at children, it is important to acknowledge that they are capable, competent learners who are not helpless. Children are competent enough to be innovated by learning, creating changes and solving problems. We should also emphasize design thinking approach where children are engaged in real life context to solve problems and create solutions. Thus, the opportunities actively engage children to be part of a community member. They can highly relate their learning in their real life that matters and is meaningful. We should be providing real tools and materials to build real things where children have an access to these materials for their creative ideas of invention. The social contexts of cognition and learning have obvious applications to the classroom. As any teacher knows, the classroom is above all a social environment and teaching is a form of social interaction that affects group collaboration, motivation, learning and even use of technology[23].

One of the strength of these kind of learning approaches is that these encourage children to form great cognitions and fulfil their potentials. By recognizing children's capacities to think, learn, and change will help them to see their learning abilities. Also, these approaches of learning are very good for children to enjoy and have some fun. Because it requires children to come up with their own creative ideas and solutions, they can have more interest in what they do and learn throughout the process. The weakness in these approaches is the possible financial problem. Many resources and materials are probably needed for children to access that could cost quite of bit of money. If these approaches of learning are incorporated in other regular classes, funding will be needed and not all schools can afford it as they wish.

The self-directed learning approach can help students to be engaged in what they learn and do with genuine interests[24]. Also, being in the field rather than simply staying in the classroom can motivate them better. Thus, the learning can be made more effectively. For instance, whenever students go to a field trip to learn about certain thing with their own eyes, it got me more interested and motivated. Do you still vividly remember when you went to Science World, different kinds of museums, and Camps where you got to participate in activities that engaged you actively? The answer will be yes. Institutional

The whole education system is seems like "Building a house", and the base or the foundation construction is the most important part for a building, just like the meaning of the elementary education for the whole education system[24]. Lots of schools are ranked according to standardized testing, but the author didn't told us is this kind of practice is right or wrong, good or bad. However, school ranking in some way is good, they may help schools to improve themselves by comparative. But with my personal experience, the ranking by testing for student is not good and really make me stressful in my whole middle and high school. In China, school ranking and ranking students in all schools is very universal, they divide student into two classes, good and bad. Then, the parents who wants their child get in the good school or class, they will pay a lot money and time for them. This classification is serious influence and hurt students' self-esteem and enthusiasm for learning and study. In conclusion, in view of all its defects and the harmful effects of university and schools, why would anyone pay attention to the school ranking?

"when the teaching begins, educators must ask, who are the students, what are their particular needs, and what do they bring to the classroom?" points out the importance of student in teaching and curriculum design as well as the whole education process. When a school designs their education methods, they should consider the students themselves. What is their goal of learning? How will students' own value, culture and experience influence their learning? And what can teachers learn from the students? If remembering the questions when designing and implementing curriculum, I think the curriculum can better cope with students' needs.

We do have pressure on curriculum, which includes technology, culture, economy and environment, etc. When designing and implementing curriculum, it is also very important to consider these factors that will influence students' learning goals, needs, etc. For example, a curriculum for in-class course may greatly differ from a distance course.

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These media influences affect the development of the authentic self for both females and males in a sense that when they are exposed to inaccurate representations without knowledge on the corporate strategy behind it, they will be easily manipulated into believing that who they are and how they look isn't good enough. Especially for girls and boys who are exposed to explicit and exploitative content at a young age, they will start to believe that what they see on media is their reality. When in reality, everyone is different – we come in all shapes, sizes, and color – and it's important to base your beauty from within rather than from the physical.

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In conclusion, from a socio-cultural perspective there are many social influences on cognitive development. As previously stated, the socio cultural context of cognition is explained through social and situated cognition, cultural production, social interaction and cognitive tools, socio-cultural theory, and individual contextual differences.Through social interaction students learn social cognition and develop cognitive tools. Individual differences in socio-cultural contexts are influenced by those closest to you. Over time these differences are internalized, and affect your cognition, thought patterns, and views about the world. As learners, we are influenced by macrosystem factors outside our control. This includes societal, individual, classroom, and institutional differences in contexts and situations of learning. This can have many instructional implications, and calls for more place based and cooperative classroom pedagogies, Research has stated that situated learning has an increasing influence on education. The ecological model also states that in order to understand human development, one must consider the entire ecological system in which growth occurs. As discussed, recent research suggests that prospective teachers hold simplistic views of student differences. They have little knowledge about different cultural groups. In fact, they may have negative attitudes toward those groups, and view the diverse backgrounds of students as a problem, and have lower expectations for the learning of ethnic minority students. In the development of children, there are many social processes of interaction. These early interactions will shape and serve as a template, for future pro social behaviours. The social context can have various of influences on our cognitive development. Such as : intelligence, environment factors, learning opportunities, economics status, family and society. In order to be effective instructors, one must take into account the social-cultural perspective, and account for the social influences on cognitive development. Glossary

Acculturation: adapting the norm, behavior, skills, belief, language, and attitudes of a particular community[4].

Cognitive development: Cognitive development is a field of study in neuroscience and psychology focusing on a child's development in terms of information processing, conceptual resources, perceptual skill, language learning, and other aspects of brain development and cognitive psychology compared to an adult's point of view[4].

Dialectic contradictions: Historically accumulated structural tensions in a language. . Each child, has their own set of deliberate semantics. Therefore, words can have different meanings according to each child[15].

Ecological model: An ecosystem model is an abstract, usually mathematical, representation of an ecological system (ranging in scale from an individual population, to an ecological community, or even an entire biome), which is studied to gain understanding of the real system[7].

Exosystem: The exosystem refers to a setting that does not involve the person as an active participant, but still affects them. This includes decisions that have bearing on the person, but in which they have no participation in the decision-making process. An example would be a child being affected by a parent receiving a promotion at work or losing their job[9].

Macrosystem: The macro-system encompasses the cultural environment in which the person lives, in the larger sociological context. This level of the ecological model often influences students without them even knowing it, leading to implicit beliefs or beliefs shared by a culture. Examples could include the economy, cultural values, and political system[9].

Mesosystem. The mesosystem consists of the interactions between the different parts of a person's microsystem. The mesosystem is where a person's individual microsystems do not function independently, but are interconnected and assert influence upon one another. These interactions have an indirect impact on the individual. For example, the relationship between parent and teacher, can have an indirect impact on a students learning[9].

Microsystem: The system closest to the person and the one in students have have direct contact. Some examples would be home, school, daycare, or work. A microsystem typically includes family, peers, or caregivers[9].

Place based instruction: The environment in which we learn and situation in which the learning takes place, is responsible for co-creating our knowledge. A place based learning approach is suited for the multi-cultural classroom. It focuses on transforming the traditional classroom environment, into a place that is engaging for all types of learners[18].

Scaffolding: building of a students prior knowledge to learn new or difficult concepts[17].

Situated Cognition: A theory based upon principles related to the fields of anthropology, sociology and cognitive sciences. Its main argument is that all knowledge a learner acquires is somehow situated within activities that are socially, physically or culturally-based[4].

Social cognition: A subtopic of social psychology that focuses on how people process social information (especially its encoding, storage, and retrieval) and how this information is applied to social situations, other people, and social interactions[4].

Social Context: refers to the immediate physical and social setting in which people live or in which something happens or develops. It includes the culture that the individual was educated or lives in, and the people and institutions with whom they interact[4].

Zone of proximal development: The zone of proximal development, often abbreviated as ZPD, is the difference between what a learner can do without help and what he or she can do with help[17]. Suggested Readings

Bronfenbrenner, U. (1999). Environments in developmental perspective: Theoretical and operational models. In Measuring environment across the life span : emerging methods and concepts(1st ed., pp. 3-28). Washington DC: American Psychological Association.

Brown et al., (1989). Situated cognition and the culture of learning. Educational Researcher, 32- 42

Campbell, F. A., Pungello, E. P., & Miller-Johnson, S. (2002). The development of perceived scholastic competence and global self-worth in African American adolescents from low income families: The roles of family factors, early educational intervention, and academic experience. Journal of Adolescent Research, 17, 277-302.

Poch, S. (2005). Higher education in a box. International Journal of Educational Management 19(3), 246-258. doi:10.1108/09513540510591020

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes Cambridge, Mass.: Harvard University Press. References

Miller, S. A. (2010). Social-cognitive development in early childhood.interactions, 20, 21. Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). Rediscovering the social group: A self-categorization theory. Cambridge, MA, US: Basil Blackwell, Inc. Smith, E. R., & Conrey, F. R. (2009). The social context of cognition.Cambridge handbook of situated cognition, 454-466. Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. Educational researcher, 18(1), 32-42. Anderson, J. R., Reder, L. M., & Simon, H. A. (1996). Situated learning and education. Educational researcher, 25(4), 5-11. Smith, E. R., & Conrey, F. R. (2009). The social context of cognition.Cambridge handbook of situated cognition, 454-466. Bronfenbrenner, U., & Morris, P. A. (1998). The ecology of developmental processes. Cervone, D., Shadel, W. G., & Jencius, S. (2001). Social-cognitive theory of personality assessment. Personality and Social Psychology Review, 5(1), 33-51. Bronfenbrenner's, U. (2011). YOUTH, Science TEACHING AND Learning. Böhmer, W. (2009). An investigation into the inclusion of child development in early childhood programs (Doctoral dissertation). Gay, G. (2000). Culturally responsive teaching: Theory, research, and practice. New York, NY:Teachers College Press Hollingsworth, S. (1989). Prior beliefs and cognitive change in learning to teach. American educational research journal, 26(2), 160-189. Maschinot B. (2000).The Changing Face of the United States The Influence of Culture on Early Child Development: 2000 M St., NW, Suite 200, Washington, DC 20036-3307 (202) 638-1144 Rogoff, B., & Morelli, G. (1989). Perspectives on children's development from cultural psychology. American Psychologist, 44343-348. doi:10.1037/0003-066X.44.2.343 Mahn, H. h. (2012). Vygotsky's Analysis of Children's Meaning Making Processes. International Journal Of Educational Psychology,1(2), 100-126. doi:10.4471/ijep.2012.07 Reunamo, J. J., & Nurmilaakso, M. (2007). Vygotsky and agency in language development. European Early Childhood Education Research Journal, 15(3), 313-327. doi:10.1080/13502930701679320 Thompson, I. (2013). The Mediation of learning in the Zone of Proximal Development through a Co-Constructed Writing Activity. Research In The Teaching Of English, 47(3), 247-276. Sloan, C. (2013). Transforming Multicultural Classrooms through Creative Place-Based Learning. Multicultural Education, 21(1), 26-32 Kana'iaupuni, S., Ledward, B., &

Jensen, U. (2010). Culture-based education and its relationship to student outcomes. EDUCATION. Clapper, T. t. (2015). Cooperative-Based Learning and the Zone of Proximal Development. Simulation & Gaming, 46(2), 148-158. doi:10.1177/1046878115569044 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971 Atherton J S (2013) Doceo; Assignment Presentation Guidelines [On-line: UK] retrieved 2 March 2016 from `http://www.doceo.co.uk/academic/assignment_presentation.htm#Referencing` Lajoie, K& Azevedo, J (1992). Laughter and stress Humor, 5, 43-355. Dobbin, F. 2004.The New Economic Sociology: A Reader. Princeton, NJ: Princeton University Press. Social emotional learning (SEL) is the development of knowledge, skills and attitudes to effectively manage and understand emotions in social settings. SEL programs teach children to establish positive relationships while making responsible decisions in the school setting. SEL is intended to provide a foundation for socialization and achievement in school and later life.[91] There are five competencies identified within SEL: self-awareness, self-management, social awareness, relationship skills and responsible decision making.[92] These competencies enhance students' understanding of themselves and others around them. This chapter examines the theory, research and application of the five SEL competencies.

13.6 Self-Management

Self-management is the management of one's emotions, behaviours, and thoughts in a variety of situations. There are three approaches to social emotional learning: **positive youth development** (PYD), **critical youth empowerment** (CYE), and **sociopolitical development** (SPD). The approach that relates to self-management the most is PYD. PYD uses a variety of activities and experiences to assist young people in building their social and emotional competence in the society[93]. These activities and experiences allow young people to build an attitude towards their capability at different stages of their life. It is important to develop a positive attitude because attitude is the way of thinking or feeling that is reflected in one's behaviour. In order to maintain a positive attitude, one need to learn their capability on managing stress, motivating oneself, controlling impulses, and setting toward achieving personal and academic goals[94]. In an educational setting, self-management is an essential component for young people to grasp. Stress is often the feeling that occurs to young people the most often in school. Self-management will benefit young people by preventing a mental breakdown and have methods of calming oneself. So through the PYD activities and experiences, young people can learn how to self-manage their social and emotional competence.

91 Denham, Susanne A. (2014). How Preschoolers' Social-Emotional Learning Predicts their Early School Success: Developing Theory-Promoting, Competency-Based Assessments. 426-454.

92 SEL Defined. (n.d.). Retrieved November 1, 2015

93 Jackson, Cassandra McKay. (2014). A Critical Approach to Social Emotional Learning Instruction Through Community-Based Service Learning. 292-312.

94 SEL Defined. (n.d.). Retrieved November 1, 2015

13.6.1 Managing Emotions

Emotions are an instinctive or intuitive feeling derived from reasoning or knowledge. Being able to manage emotions is important because it can either affect an individual's behaviour in a positive or negative way. Every individual has different methods of coping with emotions; it just comes down to the individual's self-management skills. An individual first self-manages through learning how to manage stress, motivate oneself, control impulses, and set toward achieving personal and academic goals[95]. Research has shown that stress is one of the factors affect a student's level of functioning. **Academic stress** is when a student feels they lack the skills, emotions, and time to effectively perform a given task[96]. Under stressful conditions, it is difficult for students to manage their emotions because majority of the time, they feel helpless about a task. **Motivation** can be one of the best methods to manage emotions. Motivation gives an individual the drive to set towards achieving their personal and academic goals. Throughout that process, an individual can maintain positive when they think about what their accomplished goal or the reward (if any) at the end of the goal. In a school setting, student motivation is called **autonomous motivation**. Autonomous motivation is undertaking an activity because of its meaningfulness and relevance[97]. Students are more motivated to pursue activities that made more meaningful to them by their educators. It is called autonomous motivation because the educators will mold a classroom environment that allows students to make choices of their own in classroom interactions. According to a research done on social emotional learning skills such as motivation and managing stress, these skills are good indicators of future academic outcomes[98]. The research was conducted towards high school students. The results showed that students who had lower social emotional learning skills academically scored in the bottom 25%, and students with high social emotional learning skills academically scored in the top 25%[99]. Students who saw college as an important journey or goal in life was reflected in their grade point average (GPA) after their first year of high school. If there is a steady or significant increase in a student's GPA, this means they had the motivation to work towards getting admitted into college. By improving students' social emotional learning skills, students will become more self-regulated and engaged learners[100]. Becoming self-regulated means to become autonomous by controlling their own emotions and behaviour. Self-regulated students will be able to effectively seek motivational goals to pursue. They will also be able to seek methods that can sufficiently cope with their stress.

95 SEL Defined. (n.d.). Retrieved November 1, 2015

96 Alan Davis, V. Scott Solberg, Christine de Baca & Taryn Hargrove Gore (2014) Use of Social Emotional Learning Skills to Predict Future Academic Success and Progress Toward Graduation, Journal of Education for Students Placed at Risk (JESPAR), 19:3-4, 169-182, DOI: 10.1080/10824669.2014.972506

97 Alan Davis, V. Scott Solberg, Christine de Baca & Taryn Hargrove Gore (2014) Use of Social Emotional Learning Skills to Predict Future Academic Success and Progress Toward Graduation, Journal of Education for Students Placed at Risk (JESPAR), 19:3-4, 169-182, DOI: 10.1080/10824669.2014.972506

98 Alan Davis, V. Scott Solberg, Christine de Baca & Taryn Hargrove Gore (2014) Use of Social Emotional Learning Skills to Predict Future Academic Success and Progress Toward Graduation, Journal of Education for Students Placed at Risk (JESPAR), 19:3-4, 169-182, DOI: 10.1080/10824669.2014.972506

99 Alan Davis, V. Scott Solberg, Christine de Baca & Taryn Hargrove Gore (2014) Use of Social Emotional Learning Skills to Predict Future Academic Success and Progress Toward Graduation, Journal of Education for Students Placed at Risk (JESPAR), 19:3-4, 169-182, DOI: 10.1080/10824669.2014.972506

100 Alan Davis, V. Scott Solberg, Christine de Baca & Taryn Hargrove Gore (2014) Use of Social Emotional Learning Skills to Predict Future Academic Success and Progress Toward Graduation, Journal of Education for Students Placed at Risk (JESPAR), 19:3-4, 169-182, DOI: 10.1080/10824669.2014.972506

13.6.2 Classroom Management

In an educational setting, classroom management is one of the contributing factors to students' self-management. Classroom management is the teacher's knowledge about student's behaviour and development, as well as developing strategies and practices that would assist students[101]. With this knowledge, teachers can pass down the tools necessary for students to successfully manage their own behaviour. For students to gain the capability of managing their behaviours in a classroom, they must first learn how to regulate their own emotions. For example, if a student knows how to calm their own emotions and be patient, chances are they will be less disruptive in class. However, students are not the only ones who must learn how to regulate their own emotions. As an educator of the students, they must learn how to regulate their emotions before becoming a role model for the students. As a role model, the teacher demonstrates proper solutions on handling situations, as well as creating positive relationships with every student in the class[102]. Creating positive relationships with the students will allow the teacher to understand them better. This way, teachers can develop better strategies and practices tailored to each student's needs.

There are four principles of effective classroom management[103] :

Four Principles of Effective Classroom Management	**Details**
1. Planning and Preparation	Teachers have a clear lesson plan for the day so transitions between activities will be smooth.
2. Extension of the Quality of Relationships in the Classroom	Creating positive relationships with students will decrease the possibilities of classroom disruptions.
3. Management is Embedded in the Environment	Teachers use materials to support their teaching routines (eg: using charts or pictures)
4. Ongoing Processes of Observation and Documentation	Teachers need to consistently reflect upon their management skills to see if it is working effectively.

The main purpose of these principles is to allow educators to gain the skills to prevent the worst case scenarios. This means being planning ahead of time so educators will not panic and handle the situations ahead of them. These principles are not to prepare educators on how to react, but how to prevent and build skills[104]. Reaction is how the educator manages and expresses their emotions during a situation, whereas prevention will allow the educators think ahead of time and prepare for the worst. In doing so, this promotes organization and educators will have control over the classroom. A technique that could be used to gain control over the classroom is enforcing a daily routine. This routine could be used when transitioning between activities[105] or to get the class to quiet down. For example, if an educator wants to get the students' attention, they could clap their hands in a rhythm and have the students follow. By doing so, this enforces positive behaviour from the students

101 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

102 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

103 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

104 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

105 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

and students will manage themselves by reinforcing expectations[106]. The clapping creates a positive behaviour and will be emitted by students in applicable situations. Also, having a particular transition between activities can create positive behaviour because it will make the classroom more predictable[107]. For example, educators can use a particular song to end an activity to start the next. Students will get into the habit of this routine and manage themselves through reinforcing the positive behaviour.

Using these principles, students can gain autonomy through managing their own behaviour[108]. These principles not only allow educators to gain control over their classroom, but students will have the opportunity to self-manage. To create a positive relationship with the students, educators will need to create boundaries and balance between warmth and discipline[109]. Educators need to understand the degree of their discipline because going by the rules for everything will stray the students away from the educators. Discipline that are over controlling can cause educators to be inflexible and unresponsive to student needs[110]. There should not be a determined discipline because every year, there will be new students in every classroom. The discipline should be modified based on the needs of the students so there will be opportunities for students to learn the skills to self-manage.

13.7 Self-Awareness

Self-awareness is assessing one's emotions and thoughts and its impact on behaviour. One of the three approaches to social emotional learning, sociopolitical development (SPD), connects to self-awareness. SPD is the critical reflection of young people that help them see and understand structures, social values and practices that they may be struggling with[111]. Critical thinking will assist young people on realizing what their weaknesses are. Self-awareness allows the young people to determine their strengths and weaknesses, as well as maintaining a positive attitude and confidence. This is especially important in an educational setting because young people need to understand their capabilities to set goals for themselves that are not out of their limits. Figuring out what one's strengths and weaknesses are can influence emotions and thoughts either a positive or negative way. If one is struggling with their weaknesses, this could result with frustration, anger, or any negative emotions or thoughts. This will also lead up to negative behaviour. In an educational setting, educators need to understand students' weaknesses so they can **scaffold** alongside to turn them into strengths. This will be beneficial with students' self-awareness.

106 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.
107 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.
108 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.
109 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.
110 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.
111 Jackson, Cassandra McKay. (2014). A Critical Approach to Social Emotional Learning Instruction Through Community-Based Service Learning. 292-312.

13.7.1 Morals and Values

On one hand, morals are a person's standards of behaviour involving their definitive belief about what is acceptable and what is not acceptable for them to do. It is crucial for people to develop morals because they establish a set of rules for themselves based on their belief between right and wrong. Having morals will provide a person with directions, guiding them towards more positive decisions and preventing themselves from negative choices. This works in with SPD through the critical reflection that one must go through. SPD seeks out social values, structures, practices, and processes that need to be altered[112]. A person with morals can easily seek out those social factors that do not fit in with their beliefs. Setting a set of ground rules allows an individual to determine whether their emotions and thoughts are generating a positive or negative behaviour.

On the other hand, values are what are important to an individual. Values and morals work to build on each other. Morals determine what is acceptable and not acceptable in an individual's perspective, and values determine what is important. Values will trigger the emotions in an individual because a value sets an importance on an object, a person, a place, etc. in the individual's life. Values can give an individual confidence and optimism in life because these values act as a motivation for the individual. Motivation is a factor that will benefit young people in schools. Motivation gives people a reason to do things because it interests them. Usually, an individual will develop motivation for a task because they can get something out of it (eg: a reward). The reward they get out of a task could be of some value of theirs. Thus, having values can also be used as a motivator for people.

112 Jackson, Cassandra McKay. (2014). A Critical Approach to Social Emotional Learning Instruction Through Community-Based Service Learning. 292-312.

13.7.2 SECURe

SECURe (PreK) routines and strategies

Routine/strategy	Targeted skill(s)	How does it work?
Making choices	Planning and goal setting Flexibility and transitioning	Teachers use a visual board to show students what centers are available (blocks, art, etc.). Children indicate where they will play by putting their name card on a sign-in board at that center. Children can move to another center if there is an available spot on the sign-in board.
Cool kid	Prosocial behavior Noticing and respecting others Positive communication	Cool Kid wears a button to identify him/her. Children give compliments to Cool Kid for positive (helpful, friendly) behaviors all day. At end of day, teacher writes three compliments on a certificate that the Cool Kid takes home to show his/her parents. Cool Kid is chosen at random each day; every child is chosen the same number of times throughout the year.
Taking turns bag	Conflict resolution	Children can get the bag anytime during the day if they're having trouble sharing a toy or object. Bag contains a coin and timer. Children flip the coin to see who goes first, then use the timer to ensure that both children get an equal turn.
Feelings thermometer	Emotion knowledge Emotion and behavior regulation Positive communication	Feelings thermometer poster includes the numbers 1-5 to illustrate that feelings can be more or less intense/strong. Children use the numbers to tell each other when they are about to "lose their cool."
Think-pair-share	Prosocial behavior Positive communication Teamwork and partnerships (Listening, speaking, and waiting/taking turns)	Children hold a laminated strip that reminds them to first think about what they want to say, then pair up with a partner, and finally to take turns sharing their idea.
I messages / Say it back	Noticing and respecting others Positive communication Empathy and viewing from others' perspectives	I messages is a communication strategy for intense or escalating situations: "I feel xxx because xxx." After an I message is given, the other person uses "say it back" to acknowledge the other person's feelings and repeat what they heard: "You feel xxx because xxx."

Figure 26 SECURe (PreK) Strategies and Routines

Researchers have come up with a school intervention called **SECURe**[113]. SECURe stands for Social, Emotional, and Cognitive Understanding and Regulation in education. This intervention is used in primary education to assist with three skills: cognitive regulation/executive function, emotion processes and interpersonal skills[114]. SECURe uses games and songs to teach these skills, such as using a storybook to identify the emotions of the

113 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

114 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

characters. The educator would then teach a method called, "I Message" [115]. This method teaches students to express their emotions to their classmates. For example, if a student is upset with their classmate because they were calling them names, then the student would speak up to their classmate and say, "I am upset because I do not like being called names". I Message is beneficial in assisting students to become self-aware because this method allows students to regulate their emotions to discover how they were feeling and why they felt that way. By becoming self-aware, students can regulate their emotions and communicate in a calm manner to their peers about how they feel. This reduces the chance of students acting in an irrational behaviour that could lead to negative consequences.

Another component of SECURe is creating daily structures and routines because this provides opportunities for students to practice skills in recurring interactions and relationship-building activities[116]. This is mainly for students in prekindergarten and/or kindergarten. These students have just started interacting with other students their age so creating a routine is very beneficial. Creating a structure or routine will give them the basic understanding of which behaviour to use in certain situations. Grasping this component of SECURe will enable them to move further as they progress and eventually self-manage.

13.8 Social Awareness

Social Awareness Refers to
Being aware of others
Understanding that others have feelings
Knowing that YOUR actions affect others

Social awareness is the student's ability to express and control their thoughts and emotions in different situations. Developing the student's ability to **self regulate** their thoughts, emotions, attention and **reactivity** is a key goal of SEL. Through learning social awareness strategies, students can identify which emotions are appropriate to display in different social events. For example, students know how to regulate their behaviors inside a classroom compared to a formal event such as a wedding ceremony or funeral. As students continue to develop frameworks on how to behave in a formal setting compared to a casual setting, students demonstrate more behaviors aligned with the social norm.

Through becoming socially aware of one's surroundings, students also learn techniques in how to remain motivated and focused on a given task within the classroom. For example throughout the school day, students can learn how to improve their level of motivation and focus as teachers encourage them to practice **mindfulness** techniques which refers to being consciously aware of how one is feeling physically and emotionally at that present moment and accepting those emotions. Research has shown students who are mindful of their emotions are more socially aware of how to regulate those positive and negative emotions [117]

115 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

116 Jones, S.M., Bailey, R., Jacob, R. (2014). Social Emotional Learning is Essential to Classroom Management. 19-24.

117 John Meiklejohn (2012) Integrating Mindfulness Training into K-12 Education: Fostering the Resilience of Teachers and Students. 291–307.

For example, when students are feeling stressed and angry, being mindful of their current emotional state allows students to reflect on how they are feeling and encourages regulation of their emotions through talking about their feelings, or accepting their emotional state and relaxing. Social awareness also refers to the student's ability to see situations in different perspectives. This teaches students how to be respectful, and open minded when being introduced to new situations with different challenges such as transitioning into a new school, classroom or having to work with new people. These new situations allow students to become more aware of one's surroundings as it also encourages students to be accepting of diverse point of views. If these skills are not practiced within the classroom, these transitional situations would lead to chaos as individuals will not understand the importance of compromising and integrating ideas from both the sides of the relationship. For example, teachers can demonstrate social awareness within the classroom by incorporating the student's ideas when creating classroom rules and boundaries. This demonstrates social awareness as the students are encouraged to speak up and share their perspectives on situations in which the teacher will take into consideration. This demonstrates social awareness as there is a level of compromise and integration of ideas when creating classroom standards and rules. These types of relationships leads students to build a trusted relationship with their teacher which allows the student to be less at risk of developing social and emotional regulation problems as the students learn new strategies in how to be open minded to different ideas [118]. Through being open minded, students learn compromise helps to resolve social, emotional and physical problems. For example, if there is a conflict between two friends, if both individuals demonstrate social awareness by listening to the perspective of the other individual, it is more likely that the conflict will be resolved sooner as both sides of the relationship shares their ideas while listening to the other.

Mindfulness brings many advantages to students Physically, Emotionally and Mentally

Physically	**Emotionally**	**Mentally**
Students report feeling less fatigue	better emotional regulation	Better attention span
Improved sleep cycle	teaches students to "think before acting"	better memory capacity
Lowers blood pressure	feeling less stressed	higher academic performance
Helps relieve physical tension	teaches relaxation techniques	less substance use and depression

13.8.1 Gestures

Gestures are the ways in which children learn to express how they are feeling through physical hand motions and body movements. These methods of learning can be integrated into the classroom setting by teaching students ways in which they can express their emotions through words and showing their emotions through their their hand gestures. For example, when teachers ask students how everyone is feeling today from 1-5 (1 being bad), students should learn to express their emotions through hand gestures not simply holding their emotions into themselves. When students do not practice skills in expressing their emotions

118 Robert C. Pianta (2012) Recent trends in research on teacher–child relationships Institute for Policy Research, Northwestern University, Evanston, IL, USA; C213–231

through gestures, they are more likely to develop temperament as these students may internalize all their emotional expressions [119]. Gestures help students to develop more efficient ways in communicating their thoughts and feelings which may be unclear for teachers and peers.Gestures can also be used to teach students new information. For example, when learning their colors, body parts and letters, students can learn these information through songs, videos, and hand gestures such as Head, Shoulders, Knees and Toes or ABC. Through learning these songs, hand gestures and body movement, students can retain the information in a fun and interactive way allowing the students to be more motivated and engaged to learn new information. Gestures also teaches students strategies in reading and understanding **symbols** in different situations. For example when seeing a "quiet" sign in the library, students will know they need to remain silent inside the library, taking into consideration the other people who maybe studying and trying to focus. However, some gestures or symbols have more than one meaning. For example raising our hands in class demonstrates the student has something they want to share. On the other hand, raising our hands while crossing the street shows a different meaning as it represents manners to the driver. Students can learn which gestures are appropriate for certain situations when the teacher demonstrates the meanings behind these gestures through "role playing" in which students and teachers act out situations helping to demonstrate which gestures are appropriate for certain situations.

13.9 Relationship Skills

Relationship skills are the strategies students use to build and maintain positive relationships among peers and surroundings. When building positive relationships, researchers often wonder *why individuals chose to create friendships with certain people but not others.* Researchers wonder whether creating relationships has to do with personality traits, physical abilities, socioeconomic systems, intelligence, or other features[120]. Overall, students build positive relationships as they learn to communicate their thoughts and feelings in a positive and healthy way through using **emotional regulation**. Learning these techniques allows students to become more open minded to diversity within the classroom as they learn to interact with all peers regardless of their age, gender, size or ethnicity. When these skills are developed at a young age, students built upon these frameworks on how to build and maintain relationships in the future with their co-workers, family members and their partners, as students are able to identify which relationship strategy worked and didn't work while they were in school. Overall, students who show better acceptance by their peers often demonstrated more admirable qualities within them such as being friendly, intelligent, attractive and athletic. To add on, these students were shown to be more successful in the future facing less emotional problems such as depression and social anxiety disorder [121].

119 Ann Sanson, S. A. (2004) Connections between Temperament and Social Development: A Review. 143-170.

120 Mary E. Gifford-Smitha, Celia A. Brownell (2003) Childhood peer relationships: social acceptance, friendships, and peer networks Journal of School Psychology 41, 235–284

121 Weinstein, C.S., Romano, M. (2015) Knowing Your Students and Their Special Needs 110-145

13.9.1 Bullying

Bullying is one of the most common issue within all school environments but can be difficult to identify due to the several different methods of bullying that takes place. Bullying can be done directly (hitting, pushing punching), or indirectly (verbally abusing someone through name calling, isolating). Two main reasons for bullying others include **alleviating boredom/creating excitement** and to **split up friendship and group processes.** Bullying is common within the classroom as students choose to reject and/or ”pick on” students who look more vulnerable and seem to be easier targets [122].In general, researchers show females to be more verbally victimized whereas males report being bullied more physically [123] These situations affect children emotionally as they feel alone, misunderstood and are scared to speak up and seek help from an adult due to the believed consequences behind their actions. However, not speaking to a trusted friend or adult only makes the situation worse as bullying is often a ***destructive process*** as the bully continues to become stronger within the relationship while the victim becomes weaker [124] During these situations, teachers need to step in and teach students the effects of bullying how it can lead to depression, isolation and withdrawal within the victim [125]. The teacher can bring more awareness of the effects of bullying by incorporating role plays of different bullying situations, or having professionals come into the classroom and speak about the consequences behind bullying and the importance of speaking up when one is involved in a bullying relationship. Through these involvements, the bullies are more likely to see the situations in the perspective of the victim, as they learn ways in how to create and maintain an equal respectful relationship with their peers.

13.9.2 Building Relationships

Building relationships centers around student’s ability to learn how to create and maintain positive relationships inside and outside the classroom. It is evident that certain students have better relationship building skills compared to others, however, the true and main reason behind their advanced skills is still in research. It can have something to do with the student’s cultural family background; the student’s peer groups; personality characteristics and much more. Nevertheless, learning these skills at a young age teaches students appropriate strategies to use when building relationships with future peers, partners and co-workers. Students learn that the way they talk with their surrounds should be altered when interacting with people who are older than them such as teachers and parents. For example students should should show respect to older people by constantly being open minded towards receiving positive and negative feedback. If students chose to talk with adults like how they interact with their peers such as saying ”what’s up” or ”how’s it going”? teachers and adults can be lead into the perspective that *this student is extremely rude and*

122 Mary E. Gifford-Smith, C. A. (2002). Childhood Peer Relationships: Social Acceptance, Friendships, and Peer networks. 41, 235–284.

123 WENDY M. CRAIG & DEBRA J. PEPLER (2007) Understanding Bullying: From Research to Practice; Canadian Psychology Vol. 48, No. 2, 86-93

124 WENDY M. CRAIG & DEBRA J. PEPLER (2007) Understanding Bullying: From Research to Practice; Canadian Psychology Vol. 48, No. 2, 86-93

125 Kenneth W. Merrell, R.B. (2006). Relational Aggression in Children and Adolescents: A review with implications for school settings. Psychology in the Schools , 43, 345-361.

should be better educated. In order for these situations to be avoided, research has shown that students learn better when they are shown ways in how to build positive relationships. Therefore teachers should step into the classroom modelling positive relationship building techniques such as demonstrating how to share, be respectful, and be welcoming for diversity. For example, when providing students with snacks, teachers can demonstrate how giving all students 1 piece is the fair thing to do as everyone gets the same amount. To add on, teachers should model the different levels of acceptable interaction between one's peers compared to adults they know. Through modelling these behaviours, students learn to modify their behaviour and create positive and long lasting relationships with their peers and surroundings [126].

13.10 Responsible Decision Making

Responsible decision making is the student's ability to construct responsible choices about their personal behaviours and social interactions. For students to develop these skills they need to consider various questions such as, *how would this decision benefit me? what would be the consequences behind this decision? who will it impact?* These question, choices and behaviour are often guided by the individual's pre-constructed **ethical standards**, such as safety concerns, social norms and the evaluation of consequences behind performing these actions. These responsible decision making techniques are often guided by cultural and religious beliefs.

There are two main different cultural point of views known as:

Collectivist	**Individualistic**
We Oriented	Me Oriented
Blending in	Standing out
Belonging	Standing out
Group Goals	Individual Goals
Cooperation	Competition
Group Support	Self Reliant

For example, cultures that emphasize individualism (US, Canada, Australia), chose to make decisions based on what *they believe* would benefit themselves the most, whereas collectivist communities (Asia, Latin America) emphasizes the importance of group harmony instead of individual decisions [127]. These cultural differences affect the student's level of moral decision making even at the young age of 4. In the CBC video babies born to be good?, researchers conducted an experiment where researchers recruited students under the age of 5 to test their level of moral reasoning. All students showed diversity in age (4-5), ethnicity and gender. In each of the situations, the experimenter left one student in a room (1 on 1) full of mess. When the experimenter left the room to grab a clipboard, all the children chose to clean up the mess to help the researcher. Before conducting the experiment, researched believed students coming from collectivist communities (Asia, Latin America) will lie in order to

126 Kenneth W. Merrell, R. B. (2006). Relational Aggression in Children and Adolescents. A review with implications for school settings. Psychology in the Schools, 43, 345-361

127 Xinyin Chen and Doran C. French (2008) Children's Social Competence in Cultural Context 591-616

not receive credit for helping the researcher whereas individualistic communities would be honest and take the credit for the job being done.The results confirmed the hypothesis as researchers found students from individualistic communities didn't mind "standing out" and receiving acknowledgement" whereas collectivist students preferred "blending in". These cultural differences can be present upon individuals as they grow older due to their different moral and ethical values. For instance, when a student receives a job offer, individualistic communities would encourage the students to make the decision based on *how the situation would benefit the individual* whereas collectivist communities emphasize putting their group unity before their individual choices. Despite the different cultural perspectives, in order for responsible decision making to take place, individuals need to keep in mind how this decision would affect themselves as well as their surroundings. Through using responsible decision making, students learn to become critical thinkers as it introduces them to the importance of "thinking before acting". Teachers can integrate these aspects of learning through reading short scenarios of a story and by asking students questions on *what would be the responsible thing to do next? or What action can lead to a big consequence?* These scenario acting techniques help students learn strategies in regulating their actions to fit their ethical beliefs.

13.10.1 Social Behaviour

Social behaviour looks at how individuals interact physically, emotionally and socially in different situations. This includes looking at how individuals interact through verbal face to face conversations or talking through a phone or electronic device. Social behavior also refers to physical interactions through holding hands, linking arms, hugging, etc. An individual's level of social behaviour is highly correlated with their past experiences. For example, when a child is highly **neglected** by their parents, they are more likely to display **aggression** inside the classroom due to the fact they were mostly rejected by their primary caregiver. [128]. These negative interactions guided students to believe this world is an unsafe place therefore, they become highly defensive in new situations as they choose to reject new peers and teachers. During these situations, teachers need to step in and make the child feel safe and comfortable within the classroom, by integrating positive reinforcements such as complementing the student on their work, or providing feedback on how the student can improve their learning and understanding. Through these levels of interactions, the student often becomes less aggressive in different situations as the teacher helped to restructure the students understanding of the world to be a "safe environment" altering one's morals and shaping their interactions with their peers and parents.

13.10.2 Teamwork

Teamwork is build within the classroom when students acknowledge the importance of **collaboration** of different works and ideas to make it better. Through using teamwork strategies, students learn ways in feeding off of each other through learning ways in getting their points and ideas across while listening to the opinions and feedbacks of other

128 Ann Sanson, S. A. (2004). Connections between Temperament and Social Development: A Review. 143-170.

individuals. For example, when students work on group assignments, they often split up the work evenly and collaborate their ideas in the end. This allows the work to become more developed as it integrates different perspectives of the situation into one assignment. When there is a disagreement within the group, students learn more teamwork strategies by compromising and being respectful towards the ideas of their peers. However, if these skills are not practiced, teamwork situations would become chaotic for learners as well as teachers and students will struggle to regulate their ideas, emotions and relationships. Nevertheless, when teamwork is practiced inside the classroom through doing group projects, or playing team sports, children learn ways in building neutral and respectful relationships in the future. For example through playing a team sport, students better understand that in order to run a company, there needs to be different individuals having different roles to run the company however, group collaboration is important for the company to be successful.

13.10.3 Conflict

Individuals often face social and emotional conflicts inside and outside the classroom setting. The individual's ability to deal with these conflicts are highly dependent on their previous experiences resolving conflicts and is often shaped by their beliefs of social norms and ethical beliefs. For instance, at a young age, students are often unclear on social norms on how to resolve a conflict as they may have not been exposed to these situations. These students may lack morals therefore, may believe the best way to resolve a conflict is fighting back and becoming defensive. During these times, teachers can show students the consequences behind fighting back as it only makes the conflict worse. Teachers can then teach students ways to resolve the conflict through talking about the problem as students may have had a miscommunication. Many individuals also face emotional conflict such as feeling lonely, rejected, mad, and sad. During these situations, teachers should guide students in having a conversation about what they are feeling and why they are feeling this way. Research has shown students who resolve emotional conflicts through talking about it, lead the student to become more emotionally and socially stable in the future [129]

13.11 Glossary

Academic Stress: An academic task is perceived as stressful by people who do not feel as if they have the skills, or emotional or time resources, needed to effectively manage a given activity.

Aggression: The practice of making assaults or attacks; boldly assertive.

Alleviating Boredom/Creating Excitement: Picking on an individual to make their lives more fun, eventful and interesting.

Autonomous Motivation: Engaging in an activity because of its perceived meaningfulness and relevance.

Collaboration: to work, one with another; cooperate, integrate ideas

129 Joseph E. Zins, M. J. (2006). Social and Emotional Learning: Promoting the Development of All Students. Journal of Educational and Psychological Consultation, 17, 233–255.

Collectivist Perspective: view point of Asian, Latin American communities emphasizing importance of group collaboration, group unity, and group belonging.

Critical Youth Empowerment (CYE): Focuses on collaboration and connection through various models of youth empowerment.

Destructive process: as the bullying continues, the power imbalance becomes greater because the bully continues to grow stronger as they figure out more vulnerable aspects of the victim making the victim weaker and an easier target.

Diversity: The inclusion of individuals representing more than one national origin, color, religion, sexual orientation, etc.

Emotional Regulation: The child's ability to monitor their behaviour in different situations.

Ethical standards: Perception of what is morally right and wrong, and their reasoning behind beliefs.

Individualistic Perspective: view point of Canadians, Americans, Australian citizens emphasizing the importance of independence, having privacy, being self oriented, etc.

Motivation: The reason for acting or behaving in a particular way.

Neglected: Given little attention to, fail to show care.

Positive Youth Development (PYD): Using activities and experiences to assist young people in developing social, moral, emotional, physical, and cognitive competence in their community.

Reactivity: How the individual responds to the environment.

Scaffold: Process through which educators guide children along their emerging abilities.

SECURe: Social, Emotional, and Cognitive Understanding and Regulation in education.

Self Regulation: Child's ability to control their reactivity in different situations while controlling their emotion and attention.

Sociopolitical Development (SPD): Promotes an understanding of the cultural and political forces that shape one's societal status by emphasizing the acquisition of practical, analytical, and emotional faculties to act within political and social systems.

Split up friendship and group processes: Convincing others to not hangout with certain people due to having undesirable qualities.

Symbols: Something used for or regarded as representing something else; Can include words, images, phrases to represent another object.

13.12 Recommended Readings

Ann Sanson, S.A. (2004) Connections between Temperament and Social Development: A Review. 143-170.

Jackson, Cassandra McKay. (2014). A Critical Approach to Social Emotional Learning Instruction Through Community-Based Service Learning. 292-312.

Weinstein, C.S., Romano, M. (2015) Knowing Your Students and Their Special Needs. 110-145.

13.13 References

14 Metacognition and Self-Regulated Learning

15 Metacognition and Self-Regulated Learning

This chapter explores how learners take an active role in their own learning through self-regulation. We examine the stages of self-regulated learning (SRL) and how the ability to reflect on our own thinking, known as metacognition, facilitates these stages. We discuss the theory of metacognition and self-regulated learning and show how these fundamental cognitive processes drive learning in academic settings.

15.1 The Concept of Metacognition

Metacognition is one of the key components of self-regulated learning which involves knowledge about our cognitive thinking and regulation of thinking.

15.1.1 Definition of Metacognition

Metacognition is the knowledge and regulation of your own thinking. Someone who is able to monitor and control his learning is thought to have metacognitive ability. [1] This notion has a huge implication in the field of education because studying often involves these skills. In this section, we will look at how the definition of metacognition has evolved.

In 1979, Flavell introduced the concept of metacognition. [2] From his and other's study, Flavell found out that "young children are quite limited in their knowledge and cognition about cognitive phenomena, or in their metacognition" in other words, "cognition about cognition" [3]. This was the beginning of research in metacognition and the field has been growing since then. The notion of metacognition also led educational psychologists to study self-regulated learning, which will be discussed later in this chapter. Metacognition not only holds importance in educational psychology but also in developmental psychology, along with theory of mind, and cognitive psychology. This is why researchers always come back to the notion of metacognition.

Metacognition is related to various aspects of life including reading, writing, planning, and evaluation. Flavell initially states that metacognition serves two basic functions, which

1 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). *Cognitive psychology and instruction* (5th ed.). Boston, MA: Pearson

2 Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906-911.

3 Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906-911.

are the monitoring and control of cognition [4]. Similarly, Ann Brown in 1980, provides a definition including the knowledge and regulation of cognition [5]. This is when the word "regulation" comes in. In recent research, metacognition is usually divided into three forms. They are metacognitive knowledge, metacognitive experiences, and metacognitive skills or strategies [6][7].

Metacognitive knowledge is declarative knowledge such as language and memory [8]. It also involves information about tasks, strategies, goals and persons. That includes how people process tasks.

Metacognitive experiences are "what the person is aware of and what she or he feels when coming across a task and processing information related to it" [9]. Metacognitive experience is especially important in self-regulated learning because it allows people to make attributions about their feelings. For example, a student might feel that the task is too difficult. This leads the student to adjust his goals.

Metacognitive skills are the "deliberate use of strategies (i.e. Procedural knowledge) in order to control cognition. [10] Metacognitive skills include "orientation strategies, planning strategies, strategies for regulation of cognitive processing, strategies for monitoring the execution of planned action, and strategies for the evaluation of the outcome of task processing" [11].

Efklides also adds that "metacognition is a representation of cognition, and that metacognition and cognition are connected through the monitoring and control functions" [12]. This is the concept Flavell and Brown were missing and it is called the meta-level thinking. Metacognitive experiences and metacognitive knowledge are related to the monitoring of cognition, and metacognitive strategies are related controlling of metacognition [13]. These definitions and assumptions of metacognition led Efklides to conceptualize metacognition as first, "metacognition is multifaceted. Specifically, there are metacognitive experiences and metacognitive knowledge, which are related to the monitoring of cognition, and the control

4 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

5 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.). Boston, MA: Allyn & Bacon/Pearson.

6 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation.

7 Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: An International Journal Of Research And Practice, 21(3), 273-284.

8 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

9 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

10 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

11 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

12 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

13 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.

processes that are distinct from the monitoring of cognition". [14] Second, metacognition is a conscious process. Third, metacognitive monitoring and metacognitive control are strictly limited to the self-regulation of cognition without any interaction with affect or broader self-regulation of behaviour".[15] Fourth, "metacognition is purely individual phenomenon".[16] Usually, metacognition is measured using self-report questionnaires. However, Efklides suggests that behavioural measures such as verbal and non-verbal behaviour, and physiological measures also needed[17]. In order to study metacognition in the self-regulation processes, we need to combine "experimental methodology that implicate the self (e.g., feedback, social comparison) along with measures of metacognitive experiences and affect" [18]. A number of interventions have been developed in education because metacognitive experience is important for the control of cognition and learning. [19] The Emphasis of interventions is often on the metacognitive knowledge of strategies and the procedures involved in metacognitive experience because they can be improved over time. Specifically, metacognitive interventions should be able to identify reasons why metacognitive regulation is failing. "That is, if it is metacognitive knowledge, metacognitive skills or metacognitive experience. Then, they can target that particular facet of metacognition and support regulation"[20].

3 forms of metacognition
Metacognitive knowledge
Metacognitive experiences
Metacognitive skills

21

15.1.2 Judgments of Learning

A topic related to metacognition is Judgements of learning. **Judgments of learning (JOLs)** are "assessments that people make about how well they have learned particular information".[22] Nelson and Dunlosky (1991) [23]first introduced this concept and it is fre-

14 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
15 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
16 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
17 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
18 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
19 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
20 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
21 Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. European Psychologist, 13(4), 277-287.
22 Son, L.K., & Metcalfe, J. (2005). Judgments of learning: Evidence for a two-stage process. Memory & Cognition, 33(6), 1116-1129.
23 Nelson, T. O., & Dunlosky, J.. (1991). When People's Judgments of Learning (JOLs) Are Extremely Accurate at Predicting Subsequent Recall: The "Delayed-JOL Effect". Psychological Science, 2(4), 267–270.

quently discussed since then. They suggest that judgements of learning "help to guide self-paced study during acquisition".[24] Although judgements of learning can be inaccurate a lot of the times, Nelson & Dunlosky argue that judgments of learning made shortly after study is more accurate than judgements of learning made immediately after study. This implies that students should evaluate their progression of study after waiting for a short time. Nelson & Dunlosky call this "delayed-JOL effect". Knowing what one knows has a huge effect on later recall because they can go back and re-study the items they do not know. This leads to better study outcome because they can allocate their study time more efficiently on later study sessions. Nelson and Dunlosky use the word "self-monitoring during learning" to represent judgements of learning. Thus, metacognition is once again a crucial component of judgements of learning, and self-regulated learning. **Feeling-of-knowing judgment** is another concept related to judgements of learning. Feeling-of-knowing refers to "the judgment about the degree of accuracy for recognizing or knowing a task or answer and predicting one's knowledge"[25] It is similar to the concept of judgments of learning except the accuracy is considered. Feeling-of-knowing and self-regulation of learning are related because it is related to metacognitive accuracy. Metacognitive accuracy will be discussed later in this chapter. Nelson and Leonesio (1988) suggest that feeling-of-knowing judgment is part of metacognition. Feeling-of-knowing judgment is part of monitoring components of metamemory which is a similar concept of metacognition. Another important concept of knowledge and monitoring of one's cognition is metamemory. Metamemory is "a high level of cognitive functioning involving decisions of when to deploy a strategy and knowledge of one's memory abilities".[26] During Bembenutty's study on undergraduate students, all students allocated their study time according to their feeling-of-knowing. The study also revealed labor-in-vain effect which means that the longer self-paced study time did not predict better recall. This might be because feeling-of-knowing is often inaccurate. Then, the question would be how can we improve our understanding of knowledge? In other words, how can we improve metacognitive knowledge? Implication in educational settings will be discussed later.

15.1.3 Metacognition in Writing

Metacognitive abilities are essential in writing, especially in university level courses. Although instructors often urge students to reflect on their writing and revise it several times, it is rare for students to actually evaluate and re-work their writing in a detailed fashion. Parrott and Cherry brings up this concept and suggest a new teaching tool to make students think about their writing more actively. The strategy is called process memos. **Process memos** are guided reflections submitted from students and teachers. [27]Students submit process memos after writing the first drafts and the final versions of their papers. For the

24 Nelson, T. O., & Dunlosky, J.. (1991). When People's Judgments of Learning (JOLs) Are Extremely Accurate at Predicting Subsequent Recall: The "Delayed-JOL Effect". Psychological Science, 2(4), 267–270.

25 Bembenutty, H. (2009). Feeling-of-Knowing Judgment and Self-Regulation of Learning. Education, 129(4), 589-598.

26 Bembenutty, H. (2009). Feeling-of-Knowing Judgment and Self-Regulation of Learning. Education, 129(4), 589-598.

27 Parrott, H. M., & Cherry, E. (2015). Process Memos: Facilitating Dialogues about Writing between Students and Instructors. Teaching Sociology, 43(2), 146-153.

first draft, students are asked to reflect on their paper, helpfulness of the rubrics, questions regarding the assignment, strengths and weaknesses of their paper, and what they think they need to improve in the final version of the paper. After this, teachers mark the paper and provide feedback. In the second process memo, students are asked to reflect on the feedback they received from the teacher. Questions include "which comments were most helpful, and why?". [28] Parrot and Cherry started testing out process memos in 2005 and fully implemented it in a study in 2015. The study included 242 university students in various sociology courses, including introductory courses and more advanced courses. The results suggest that process memos help both students and teachers to actively engage in the process of writing. Teachers get feedback on their instructional qualities so that they can improve their teaching in the future and make sure the rubrics are clear. Although some students did not take process memos seriously and provided insufficient comments, most students found this method useful in improving their writing skills. Most students were honest about their comments. Process memos also promoted communication between students and teachers which allowed teachers to directly respond to students' reflections. Another advantage of using process memos is that they engage every student in the class so students who feel too shy to raise their hands and ask questions in class can benefit.[29] It is an efficient way to enhance students' metacognitive awareness, and guide students' writing step by step.

15.1.4 Metacognition in Reading

Recent research on metacognition and the effect on reading comprehension includes studies on individuals with language disorders and adolescents. These studies show the relationship of metacognition with reading and writing, as well as the applicability of metacognitive interventions. Furnes and Norman (2015) [30]compared three forms of metacognition (that is metacognitive knowledge, metacognitive skills, and metacognitive experiences) in normally developing readers and readers with dyslexia. Participants read two factual texts, and their learning outcomes were measured by a memory task. Metacognitive knowledge and skills were assessed by self-report and metacognitive experiences were measured by predictions of performance and judgements of learning.[31] The results show that reading and spelling problems of individuals with dyslexia are not generally associated with lower levels of metacognitive knowledge, metacognitive strategies or sensitivity to metacognitive experiences in reading situations.[32] A longitudinal study on normally developing children indicate that

28 Parrott, H. M., & Cherry, E. (2015). Process Memos: Facilitating Dialogues about Writing between Students and Instructors. Teaching Sociology, 43(2), 146-153.

29 Parrott, H. M., & Cherry, E. (2015). Process Memos: Facilitating Dialogues about Writing between Students and Instructors. Teaching Sociology, 43(2), 146-153.

30 Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: An International Journal Of Research And Practice, 21(3), 273-284.

31 Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: An International Journal Of Research And Practice, 21(3), 273-284.

32 Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: An International Journal Of Research And Practice, 21(3), 273-284.

girls have better metacognitive knowledge between age 10 -14.[33] The study also revealed that text comprehension is positively correlated with individual differences in metacognitive knowledge of strategy use. These two studies suggest that text comprehension in dyslexia is not related to their metacognitive skills, metacognitive knowledge or metacognitive experiences, however for normally developing children, their text comprehension is related to their level of metacognition. **Question generation** often help students understand the texts better. "An ideal learner – self-regulated to active – is a person who asks deep questions and searches for answers to thought -provoking questions".[34] A number of research are done regards to question generation on reading. This suggests that question generation is an important aspect of reading. Question generation also benefits learning in science. García et al. (2014) [35]examined 72 ninth-grade students in science class. The results indicate that "question-generation training influenced how students learned and studied, specifically their metacognition".[36] Participants in group 1, who received question-training by providing prompts had the highest score on metacognitive knowledge and self-regulation. This suggests that effectiveness of question generation depends on the person's metacognitive knowledge. It is important for teachers to recognize students' knowledge before letting students generate questions.

15.1.5 Metacognition in Science Education

As mentioned before, metacognition is important in the field of science education because higher levels of science require students to reconstruct perceptual knowledge and procedural strategies on their own. It is also important for students and teachers to be aware of the beliefs they have about science as they affect their learning and for teachers it affects how they teach science in classrooms. [37] However, a number of teachers take these beliefs for granted. A study where researchers interviewed preservice teachers and students reveals that not many teachers teach beliefs about science or nature of science. Some teachers in this study believe that teaching the nature of science is not as important as teaching other concepts in science. [38] This becomes a problem when students proceed to university and learn higher levels of science. It also affects students' motivation to study science because it hinders their understanding of science. Schraw, Crippen & Hartley agrees to this and state that "effective instruction should help students and teachers aware of the beliefs

33 Kolić-Vehovec, S., Zubković, B. R., & Pahljina-Reinić, R. (2014). Development of metacognitive knowledge of reading strategies and attitudes toward reading in early adolescence: The effect on reading comprehension. Psychological Topics, 23(1), 77–98.

34 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self-regulation and learning approaches in Science. Psicothema, 26(3), 385-390.

35 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390.

36 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self-regulation and learning approaches in Science. Psicothema, 26(3), 385-390.

37 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

38 Abd-El-Khalick, F., Bell, R. L. and Lederman, N. G. (1998), The nature of science and instructional practice: Making the unnatural natural. Sci. Ed., 82: 417–436.

they hold about science". [39]Then, how do we promote metacognition in science learning? Schraw, Crippen and Hartley suggest that "authentic inquiry promotes metacognition and self-regulated learning because students are better able to monitor their learning and evaluate errors in their thinking or gaps in their conceptual understanding." [40]This is part of the **inquiry based learning** that many researchers believe it is effective for science teaching. In inquiry based learning, students pose questions and construct solutions. [41]Another way to enhance metacognition in classroom is by collaboration among students and teachers. This will promote feedback, modeling and social interaction, which will benefit in students' motivation and epistemological beliefs. [42] Similarly, metacognition and self-regulated learning is highly discussed in math learning and instruction research. Please refer to [43] for more information.

39 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

40 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

41 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

42 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

43 https://en.wikibooks.org/wiki/Cognition_and_Instruction/Learning_Mathematics

15.1.6 Individual Differences in Metacognition

Figure 27 Different minds

Another popular topic in the studies of metacognition is individual differences in metacognition. Research in individual differences in metacognitive ability shows that it is very difficult to measure metacognition. Winne (1996) proposed that there are 5 sources of individual differences affecting metacognitive monitoring and control in self-regulated learning. They are "domain knowledge, knowledge of tactics and strategies, performance of tactics and strategies, regulation of tactics and strategies, and global dispositions" [44] Global dispositions refer to dispositions about learning. In other words learning styles. Winnie emphasized that his proposals are tentative and requires further investigation. However, his research encouraged other researchers to dive into this topic. A number of researchers suggest that individual differences in metacognitive accuracy reflect differences in metacognitive ability, however Kelemen, Frost, & Weaver, (2000) suggest that this is not the case. **Metacognitive accuracy** refers to "the relationship between metacognition and future memory performance". [45] The study measured 4 common metacognitive tasks. They are ease of learning

44 Winne, P. H. (1996). A metacognitive view of individual differences in self-regulated learning. Learning and Individual Differences, 8(4), 327-353.

45 Kelemen, W. L., Frost, P. J., & Weaver, C. A. (2000). Individual differences in metacognition: Evidence against a general metacognitive ability. Memory & Cognition, 28(1), 92-107.

judgements, feeling of knowing judgements, judgements of learning, and text comprehension monitoring. In the study including pre-test and post-test, memory and confidence levels were stable however, individual differences in metacognitive accuracy were not. [46]This suggests that metacognitive accuracy is not reliable when it comes to measuring individual differences in metacognitive ability. However, the validity of research is unknown as a lot of researchers acknowledge the difficulty of measuring metacognition. Further research are required in this field. The notion of individual differences in metacognitive ability also suggest that there is no one-size-fits-all solution for metacognitive instruction. Lin, Schwartz and Hatano (2005) suggest that application of metacognition need to be proceeded with careful attention to differences in individual learning and classroom environment.[47] Lin, Schwartz and Hatano (2005) suggest teachers to use **adaptive metacognition** which involves "both the adaptation of oneself and one's environment in response to a wide range of classroom variability." [48] Classroom variability includes social and instructional variability. In order to implement adaptive metacognition, Lin, Schwartz and Hatano suggest an approach called Critical Event Instruction which "help teachers appreciate the need for metacognitive adaptation, particularly in situations that appear routine on the surface level". [49] This approach helps prepare preservice teachers deal with commonly occurred problems in the classroom. It provides information on how to deal with different values, goals and experiences. [50]

15.2 The Concept of Self-Regulated Learning

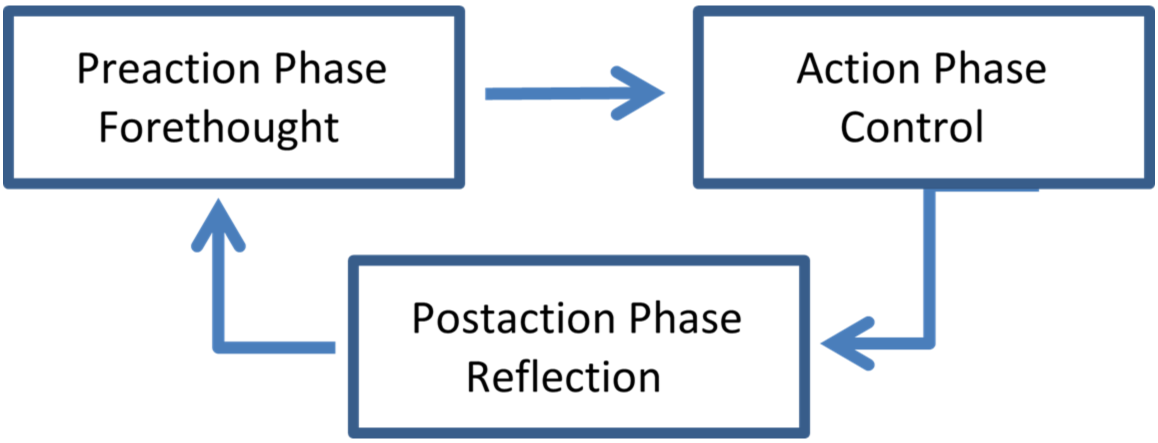

Figure 28 Self-regulated learning

46 Kelemen, W. L., Frost, P. J., & Weaver, C. A. (2000). Individual differences in metacognition: Evidence against a general metacognitive ability. Memory & Cognition, 28(1), 92-107.
47 Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. Educational Psychologist, 40(4), 245-255.
48 Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. Educational Psychologist, 40(4), 245-255.
49 Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. Educational Psychologist, 40(4), 245-255.
50 Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. Educational Psychologist, 40(4), 245-255.

Self-regulated learning is the ability to control learning [51]. People who are self-regulated are metacognitively, motivationally and behaviourally active participants in their own learning, they are self-motivating and make learning easier for themselves [52]. Another aspect of self-regulation is the focus on why and how students initiate control of their own learning [53]. It is believed that people who self-regulate are capable of influencing their own learning. By changing ones own learning strategies, one is better able to understand the knowledge they are learning and the process by which they are achieving it. Active planning before learning takes place, monitoring during learning, and evaluation after learning are simple strategies that can help one self-regulate [54]. Being a self-regulated learner prompts the ability to change and alter learning strategies based on the growth of self understanding [55].

For example: Emily is trying to learn the process of evolution. She reads three chapters and realizes that she can not remember what she just read. As she reads the next chapter she summarizes each paragraph in one sentence into her notebook. Writing notes helped her understand the overall concept of what she was learning. The process she went through was self regulating because she understands that she was not learning by simply reading and she change her learning strategy so that she could learn more information.

Self-regulated learning is beneficial because with better metacognitive awareness one is better able to judge their learning strengths and weaknesses and can alter their learning patterns from what they know about themselves [56].

Self-regulated learning can be better understood through viewing specific strategies which people use to engage in their own learning. The large scale structure of self-regulated learning is as follows:

Self-Regulated Learning	
Self-Assesment	Forethought Phase
Goal Setting	
Strategic Planning	
Strategy Implementation	Performance Phase
Strategy Monitoring	
Outcome Evaluation	Self-regulation Phase

This model of self-regulated learning is broken down into three phases. The **forethought phase** (self-assesment, goal setting, strategic planning) which is what takes place before

51 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

52 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.

53 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.

54 Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist, 34(10), 906-911

55 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390.

56 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

learning occurs, the **performance phase** (Strategy implementation, strategy monitoring) which takes place during learning and **self-regulation phase** (outcome evaluation) [57].

By adopting this method an individual is showing engagement with their learning and by assessing it they can better their understanding.

15.2.1 Self-Assessment:

Self-assessment is about understanding yourself and the way you learn. Questions you can ask yourself are: What are my skills? What are my Interests? Do I learn by watching videos? Do I learn better taking notes? Do I learn by writing or typing out notes? Do I learn best my memorizing and explaining? Self-assessment makes people reflect on their abilities and their strategies. It requires choosing techniques that are most appropriate for the information needed to learn [58]. This first stage in self-regulated learning is not always easy because one must be motivated, one must have the will and effort to test new learning techniques [59]. Self-assesment requires a specific attitude [60]. Negative attitudes towards studying will not promote self-assesment. It will promote the idea that studying and changing techniques of learning will not enhance understanding. However a positive attitude and having an open mind in changing learning techniques can enhance the process of self-assesment. With optimal motivation, persistency and emotion one is better able to asses themselves and find techniques that work and don't work. These traits are also important in total self-regulation.

15.2.2 Goal Setting:

Goal setting is looking at what you need to achieve and how to get there in a specific time frame [61]. Goal setting requires a basic understanding of the information you will be learning, because in order to set a goal you must have some knowledge in what the outcome should look like. Goal setting is important because it helps create motivation and can motivate a person to accomplish a specific goal. It is essential to create attainable goal. Attainable goals are goals which one is capable of reaching. Therefore the goal one sets is not too high and not too low, it is in the persons realm of attaining and succeeding. By creating attainable goals and many goals, a person is more likely accomplish them. Attainable goals

57 Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: An International Journal Of Research And Practice, 21(3), 273-284

58 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

59 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

60 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

61 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

promotes desire and will power because it is not so far out of reach. Some questions that one could ask themselves to goal set are as follows:

What do I want to achieve? What steps will take me to my goal?

15.2.3 Strategic Planning:

Strategic Planning is similar to goal setting in that you need to have a basic understanding of the information you will be learning. This is important because after setting a goal there are specific strategies which you will set to achieve that goal. [62].

For example if you had seven days to study for an exam covering 14 chapters you might separate your learning into studying two chapters per day. By strategically planning how much you need to study everyday, the end goal of learning 14 chapters in 7 days will be achieved.

People goal set and strategically plan for athletic goals too.

A person may have one month to train for a marathon. To properly plan their training they can create a timeline of how much they should improve each week, how long they will run each day and each week and how much to add or take out of their workouts each day and each week.

Strategic Planning is a more detailed way to reach your goal. It is composed of smaller goals within the bigger goal. To have a good plan one must understand their goal, one must know the direction they want to pursue. Some questions one could ask themselves to help promote strategic planning are as follows:

How will I reach my final goal? What do I normally do? Will I be able to achieve this? How do I study/learn best? How can I implement my learning strategies into my goals? Do I have enough time to accomplish each goal? Are my goals realistic in this specific time frame? How should I study/learn for this specific goal? What are my values? How does my personality affect my learning and goals? What distracts me? When do I get tired of study? What things in learning do I not like?

These are several questions which can help strategic planning. Some questions such as "how does my personality affect my learning goals" can inhibit or enhance learning and the ability to reach goals. If a person has a chatty personality and wants to talk when in a group of people, that person might want to set goals to study alone. If someone has a hyperactive attitude and cannot focus on their studying due to excess energy, they might try setting goals to workout or go for a run before studying. These questions can look at many different aspects which effect the outcome.

62 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

15.2.4 Strategy Implementation:

Strategy implementation is an even more detailed organization system of goals and strategic planning. This is the process of which one will implement strategic plans and actually enforcing them into practice [63]. Strategy implementation requires motivation and self-determination. You must have a solid strategic plan to prevent environmental distractions and understand what will motivate you and demotivate you in achieving the goal. Strategy implementation is important in the success of learning because it addresses and implements when you will study or learn. It enforces how you will learn and where you will learn and is the physical act of reaching your goals.

15.2.5 Strategy Monitoring:

Strategy Monitoring is the process of monitoring how effective your strategic planning is for your learning. This is an important stage for effective learning because as you learn you can asses if the practice you are doing is effective. Strategy Monitoring occurs during learning and during the act of reaching your goal, similarly to strategy implementation [64]. You may monitor how much you are accomplishing, if you are reaching your goals, if you are actually learning, if you are being distracted and how your environment is effecting your learning process. Monitoring is evaluating your strategies and how effective they are. You must accurately adjust your strategies so that your best learning can take place.

15.2.6 Outcome Evaluation:

Outcome evaluation takes place after learning has occurred. It is reviewing your goals and planning and figuring out how effective it was [65]. Outcome evaluation is important because it allows one to improve on their learning practices and creates a better plan for the future learning processes. Questions you may ask could be as follows:

How effective were my goals? Were they attainable? How accurate was my strategy planning? Should I have included any strategy's which I did not? What should I change about my learning next time? Was my environment distracting?

63 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

64 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

65 García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. Psicothema, 26(3), 385-390

15.2.7 Other Self-regulated Terms

Self-regulated Action is the means of how regulation is conducted [66]. Self-regulated action takes into consideration the object and the action. To better explain this, the object is the end goal such as writing an essay. The action is how that goal will be achieved. Actions can include changes in cognition, emotion, motivation, behaviour, personality attributes and physical environment [67]. The action of motivation will effect if, how and when a student will write their essay. A poor behaviour will negatively effect the learning of an individual. In this case the action is the behaviour and the action is effecting the persons learning ability, which is the object.

Purpose of Engagement is a combination of self-process, purpose, and possible actions that are relevant in a specific situation [68]. For example all people have different reasons for engagement of their learning. Some people learn because it is interesting, some learn because it will make others happy. They have different motivating factors which will benefit or hinder their learning process. The reasons people have towards why they are engaged or not engaged in their learning, can and will effect the purpose of engagement. The reasons one has towards learning will change self-regulated action and the process by which one will plan, monitor and evaluate their learning.

A more detailed table of the self regulated process and how students regulate their personal functioning, academic performance and learning environments is as follows:

Self-Regulated Process
Self-evaluation
Organization and Transformation
Goal Setting and Planning
Information Seeking
Record Keeping and Self-moitoring
Environmental Structuring
Giving Self-Consequences
Rehearsing and Memorizing
Seeking Social Assistance
Reviewing

(20)

Self-Motivation Beliefs

Another important component of self-regulated learning that we have not mentioned is self-motivation beliefs. Zimmerman introduced this concept in the forethought phase and

66 Kolić-Vehovec, S., Zubković, B. R., & Pahljina-Reinić, R. (2014). Development of metacognitive knowledge of reading strategies and attitudes toward reading in early adolescence: The effect on reading comprehension. Psychological Topics, 23(1), 77–98

67 Kolić-Vehovec, S., Zubković, B. R., & Pahljina-Reinić, R. (2014). Development of metacognitive knowledge of reading strategies and attitudes toward reading in early adolescence: The effect on reading comprehension. Psychological Topics, 23(1), 77–98

68 Kolić-Vehovec, S., Zubković, B. R., & Pahljina-Reinić, R. (2014). Development of metacognitive knowledge of reading strategies and attitudes toward reading in early adolescence: The effect on reading comprehension. Psychological Topics, 23(1), 77–98

it includes self-efficacy, outcome expectations, intrinsic interest/value, and learning goal orientation.[69] **Self-efficacy** in this case is your belief about the ability to learn a task. For example, when you are learning a difficult concept in class you feel like you are going to understand it right away or you fear that you are going to get lost. ”Self-efficacy is extremely important for self-regulated learning because it affects the extent to which learners engage and persist at challenging tasks.” [70]Teachers can enhance self-efficacy by providing tasks with appropriate level of difficulty, which is related to the concept of scaffolding. Schraw, Crippen and Hartley suggest that there are two ways to enhance students’ self-efficacy. ”One is to use both expert (e.g., teacher) and non-expert (e.g., student peers) models”, “The second is to provide as much informational feedback to students as possible”[71] **Outcome expectations** is expectations about your consequences of learning. Students who believe that they can learn a difficult concept in economics class and believes that he is going to use this knowledge in the future. [72] Teachers can promote outcome expectation by reminding students that the information is going to be useful in the future. Students with high **intrinsic interest** learn because they want to acquire the task skill. A student might study education really hard because he wants to become a teacher. [73]Teachers can enhance this intrinsic interest by introducing the application of knowledge. Students who have **learning goal orientation** value the process of learning. They simply enjoy learning the material. Teachers can enhance learning goal orientation by making the class entertaining or intrigue students’ attention using different modality (video clips, graphs). Another component of self-regulated learning in the category of motivation is epistemological beliefs. **Epistemological beliefs** are “those beliefs about the origin and nature of knowledge”. [74]These beliefs affect problem solving and critical thinking, which are important component of self-regulated learning. [75]Please refer to chapter 4 [76] for further information about motivation and beliefs about self. Another component of self-regulated learning in the category of motivation is epistemological beliefs. Epistemological beliefs are “those beliefs about the

69 Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. Theory Into Practice, 41(2), 64-72.

70 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

71 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

72 Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. Theory Into Practice, 41(2), 64-72.

73 Zimmerman, B. J. (2002). Becoming a Self-Regulated Learner: An Overview. Theory Into Practice, 41(2), 64-72.

74 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

75 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

76 https://en.wikibooks.org/wiki/Cognition_and_Instruction/Motivation_and_Beliefs_About_Self

origin and nature of knowledge".[77] These beliefs affect problem solving and critical thinking, which are important component of self-regulated learning. [78]

15.3 Critical Review of Metacognition and Self-Regulated Learning

15.3.1 Conceptual Confusion

While self-regulated learning has blown up to be the topic of discussion in contemporary educational psychology, there are a number of criticisms being set forth. In an extensive critical analysis done by Martin & McLellan (2008) conceptual confusions, especially with respect to the definitions surrounding self-regulation, have been noted to lead to misunderstandings in knowing what is really being measured. Multiple terms are being used to pinpoint the focus of self-regulation such as "self-management", "metacognitive strategies", "behavior management" and "self-regulated learning"[79]. Some researchers use these interchangeably [80] which can be misleading. Yet still some tend to emphasize and categorize defining features based on internal mental activity (i.e. Winne and Hadwin, 1998 as cited in [81]) while others define it by reference to action and activity (i.e. Bandura, 1986 and Zimmerman, 1989 as cited in [82]). The former group view self-regulation as metacognitive capabilities that can develop over time with respect to individual variation while the latter more-so consider beliefs and behavior that are context dependent. [83] According to Martin & Mclellan (2008), it is important to consider that the lack of conceptual boundaries in some cases and that over-integration of terms in other can account for problems in empirical research. Without knowing what it is exactly that is being studied, or having too wide of a range in inclusive criteria, it will be difficult to reach the purpose of bettering the models of SRL [84].

77 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

78 Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research In Science Education, 36(1-2), 111-139.

79 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

80 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

81 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

82 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

83 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

84 Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. Stud Philos Educ, 27,433-448.

15.3.2 Cultural Differences

Culture may play an impact on self regulated learning but there is still not a significant amount of research to understand how much it impacts self-regulation. Every individual is different and therefore stereotypes of how one culture learns is not a complete replication of how all people from that culture learn. To add to this point, self-regulation can change as one ages and can change when emerged into a new or different culture [85]. One study found that American students placed a high value on education but the academic achievement of african Americans and Hispanic Americans were considerably less than European and Asian Americans [86]. Japanese and Chinese students were found to have high levels of academic achievement [87]. The difference in achievement may be due to cultural influence on self-regulated learning. This same study measures strategies used by Australians, Japanese and Japanese students in Australia in self-regulation. The study evaluates these students on their self-evaluation, organizing and transforming, environmental structuring (for example: turning off the radio), rehearsing and memorizing, and the nonstrategic category of "other" which analyzes if their learning behaviour was an outcome initiated by another person.

Japanese students in Australia:

The study found that Japanese student's studying in Australia had lower environmental structuring strategies, little seeking assistance strategies and little strategy use of outcomes initiated by others [88]. However these students were high in memorization and rehearsing strategy use [89]. These Japanese students used a great deal of checking, outlining, drafting, recording, reviewing notes, reviewing tests and using willpower [90]. The high achievement and their self-regulation results correlate to the traditional ways Japanese students are raised at home and in school. Traditional Japanese culture emphasizes effort because effort is a large contributing factor in success. They emphasize group cooperation and persistence, and also believe that achievement is met with individual diligence and self-discipline [91].

Japanese Students: Memorization was found to be the most important self-regulated learning strategy used by Japanese students [92]. Repetition was another strategy widely used by Japanese students [93]. In Japanese culture it is believed that spontaneous understanding

85 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
86 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
87 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
88 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
89 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
90 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
91 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
92 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.
93 Purdie, Nola, and John Hattie. "Cultural Differences in the Use of Strategies for Self-regulated Learning". American Educational Research Journal 33.4 (1996): 845–871.

will occur when a person has read the information they are learning 100 times [94]. Values are different in Japan than they are in the western world. They value “compliance with authority”, “obedience in good grace,” and ”cooperation with the teacher” [95]. Japanese students are likely to use a high will power to achieve and self-regulate successful learning [96].

Australian Students:

Memorization was not encouraged in an Australian classroom [97]. They were aiming for understanding rather than memorizing. Although Australian students did use memorization, they did not use it to the extent that Japanese students did [98]. Australian culture, alike to American culture, values self-confidence, tolerance of differences, creativity and assertiveness [99].

Culture may impact self-regulated learning. However when an individual is learning in a new culture some of their learning strategies may change and some of their learning strategies may stay the same. For example, one study found that Japanese students maintained their memorizing strategy as a learning behaviour in the Australian learning system even though the Australian classroom did not recommend it. Because memorization is a large part of learning in Japanese culture it effected their learning strategy use when they moved to Australia to learn. This is one example of how culture effects self-regulated learning. Learning strategies are approached differently in ever country, every town, every school and every classroom. Therefore the learning strategies of every individual is different, and culture is not necessarily the driving force of how we implement self-regulation although it can be a big influencer. Another point is that the strategies used by Australian students, Japanese students and Japanese students studying in Australia are not necessarily right or wrong.

15.3.3 Concept of Learning

The concept of learning can be looked at in six steps:

1. Increasing one’s knowledge
2. Memorizing and reproducing

94 Purdie, Nola, and John Hattie. “Cultural Differences in the Use of Strategies for Self-regulated Learning”. American Educational Research Journal 33.4 (1996): 845–871.

95 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

96 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

97 Purdie, Nola, and John Hattie. “Cultural Differences in the Use of Strategies for Self-regulated Learning”. American Educational Research Journal 33.4 (1996): 845–871.

98 Purdie, Nola, and John Hattie. “Cultural Differences in the Use of Strategies for Self-regulated Learning”. American Educational Research Journal 33.4 (1996): 845–871.

99 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

3. Applying
4. Understanding
5. Seeing something in a different way
6. Changing as a person. [100]

Their are many different views of learning such as what is learning and what strategies are used in learning. According to Purdie learning is viewed in several ways: It is a way to increase knowledge, it requires memorization, it requires reproducing and studying [101]. Learning is seen to help generate a career and learning is viewed as understanding [102]. Learning is also a way to see things in a different or new way, it is a means of personal fulfillment and can be considered a 'duty' to some individuals [103]. Learning may be seen "as a process not bound by time or context" and also as a way to "develop social competence" [104]. These different views of learning generate a concept of learning which help to understand self-regulated learning. Understanding the different views of learning is self-regulating itself and it can also help one to understand the learning strategies people use when self-regulating.

15.3.4 Concept of Learning in Relation to Cultural Differences

The concept of learning relates to cultural differences and self-regulation because most information on 'self-regulation', and the 'concept of learning' are Western views. This makes understanding the cultural effect of self-regulation one sided. Being exposed to different cultures, exposes people to different ways of thinking. When the Japanese students studied in Australia they learnt different learning strategies and found new ways to understand knowledge than what they were used to. This process may have been unconscious but because they were put into a new system with a different language and a different structure, they would be forced to change some of their learning strategies. When viewing learning from different perspectives people may start to see that knowledge is not necessarily dualistic [105]. This means that knowledge is not right and wrong, or good and bad. Learning may become viewed as relativist where one can "recognize the flexibility of knowledge and understand that knowledge can be questioned. The stereotypical view of Asian culture on

100 Purdie Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

101 Purdie, Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

102 Purdie, Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

103 Purdie, Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

104 Purdie, Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

105 Purdie, Nola, John Hattie, and Graham Douglas. "Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison." Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

learning is that knowledge is something learnt by an authority figure who knows right and wrong [106]. Knowledge is to be learnt and memorized [107]. This results in the assumption that students from Asia are passive learners who are compliant, obedient, and absorb knowledge rather than understand it [108]. The stereotypical view of Australian students are that they are active learners. This results in the assumption that they are “assertive, independent, self-confident, accepting of diversity and willing to question and explore alternative ways of thinking and acting” [109].

15.4 Metacognition Through a Developmental Lens

Research shows that metacognitive abilities are related to factors such as age and biology (citation 4). It is therefore important to understand the developmental progression in order to apply the theory.

15.4.1 Maturation Bases

- Age as a factor
  - Young children
    - Theory of Mind
- Adolescents
- Adults

15.4.2 Biological Bases

- Deficits in Learning

15.5 From Theory to Application

A review of how theories around self-regulated learning and metacognition are put into practice in educational settings.

106 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

107 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

108 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

109 Purdie, Nola, John Hattie, and Graham Douglas. ”Student Conceptions Of Learning And Their Use Of Self-Regulated Learning Strategies: A Cross-Cultural Comparison.” Journal Of Educational Psychology 88.1 (1996): 87-100. PsycARTICLES. Web. 30 Nov. 2015.

15.5.1 Commonly Used Strategies

Self-regulated learning is a vastly growing topic of interest, especially within the field of educational psychology [110]. The aim lies in seeking to integrate theories into a cohesive framework that can be used to guide educators and learners. In a review of the literature regarding self-regulated learning, Paris & Paris (2001) summarize several principles outlined by Paris & Winograd (1999) as being practical applications of SRL in the classroom environment[111]. They categorized them within the confines of four ideas that integrate the research in this field. Firstly, students are capable of better understanding what learning entails when they can make self-appraisals [112]. This means that by analyzing their ways of learning and comparing it to others, evaluating what they have and don't have knowledge about, and assessing their efforts students can enhance their awareness of the process of learning [113]. Secondly, self-management of thought and affect allows for greater flexibility in the ability to problem solve adaptively [114]. By setting realistic goals that focus on improving their competence, effectively managing their time through continual monitoring, and reviewing/revising learning strategies students can commit to higher performance standards for themselves [115]. Thirdly, with respect to instruction self-regulated learning can be taught in a variety of ways that allows for accommodation [116]. SRL may be taught to students explicitly (directed reflection, discussions around metacognition, practice with experts); it can be taught indirectly (modeling, and reflective practices); and it can be prompted with individualized mapping of growth [117]. Lastly, it is believed that self-regulation is intertwined with the narrative experiences related to identity for each student [118]. The way in which students choose to assess and monitor their behavior is consistent with the identity they desire and by being a part of a reflective community of learners/instructors, one can enhance the level of depth by which they look at their self-regulated learning [119].

While there may be variation in the ways in which students self-regulate, the importance lies in understanding how children come to self-regulate in the first place. According to Paris & Paris (2001), SRL can be enhanced in three ways: (1) Indirectly through experience: repeated exposure to experiences in school can elicit learning of what is expected by the

110 Rosman, Tom; Mayer, Anne-Kathrin; Krampen, Günter. (2015). Combing Self-Assesments and Achievment Tests In Information Literacy Assesment: Empirical Results And Recommendations For Practice. Assessment & Evaluation in Higher Education, Vol 40(5), pp. 740-754.

111 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

112 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

113 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

114 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

115 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

116 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

117 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

118 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

119 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

teacher and what is most beneficial to the student [120]. An example of this is the learning that double-checking work, although initially time-consuming, can be beneficial in the long-run and will therefore be advantageous to do the next time around also. (2) SRL can be taught directly: students can learn from the explicit instruction of educators who highlight effective strategy use, and increase awareness of the importance of goal-setting [121]. As an example, an instructor may emphasize the strategic steps of how to analyze a word problem from start to finish. (3) Self-regulation can be elicited when integrated with active practices that embody SRL within them [122]. An effective practice that encompasses SRL into it is collaborative learning projects where each student takes on responsibility for a portion of an overall project [123]. Self-regulated learning appears throughout such projects as students are bound to learn from the feedback of others, and from analysis of what they have done to contribute to the whole. These three outlined ways of enhancing SRL are often found in combination as students get exposed to experiences with their peers and instructors in their educational environment [124].

Throughout education, students are taught various learning strategies to incorporate into their studies; yet as research shows, it is not always enough to know such learning strategies but to be able to regulate the use of the strategy effectively [125]. In a computer-based training experiment by Leutner, Leopold, and Elzen-Rump (2007), researchers were able to show the benefit of not only teaching students a useful cognitive learning strategy (highlighting) but of additionally providing training on how to monitor and regulate the use of this tool with metacognitive learning strategies [126]. The study involved 45 college students randomly assigned to either a treatment group that received no training at all, one in which they were trained only in the cognitive strategy of highlighting, and the other in which training on highlighting was combined with training on self-regulation in learning about new-born babies [127]. The combined self-regulation training group had a version of the computer-program that included steps on how to obtain metacognitive control with time to practice the control strategy and apply it in the next section of their text learning [128]. The results of the study indicate that students trained in both strategy-use and metacognitive control of this strategy use were more successful in applying their learnings in a goal-oriented way when tested after the training [129]. The cognitive-strategy use only group performed better

120 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

121 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

122 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

123 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

124 Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. Educational Psychologist, 36 (2), 89-101.

125 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

126 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

127 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

128 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

129 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182

than the control group that received no training at all; however the combined training group outperformed both indicating that while strategy use can improve outcome performance, learning can be enhanced even further when students are taught to regulate such strategies [130].

The Use of Speech

Psychologist Lev Vygotsky believed that all speech, beginning as early as childhood, serves adaptive communication and socialization purposes[131]. Interacting with others as a child allows them to eventually function as self-regulated problem solvers [132]. In other words in an interaction between an adult and child, the adult at first holds responsibility for helping to perform strategies like planning and monitoring to reach a desired goal [133]; however as they work together to accomplish what can be done with assistance from a capable other as opposed to on their own, the adult helps to transfer self-regulatory performance over to the child [134]. In this sense, metacognition can be seen as being rooted in social interaction [135] as the child learns to think about the actions they take.

The literature in this field discusses the important role that speech, and in particular inner-speech, plays in facilitating self-regulation [136]. Vygotsky suggested that private speech serves the self-regulatory aspect of planning, and related cognitive functions of "orienting, organizing, and structuring behavior" [137] . This aids in understanding how to deal with various difficult situations. Even early forms of speech (i.e.egocentric speech) that become a part of a child's activities aid in "accidentally capturing or regulating behavior" (Zivin, 1979 as cited in [138]). In this sense, he advocated that language is essential to the development of self-regulation [139]. Vygotsky's student outlined verbal self-regulation occurs in a sequential process where initially others' speech controls the child, then the child's overt speech starts to regulate their own behavior, and finally the meaning of their own overt/covert speech regulates behavior in an efficient manner [140].

130 Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

131 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

132 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

133 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

134 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

135 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

136 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

137 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

138 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

139 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

140 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

Behavioral perspectives of self-regulated learning also give us insight into the important role played by self-speech, especially with regards to self-control [141]. They look at the role of induced self-speech where one self-instructs themselves in facilitating such self-regulatory processes as self-monitoring and self-evaluation [142] . These self-instructions can act as cues that guide behavior [143] and can therefore be helpful in encouraging self-regulated behavior on the part of the speaker. This sort of self-speech is described as being a "part of a complex cognitive-symbolic process that mediates and maintains behaviors when consequences are either delayed or not evident" (Mahoney & Thoresen, 1974 as cited in [144] . In other words, if we imagine an individual performing some sort of problem-solving task that requires regulatory behaviors, self-speech and talking it through with themselves can initiate progression in the task as they try to attain understanding. A study of third-grade students who were taught to self-instruct and self-monitor the use of a comprehension strategy yielded more use of the strategy in comparison to the teacher only explicitly teaching it to them (Elliott-Faust & Pressley, 1986, as cited in [145]). Continuation in empirical evidence is needed to further understand the specifics of when and how this sort of speech allows for self-regulation [146] as limitations do exist in the assessment and methodology of researching private speech.

15.5.2 Incorporating Technology

With the undeniable growth in technological use, it is important to consider ways in which this can be used to improve self-regulated learning for students in today's educational system. Graesser et al. (2005) notes that there is a need for "inquiry and explanation-centered learning", and a good starting point for this would be incorporating computer programs into schools that are capable of fostering this. Certain computer programs have the ability to produce positive learning outcomes by allowing for deep learning, scaffolding, elaboration, and self-monitoring [147] while creating a reflective environment that employs collaboration [148]. Students have the opportunity to interact with these computer programs which allow them to learn not only the topic of study but of how to approach that topic in an effective manner that enhances them as learners. In a study based on interactive software, White & Frederiksen (2005) were able to assess metacognitive changes. This Inquiry Island software allowed for learners to interact with different characters on an "island" that incorporated

141 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

142 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

143 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

144 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

145 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

146 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

147 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

148 White, B., & Frederiksen, J. (2005). A theorietical framework and approach for fostering metacognitive development. Educational Psychologist, 40 (4), 211-223.

various knowledge, advice, and tools that supported metacognitive growth [149]. It gave students the opportunity to internalize forms of expertise (e.g. questioning) as they carried out their projects [150]. The results of pre and post assessments show that the program allowed for significant gains on metacognition and inquiry assessments while simultaneously decreasing the performance gap between low and high achieving students as they engaged in these reflective activities [151].

Based on prior research, The Learning Kit Project [152] became an extensive study looking at self-regulated learning through the development of a software program known as gStudy. This software could be used in a variety of subjects and allowed for learners to study through interacting with a shell of knowledge that used cognitive tools such as note-making, glossaries, mind-map construction, and collaborative chat [153]. A particularly important design of this software that aided research was the fact that it contained a non-invasive log analyzer that traced the work of learners through a time-referenced, real-time account of how students interacted with the material/tools [154]. This allowed for researchers to see that, for example, data for students who reported higher mastery goals aligned with them engaging in more elaborate and frequent note taking [155].

149 White, B., & Frederiksen, J. (2005). A theorietical framework and approach for fostering metacognitive development. Educational Psychologist, 40 (4), 211-223.

150 White, B., & Frederiksen, J. (2005). A theorietical framework and approach for fostering metacognitive development. Educational Psychologist, 40 (4), 211-223.

151 White, B., & Frederiksen, J. (2005). A theorietical framework and approach for fostering metacognitive development. Educational Psychologist, 40 (4), 211-223.

152 Winne, P.H., Nesbit, J.C., Kumar, V., Hadwin, A.F., Lajoie, S.P., Azevedo, R., & Perry, N.E. (2006). Supporting self-regulated learning with gStudy software: The learning kit project. Tech, Inst., Cognitive and Learning, 3, 105-113.

153 Winne, P.H., Nesbit, J.C., Kumar, V., Hadwin, A.F., Lajoie, S.P., Azevedo, R., & Perry, N.E. (2006). Supporting self-regulated learning with gStudy software: The learning kit project. Tech, Inst., Cognitive and Learning, 3, 105-113.

154 Winne, P.H., Nesbit, J.C., Kumar, V., Hadwin, A.F., Lajoie, S.P., Azevedo, R., & Perry, N.E. (2006). Supporting self-regulated learning with gStudy software: The learning kit project. Tech, Inst., Cognitive and Learning, 3, 105-113.

155 Nesbit, J.C., Winne, P.H., Jamieson-Noel, D., Code, J., Zhou, M., Macallister, K., Bratt, S., Wang, W., & Hadwin, A. (2006) Using cognitive tools in gStudy to investigate how study activities covary with achievement goals. J Educational Computing Research, 35 (4), 339-358.

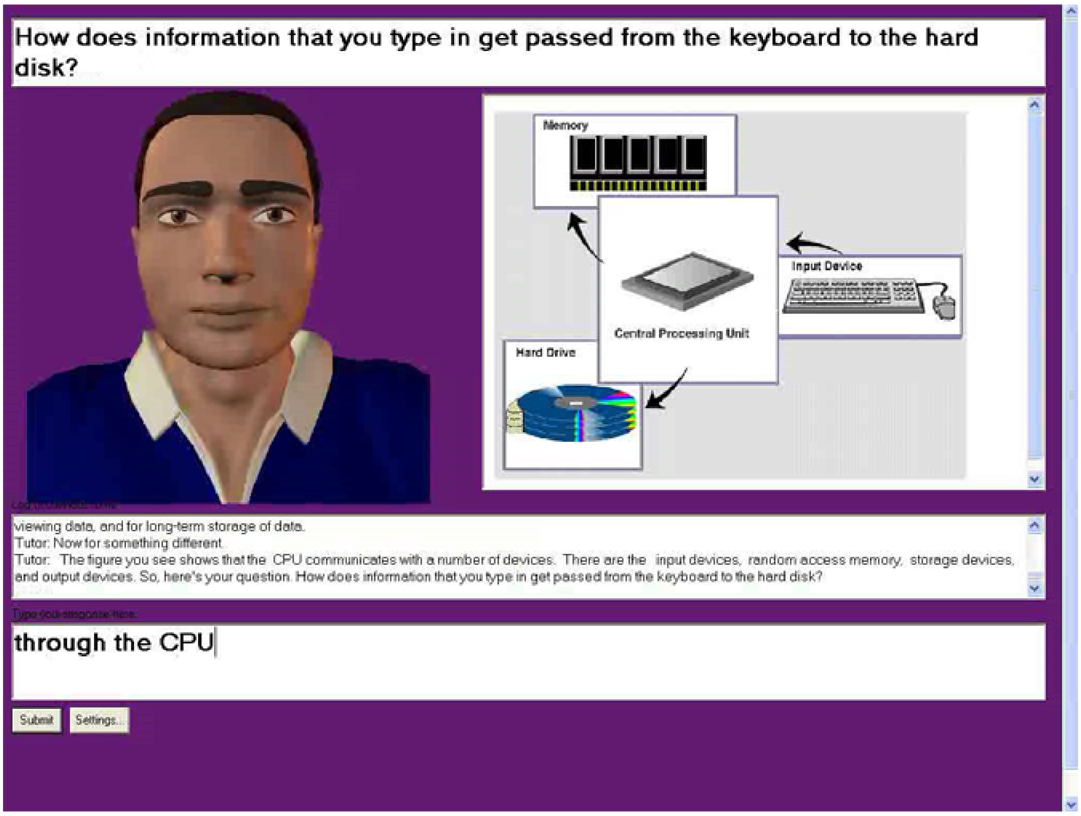

Figure 29 AutoTutor

Many computer programs aim to stimulate professional human tutoring which has shown to be advantageous [156]. Such programs include Autotutor in which animated agents converse with students to guide metacognition, Istart which teaches comprehensive reading strategies, and Betty's Brain where students are able to teach computer agents their knowledge [157]. These types of programs provide concrete ways of getting metacognitive and self-regulating practices into play in a visually and mentally engaging manner that tailors to the demographic targeted. As metacognitive expertise is needed to gain knowledge and transfer this knowledge from one context to another [158], giving students the opportunity to enhance this domain will serve to be beneficial in creating more self-regulated learners.

The question is can these tutoring systems completely replace human tutoring? Research by Azevedo (2010) shows that when it comes to approaching difficult scientific topics, hypermedia use accompanied by human-tutor scaffolding regarding course content and self-regulated learning processes can facilitate learning for students [159]. Yet given the current restrictions

156 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

157 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

158 Winne, P.H., Nesbit, J.C., Kumar, V., Hadwin, A.F., Lajoie, S.P., Azevedo, R., & Perry, N.E. (2006). Supporting self-regulated learning with gStudy software: The learning kit project. Tech, Inst., Cognitive and Learning, 3, 105-113.

159 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

on technology in this field, Azevedo (2010) notes that it is impossible for tutoring systems to completely mimic human tutors. One of the biggest challenges these types of systems face is the inability to fully monitor a student's understanding in the same sense that a human tutor would be able to given the verbal feedback and requests for help that a human can receive throughout and the timely manner in which they can respond [160]. In this respect, there are limitations with providing adaptive scaffolding[161] to the situation at hand. Scaffolds embedded within these systems pose technical challenges in, for example, judgments of learnings (JOL) described earlier in this chapter [162]: the hypermedia does not "know" that a student cannot tell if they are reading too fast [163], yet a human tutor would most likely be able to pick up on this through the interaction and conversational exchange [164].

15.5.3 Facilitating & Encouraging Self-Regulated Learning

The educational environment, the home environment, and the family of a student can play an important role in supporting and facilitating self-regulated learning. Martinez-Pons (2002) outlines practical steps that educators can take in aiming to support self-regulation both at school and home. One of these is to emphasize encouragement: this can be done by teaching students how to encourage their peers and by keeping parents informed of what challenges students are facing in what areas and therefore needing the most encouragement in to get through [165]. Another is to model self-regulation: an educator can be open to sharing their own goals and processes with students or encouraging parents to share theirs with their children to actively model what it means to have self-regulation be incorporated into their life [166]. Families can be made a source of good strategy ideas: educators can provide a monthly strategy to take home and share, or families can be encouraged to help their children with their work systematically rather than referring to textbook answers[167]. As well, providing self-evaluation guidelines can be efficient in prompting SRL[168]: Rubrics for self-evaluation can collaboratively be created with students; educators can gradually encourage students to develop their own record-keeping sheets for keeping track of their work throughout the semester; and examples of material that has been useful for some

160 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

161 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

162 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

163 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

164 Azevedo Roger. (2005). Using Hypermedia as a Metacognitive tool for Enhancing Student Learning? The role of Self-Regulated Learning. *Educational Psychologist, 40*(4), 199-209.

165 Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). Educational psychology(5th ed.). Toronto, ON: Pearson.

166 Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). Educational psychology(5th ed.). Toronto, ON: Pearson.

167 Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). Educational psychology(5th ed.). Toronto, ON: Pearson.

168 Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). Educational psychology(5th ed.). Toronto, ON: Pearson.

parents can be openly shared with others at parent-teacher meetings to stimulate ideas of how families can track the progress of their child in an effective manner [169].

Another way to promote self-regulated learning is to start implementing it at a young age, as research shows that self-regulation can effectively be fostered as early as preschool [170]. The improvement of self-regulatory competence of children in preschool was studied in Germany through providing self-regulation training to the kindergarten teachers directly involved with teaching them [171]. This short-term intervention involved 35 kindergarten teachers who underwent self-regulatory strategy training and 97 children who were interviewed before and after intervention was carried out. Teachers were taught strategies for their own learning process and for supporting the learning of these children through a model of self-regulated learning [172]. Within this model they included the notion of meta-cognitive dialogues where conversations take place between children and their teachers as they reflect on various aspects of learning [173]. Through a structured interview, changes in self-regulatory skills were measured and coded as children explained to a puppet how they could learn to ride a bike [174]. Results indicated that it is possible to improve self-regulation of preschoolers with significant differences shown throughout all phases of self-regulation [175]. The researchers discussed that kindergarten teachers ought to be adequately prepared to "help children to learn how to learn, to organize their knowledge and to solve problems" [176].

This important interaction that takes place between an instructor and a student that facilitates self-regulated learning is emphasized in other literature as well [177]. In particular, dialogue and guided discovery are important tools that can aid the learner to grow through "graduated difficulty, prompts, feedback, and social reinforcement" [178]. The student plays an active role, as well, as they work collaboratively with the teacher in determining pur-

169 Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). Educational psychology(5th ed.). Toronto, ON: Pearson.

170 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

171 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

172 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

173 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

174 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

175 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

176 Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

177 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

178 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49.

pose, strategy, and the most effective way in carrying out the discussed strategy to facilitate performance (K.R.Harris, 1985; K.R. Harris & Pressley, in press, as cited in [179].)

While many factors may ultimately influence a child's educational environment which can in turn influence their self-regulated learning (e.g. being tired), there are instructional practices that can be beneficial in promoting self-regulated learning [180] . Paris and Newman (1990) suggest a number of instructional conditions that encourage the development of self-regulated learning. The first of these is that "effective instruction provokes students to change their theories" [181]: although it may be a difficult task, students must make personal commitments to a new strategy otherwise it may seem more like obedience [182]. Modeling correct strategy use and how to revise plans is one method instructors can use but they must incorporate persuasion to an extent because simply observing the success of another is not always enough [183]. Another condition is "effective instruction makes thinking public": it is suggested that good instructional environments allow students to listen to the problems and solutions of their peers, with such discussions that arise facilitating the understanding and awareness of alternative ways to approach issues, and this ultimately allowing the instructor to address misconceptions [184]. A third practice is "effective instruction promotes active participation and collaboration": when students are encouraged to peer tutor and take an active role they are able to face their own theories and to become aware of what they do and do not sufficiently know which simultaneously aids their own learning as they teach others [185] . Paris and Newman (1990) encourage the use of these practices alongside other aspects such as motivating students to measure success or failure by their own standards and not in comparison to others while assisting them along the way.

15.6 Suggested Readings

Kaplan, A. (2008). Clarifying metacognition, self-Regulation, and self-regulated learning. *Educational Psychology Review, 20*(4), 477-484.

A helpful reading that aims to clarify conceptual boundaries.

Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist, 36* (2), 89-101.

Reviews self-regulated learning research and its practical applications in educational settings.

179 Harris, Karen R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. Educational Psychologist, 25(1), 35-49

180 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

181 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

182 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

183 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

184 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

185 Paris, S.G., Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25(1)*, 87-102.

Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. *European Psychologist, 13*(4), 277-287.

A Review of metacognition and its components.

15.7 Glossary

Dualistic: Knowledge viewed as right or wrong; good or bad.

Forethought Phase: Strategies taking place before learning. Self assessment, goal setting and strategic planning.

Metacognition: Thinking about thinking

Metacognitive Knowledge: Declarative knowledge such as language and memory.

Metacognitive experiences What the person is aware of and what she or he feels when coming across a task and processing information related to it.

Metacognitive skills: Deliberate use of strategies (i.e. Procedural knowledge) in order to control cognition.

Performance Phase: Strategies taking place during learning. Strategy implementation, and strategy monitoring.

Purpose of Engagement: The self-process, the purpose, and the possible actions that are relevant in a specific situation.

Relativist: Knowledge is flexible and changeable. It can be questioned.

Self-Regulated Action: The means by which regulation is conducted.

Self Regulated Learning: The ability to control learning.

Self-Regulated Phase: Strategies after learning has taken place. Evaluation.

15.8 References

Abd-El-Khalick, F., Bell, R. L. & Lederman, N. G. (1998). The nature of science and instructional practice: Making the unnatural natural. *Sci. Ed., 82*: 417–436.

Azevedo, R.(2005). Using hypermedia as a metacognitive tool for enhancing student learning? The role of self-regulated learning. *Educational Psychologist, 40*(4), 199-209.

Bembenutty, H. (2009). Feeling-of-knowing judgement and self-regulation of learning. *Education, 129*(4), 589-598.

Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).*Cognitive psychology and instruction* (5th ed.). Boston, MA: Pearson

Efklides, A. (2008). Metacognition: Defining its facets and levels of functioning in relation to self-regulation and co-regulation. *European Psychologist, 13*(4), 277-287.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, 34(10), 906-911.

Furnes, B., & Norman, E. (2015). Metacognition and reading: Comparing three forms of metacognition in normally developing readers and readers with dyslexia. Dyslexia: *An International Journal Of Research And Practice, 21*(3), 273-284.

García, F. C., García, Á., Berbén, A. G., Pichardo, M. C., & Justicia, F. (2014). The effects of question-generation training on metacognitive knowledge, self regulation and learning approaches in Science. *Psicothema*, 26(3), 385-390.

Harris, K.R. (1990). Developing Self-Regulated Learners: The role of private speech and self-instructions. *Educational Psychologist, 25*(1), 35-49.

Kaplan, A. (2008). Clarifying metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review*, *Vol 20*(4), 477-484.

Kelemen, W. L., Frost, P. J., & Weaver, C. A. (2000). Individual differences in metacognition: Evidence against a general metacognitive ability. *Memory & Cognition, 28*(1), 92-107.

Kolić-Vehovec, S., Zubković, B. R., & Pahljina-Reinić, R. (2014). Development of metacognitive knowledge of reading strategies and attitudes toward reading in early adolescence: The effect on reading comprehension. *Psychological Topics, 23*(1), 77–98.

Leutner,D., Leopald, C., & Elzen-Rump, V.D. (2007). Self-regulated learning with a text-highlighting strategy:A training experiment. *Journal of Psychology, 215* (3), 174-182.

Lin, X., Schwartz, D. L., & Hatano, G. (2005). Toward Teachers' Adaptive Metacognition. *Educational Psychologist, 40*(4), 245-255.

Martin, J., & McLellan, A. (2008). The educational psychology of self-regulation: A conceptual and critical analysis. *Stud Philos Educ, 27,*433-448.

Nelson, T. O., & Dunlosky, J.. (1991). When People's Judgments of Learning (JOLs) Are Extremely Accurate at Predicting Subsequent Recall: The "Delayed-JOL Effect". *Psychological Science, 2*(4), 267–270.

Nelson, T. O., & Leonesio, R. J. (1988). Allocation of self-paced study time and the "labor-in-vain effect". *Journal Of Experimental Psychology. Learning, Memory & Cognition*, 14, 676-686.

Nesbit, J.C., Winne, P.H., Jamieson-Noel, D., Code, J., Zhou, M., Macallister, K., Bratt, S., Wang, W., & Hadwin, A. (2006). Using cognitive tools in gStudy to investigate how study activities covary with achievement goals. *J Educational Computing Research, 35* (4), 339-358.

Paris, S.G., & Newman, R.S. (1990). Developmental aspects of self-regulated learning. *Educational Psychologist, 25*(1), 87-102.

Paris, S.G. & Paris, A.H. (2001). Classroom applications of research on self-regulated learning. *Educational Psychologist, 36* (2), 89-101.

Parrott, H. M., & Cherry, E. (2015). Process memos: facilitating dialogues about writing between students and instructors. *Teaching Sociology, 43*(2), 146-153.

Perels, F., Merget-Kullman, M., Wende, M., Schmitz, B., & Buchbinder, C.(2009). Improving self-regulated learning of preschool children: Evaluation of training for kindergarten teachers. *British Journal of Educational Psychology, 79*, 311-327.

Purdie, N., & Hattie, J. (1996). Cultural differences in the use of strategies for self-regulated learning. *American Educational Research Journal, 33* (4), 845–871.

Purdie, N., Hattie, J., & Douglas, G. (1996. Student conceptions of learning and their use of self-regulated learning strategies: A cross-cultural comparison.*Journal Of Educational Psychology, 88* (1),87-100.

Rosman, T., Mayer, A.K., & Krampen, G. (2015). Combing self-assessments and achievement tests in information literacy assessment: Empirical results and recommendations for practice. *Assessment & Evaluation in Higher Education, Vol 40*(5), 740-754.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a croader perspective on learning. *Research In Science Education, 36*(1-2), 111-139.

Son, L.K., & Metcalfe, J. (2005). Judgments of learning: Evidence for a two-stage process. *Memory & Cognition, 33*(6), 1116-1129.

Stoeger, H., Fleischmann, S., & Obergriesser,S. Self-regulated learning (SRL) and the gifted learner in primary school:the theoretical basis and empirical findings on a research program dedicated to ensuring that all students learn to regulate their own learning. *Asia Pacific Education Review, Vol 16*(2), 257-267.

Winne, P. H. (1996). A metacognitive view of individual differences in self-regulated learning. *Learning and Individual Differences, 8*(4), 327-353.

White, B., & Frederiksen, J. (2005). A theoretical framework and approach for fostering metacognitive development. *Educational Psychologist, 40* (4), 211-223.

Winne, P.H., Nesbit, J.C., Kumar, V., Hadwin, A.F., Lajoie, S.P., Azevedo, R., & Perry, N.E. (2006). Supporting self-regulated learning with gStudy software: The learning kit project. Tech, Inst., *Cognitive and Learning, 3,* 105-113.

Woolfolk, A.E., Winne, P.H., & Perry, N.E. (2012). *Educational psychology*(5th ed.). Toronto, ON: Pearson.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64-72.

16 Motivation, Attribution and Beliefs About Learning

Our motivations drive and direct our thought processes and actions. People in developed countries spend about 15,000 hours in school by the time they are 20.[1] It is important to understand the effects this extended school experience has on students' lives and well-being.[2] Research has repeatedly found that as adolescents get older, there is a decrease in their motivation to learn.[3] Researchers are now focusing on ways to sustain students' motivation throughout their school experience. This chapter explains how theories and research on motivation and beliefs about one's self can be applied to teaching and learning. It emphasizes the importance of motivation in learning, and how teachers can motivate students by accommodating and adapting to their needs. Motivation has two aspects that are inter-related.[4] One aspect looks at how much motivation a person has, and the second looks onto what type of motivation it is. [5] There are many theories of motivation, and here we examine three that offer understanding of teaching and learning. The first theory we look at is Self-Determination theory, which looks at two types of motivation and the factors that facilitate them by fulfilling psychological needs. The second theory we examine is Goal-Orientation theory, which looks at the power of goals in relation to the environments they are constructed within. The structure of the environment generally aligns with the type of motivational goal students strive to achieve. The third theory we examine is Expectancy-Value theory, which explains motivation in terms of the expectations individuals have for their performance in particular activities, and what value performance in those activities holds for them.

16.1 Self-Determination Theory

Self- Determination Theory, first introduced by Edward L. Deci and Richard M. Ryan, primarily looks at two different types of motivation.[6] It states that each type of motivation

1 Deci, E.L., Vallerand, R.J., Pelletier, L.G., & Ryan, R. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346.
2 Deci, E.L., Vallerand, R.J., Pelletier, L.G., & Ryan, R. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346.
3 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020
4 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020
5 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020
6 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

is built upon a reason or goal that eventually develops into a certain behaviour. [7] The first type of motivation is *intrinsic motivation*, which is motivation that comes within one's self for enjoyment and self interest without external pressures or reasons.[8] A student who decides to read a textbook for full pleasure and takes interest in the topic, does so because of intrinsic motivation. [9]On the other hand, *extrinsic motivation* comes from doing something because it leads to an external outcome. [10]This would be a student who solely reads a textbook because he or she knows there is going to be a test at the end and wants to do well on the test.[11]

Both of these types of motivation topics are extremely important to researchers and educators within the theory, because over the years there have been numerous conclusions, under the view of the Self - Determination Theory, intrinsic motivation facilitated the highest quality of learning because it included using creativity and the existence of psychological needs. [12] With recent research however, there are a few approaches that state that although the highest quality of learning does still involve the core aspects of intrinsic motivation, there are ways to include extrinsic motivators to achieve the same purpose. This will be talked about more in later sections, after defining Intrinsic and Extrinsic motivation more in depth.

Intrinsic Motivation

As mentioned above, intrinsic motivation has been concluded to facilitate the highest quality of learning, as it stimulates creativity and satisfies important yet basic psychological needs.[13] According to the Self-Determination Theory there are three personal physological needs every human tries to fulfill. [14] The first need is Autonomy. **Autonomy** is defined as being self regulation and self initiating of ones own behaviour and actions. [15] A student who is autonomous would know exactly what is needed to achieve a given task and feels that they have the individual freedom to do so with effort.The second physological need is **Competence** which is defined as being the ability to attain different outcomes both externally and internally and is successful in doing so using the environment they are sur-

7 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

8 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

9 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

10 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

11 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

12 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

13 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_

14 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The Self-Determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_

15 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_

rounded by. [16] For a student this would mean the ability to do well on a difficult exam with the skills that they already have built from previous experiences.[17] Finally, the third physiological need is Relatedness. **Relatedness**, would be the level of connection one feels from their social environment,[18] where in the case of a student, would be when a student feels that they can relate and connect to what they're learning as well as with the subjects around them. [19]

Extrinsic Motivation

The Self- Determination Theory explains that there are 4 specific types of extrinsic motivation that are different to the degree which they hold autonomy.[20]Starting from the left side of the spectrum, motivation is completely external, and as it moves in the right side direction it moves towards becoming internal.[21] The least autonomous extrinsic motivation on the left spectrum is *External regulation*. This form of motivation is where behaviours are done to receive an incentive or to avoid a sort of punishment.[22] This would be a student who decides to study for an exam strictly to get a good grade, avoid a punishment by their family members , or not be mocked by external subjects for being incapable.[23] Now moving one to the right side, the next type is *Introjected regulation*, where motivation would occur solely to fulfill self/internal power and avoid guilt.[24] A student here would change their motive of studying for an exam to elevate their ego and protect their image.[25] *Identified regulation* comes next, which moves to a more autonomous motivation as its main reason towards acting on something is because it is seen as being valuable and useful for the fu-

16 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_
17 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_
18 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_
19 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_
20 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
21 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
22 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
23 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
24 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
25 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.

ture.[26] For example studying hard for an exam because you want to do well for your future career would be identified regulation.[27] The final type of extrinsic motivation which is the most autonomous is *Integrated regulation*, which is closely tied with topics that are being learned combined with one's self interests.[28] For example, a student might want to study chemistry because it will help them become a doctor which will in turn help others and society. [29]

16.1.1 Promoting and Changing Extrinsic Motivation into Intrinsic Motivation

A key reason why it is important for students to improve their intrinsic motivation is that it leads to overall improvements in both psychological health and academic success [30]. Knowing this, many educational psychologists are constantly working towards finding ways to promote the benefits of intrinsic motivation for students in both their school subjects and emotional health [31]. We can look at literacy as a clear example. On average, 73% of American children do not read for enjoyment [32] and we can assume that this rate is high due to students not realizing the benefits of finding intrinsic motivation in literacy. Results show that students who enjoy reading perform higher in comprehension and overall feel more contended; [33] similarities were found with Math. Over the K-12 schooling years for students, academic intrinsic motivation for math shows to have the highest decline [34]. Math has shown to be able to energize students, and those who have intrinsic motivation have higher problem solving skills as well as higher confidence levels when solving complex problems in different aspects of life [35] Students with special needs and special education also proved to show higher rates of confidence[36]. For these students, this positive impact

26 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
27 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
28 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
29 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.
30 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.
31 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.
32 Perie, M., Grigg, W. & Donahue, P. (2005). The nation's report card: Reading 2005 (U.S. Department of Education, National Center for Educational Statistics, NCES 2006-451). Washington, DC: U.S. Government Printing Office.
33 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.
34 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.
35 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.
36 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.

can result in higher hopes for high school completion rates and achievements after finding intrinsic motivation.[37] In regards to emotional behaviour and health, students who were found to have high levels of intrinsic motivation were overall happier with life, and further created a friendlier and positive school environment. [38] Increased motivation also promoted positive social qualities such as being helpful, friendly, and caring. Considering this aspect, results also showed a positive decline in drug use, violence and vandalism. [39]

With understanding the benefits of promoting internal motivation and also acknowledging the degrees of extrinsic motivation, we can now work towards looking at a common concern as to how to change external motivation into internal motivation in the classroom. Let us use an example of a grade 7 class that is spending time on a specific chapter in science. Some of the students feel that the content they are being taught is extremely uninteresting and pointless. The approach teachers should take in a scenario like this is the process of Internalization and Integration, which aims to promote and discover the value of what is being taught.[40] Internalization is the method of analyzing the explicit reasons as to why one chooses to do something with external motivation. Integration is process of taking those external reasons and converting them to come from one's own self [41]. Here we will see motivation transform from something that was once external (left spectrum) to something that becomes more internal (right spectrum). [42] However, this process can only be achieved or facilitated once students are placed into environments that are allowing them to feel self determined and fulfilled in all three psychological needs of competence, relatedness, and autonomy [43]. The ways that teachers can support this is by allowing students to have a voice and and choice in the academic activities that they engage in. [44], assigning learning activities that are challenging with providing them with the tools and information needed to succeed in the activity.[45], in addition, creating an environment that makes them feel valued, respected, and regarded positively by their teachers and peers. [46]

37 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.

38 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.

39 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.

40 Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

41 Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

42 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_6

43 Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. Educational Psychologist, 26(3-4), 325-346. doi:10.1207/s15326985ep2603&4_6

44 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.

45 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.

46 Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, Competence, and Relatedness in the Classroom: Applying Self-Determination Theory to Educational Practice. Theory And Research In Education, 7(2), 133-144.

16.1.2 Cognitive Evaluation Theory and Rewards

On a similar note, **The Cognitive Evaluation Theory** (CET) is a sub section of the Self Determination Theory that was presented by Deci and Ryan (1985) [47]. It states that any event that becomes interpersonal or relational, and helps to promote the feeling of both competence and autonomy, will in turn cause intrinsic motivation. [48]The theory however, stresses that they're both interrelated and that the feelings of competence will not promote intrinsic motivation unless it is aided by the sense of autonomy. [49] Moving this theory into the classroom, when teachers look at assigning a given task or assignment, they should look to see if the guidelines will fulfill the needs of competence and autonomy in the student.[50] For example, this can be seen when a teacher assigns an individual project or presentation for science class. If the teacher allows the students to chose their own topic and pick between giving a project or presentation, it allows them to have control (feeling of autonomy), which in effect allows them pave their own pathway towards feeling successful (feeling of competence). [51]

Under the CET, research has been continuously worked on to find the results of using rewards, feedback, and other external events on intrinsic motivation to see if it further promoted or decreased the feeling of competence and autonomy. [52] The Cognitive Evaluation Theory explains that external events can do either, depending on how one's self determination or competence is perceived [53]. If an event decreases the way one perceives them, it will decrease intrinsic motivation whereas if it increases the way they perceive them it will increase it.[54] The Cognitive Evaluation Theory also claims that the two aspects of rewards, wether they are either informational or controlling, can answer this question [55] Informational increases intrinsic motivation and controlling decreases it.[56] To determine if a reward is either controlling or informational, it is first important to define the difference between verbal and tangible rewards.[57]

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47 Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

48 Deci, E. L., & Ryan, R. M. (1985). Intrinsic motivation and self-determination in human behavior. New York: Plenum.

49 deCharms, R. (1968). Personal causation. New York: Academic Press.

50 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

51 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

52 Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67. doi:10.1006/ceps.1999.1020

53 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-2

54 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-2

55 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-2

56 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-2

57 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-2

Verbal Rewards are often replaced with the common term "positive feedback "[58] It has strongly been suggested and assumed that positive feedback will increase intrinsic motivation as it is likely to fulfill a student's need to feel competence and be informational.[59] However it is important to realize that verbal rewards may have a controlling aspect as well. It can lead to a student doing actions for the sole purpose to gain appraisal and approval. (i.e. teacher or peers)[60]. The CET therefore claims that the rewards must be looked at in the terms of interpersonal context which looks at the social atmosphere that students are surrounded by(i.e. a classroom)[61]

Tangible Rewards are opposite of verbal words and are rewards that are strongly associated with being controlling and contributing to decreasing intrinsic motivation.[62] For them to be controlling, they have to be looked at as rewards that are offered as incentives for students to do things that are out of their regular norm.[63] This could mean that the student would be motivated to do something because they knew what the expected outcome of the the reward was going to be. [64]The CET takes this understanding and explains that expected tangible rewards are broken specifically based upon the tasks or circumstances that students are asked to participate in.[65] It outlines that there are three types of reward circumstances.[66]

Task-Non Contingence	Rewards that are given to students for participating in an activity
Task-Contingence	Rewards given to students for completing an activity
Performance-Contingence	Rewards given to students for completing an activity, showing success, and performing well

The use of rewards in the classroom has been a long term debated topic, as both researchers and teachers aim to consider what kinds of rewards are best to give to students and when they are the most appropriate to give as well[67]. A recent meta analysis study was done to test the effects of verbal and tangible rewards in the classroom. The effect of verbal rewards

58 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

59 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

60 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

61 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

62 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

63 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

64 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

65 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

66 Ryan, R. M., Miniis, V., & Koestner, R. (1983). Relation of reward contingency and interpersonal context to intrinsic motivation: A review and test using cognitive eval- nation theory. Journalof Personalityand SocialPsychology, 45, 736 750

67 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

showed exactly what was claimed above.[68] When verbal rewards were informational they increased intrinsic motivation and if they were to be controlling it decreased it.[69] They also found that verbal rewards had a higher significance in increasing intrinsic motivation in adolescents in college than younger students in primary school.[70] Similarly, similar results were found with experiment with tangible rewards as they showed to diminish intrinsic motivation. However, in this situation, the effect on students was higher in younger students than for adolescents in college.[71] In regards to teachers and educators giving rewards, it can be implemented in the classroom but only to be used in an appropriate manner. Verbal Rewards are highly recommended however only when it informational.[72] Although Tangible Rewards show negative results, they too can also be implemented in the classroom, however the best method for implementing them include making the rewards unexpected so that the students are not aware of what will be rewarded to them.[73]

16.1.3 Teachers

While working to apply the Self Determination theory in the classroom with students, it is important to analyze the environments that students are exposed to and look at the effects of how the external environment plays when working towards creating an environment that creates intrinsic motivation. Here we will look at the effects of teachers, and the effects that teachers have directly upon students.

Because teachers play a major role in a student's life , there are many ways teachers can influence students. The first way teachers can achieve this is by simply being intrinsically motivated themselves [74] A study was done to see if intrinsic motivation from teachers could disseminate to students in a high school physical education class. Results positively showed that when working with a intrinsically motivated teacher, higher levels of intrinsic motivation in physical education were achieved than working with a teacher who was extrinsically motivated for external rewards(i.e. being paid) [75] Similar results to promote an intrinsic environment were shown when a study was done to look at how teacher's support for basic needs effected school bullying levels. The study included looking at 536 students, grades 7-9 in different Hong Kong secondary schools, where students were asked to fill out a ques-

68 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

69 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

70 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

71 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

72 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

73 Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic Rewards and Intrinsic Motivation in Education: Reconsidered Once Again. Review Of Educational Research, 71(1), 1-27.

74 Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. Contemporary School Psychology, 1691-100.

75 Radel, R., Sarrazin, P., Legrain, P. & Wild, T.C. (2010). Social contagion of motivation between teacher and student: Analyzing underlying processes. Journal of Educational Psychology, 102, 577-587.

tionnaire based on different measures they had felt throughout that semester.[76] Some of the questions included asking students how often they excluded someone, how often they felt they were a bully victim, and how often they felt their teacher showed support in relatedness, autonomy, and competence. Results showed that the lowest amount of bullying took place in schools when teachers had shown high levels of support in relatedness, and students had felt that they had a personal bond and open relationship with their teachers. [77]

16.2 Expectancy Value Theory

In a school and learning environment, students are always making choices when it comes to what motivates them and how they act on that motivation. These choices often revolve around how much effort to put into different activities; for example one student might not put any effort into their schoolwork, but may try exceptionally hard in sports, while another student puts effort into every class but physical education. **Expectancy Value Theory**; which was developed by Atkinson and built upon largely by Eccels and Wigfield, tries to explain this concept by stating that performance and choice are most strongly influenced by the specific understanding a person has on what they are capable of in different fields, and on what they find important to them.[78] Culture, emotion, and outside parties such as parents or teachers have also been deemed by researchers such as Richard Pekrun to be influential in adding value to certain activities.[79]

16.2.1 Wigfield and Eccels' Model of Expectancy Value Theory

One of the most well received models of the Expectancy Value Theory was initially developed in 1983 by Wigfield and Eccels, with the model still being further developed.[80] What makes Wigfield and Eccel's model of Expectancy-Value Theory significant is that it easily applicable to teaching and learning as it examines the individual more closely. As a whole, **Wigfield and Eccles' model** examines ability and expectancy beliefs and personal values as significant to the expectancy-value theory.[81] Expectancies and values are influenced by an individual's beliefs in their abilities, which tasks they define difficult or simple, goals,

76 Lam, S., Law, W., Chan, C., Wong, B. H., & Zhang, X. (2015). A Latent Class Growth Analysis of School Bullying and Its Social Context: The Self-Determination Theory Perspective. School Psychology Quarterly, 30(1), 75-90

77 Lam, S., Law, W., Chan, C., Wong, B. H., & Zhang, X. (2015). A Latent Class Growth Analysis of School Bullying and Its Social Context: The Self-Determination Theory Perspective. School Psychology Quarterly, 30(1), 75-90

78 Bembenutty, H. (2012). An Interview With Allan Wigfield: A Giant on Research on Expectancy-Value, Motivation, and Reading Achievement. Journal of Advanced Academics, 23(2). 186.

79 Bembenutty, H. (2012). An Interview With Allan Wigfield: A Giant on Research on Expectancy-Value, Motivation, and Reading Achievement. Journal of Advanced Academics, 23(2). 186.

80 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 72.

81 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 72.

and past learning.[82] Expectancies and values are then in turn seen as directly influencing an individual's choices, performance, effort, and persistence.[83] When discussing the model in the context of schooling, Eccels and Wigfield identify four different values that are present in the classroom.

Intrinsic Value	Utility Value	Attainment Value	Cost
The level of enjoyment a specific activity or task gives an individual. [84]	An individual finding a certain task or activity to have a quality of usefulness; whether it is related to a present or future goal, or to please parents or friends.[85]	An individual recognizing the success in a certain activity as important.[86]	How an individual views a certain task or activity in terms of its cons, such as if any other opportunities will be lost in the place of doing this one and the amount of effort it will take to complete.[87]

These values further tie in with ability beliefs to create the certain expectancies and levels of motivation an individual sets to a certain task. **Ability Beliefs** are defined as an individual's insight on how capable they are at certain kinds of tasks.[88] Wigfeild and Eccels state that while ability beliefs are based on present ability, expectancies are based on what they expect of themselves in the future.[89]

Another important aspect of the model to examine in regards to the classroom is how a student's expectancies and values develop over the years, and when they start to develop. Wigfield and Eccles state that children start recognizing what activities they are good or bad at and what value different activities have from as early as kindergarten or grade one.[90] This includes the various domains found within a school environment, such as math, reading, music, and sports.[91] These insights on what areas they were successful in also changes over the years as students continue learning. For example, ability and expectancy beliefs for reading generally increase from a grade four student to a grade seven or grade ten student,[92] meaning that an individual who does not view themselves as a strong and confident reader may eventually become confident in their reading skills.[93] This is especially

82 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 72.

83 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 72.

84 Haichun, S., Haiyong, D., & Ang, C. (2013). NOTHING BUT BEING THERE MATTERS: EXPECTANCY-VALUE MOTIVATION BETWEEN U.S. AND CHINESE MIDDLE SCHOOL STUDENTS. International Education, 42(2), 9.

85 Haichun, S., Haiyong, D., & Ang, C. (2013). NOTHING BUT BEING THERE MATTERS: EXPECTANCY-VALUE MOTIVATION BETWEEN U.S. AND CHINESE MIDDLE SCHOOL STUDENTS. International Education, 42(2), 9.

86 Haichun, S., Haiyong, D., & Ang, C. (2013). NOTHING BUT BEING THERE MATTERS: EXPECTANCY-VALUE MOTIVATION BETWEEN U.S. AND CHINESE MIDDLE SCHOOL STUDENTS. International Education, 42(2), 9.

87 Haichun, S., Haiyong, D., & Ang, C. (2013). NOTHING BUT BEING THERE MATTERS: EXPECTANCY-VALUE MOTIVATION BETWEEN U.S. AND CHINESE MIDDLE SCHOOL STUDENTS. International Education, 42(2), 9.

88 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 70.

89 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 70.

90 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 75.

91 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 75.

92 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 75.

93 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 76.

significant because it shows that teachers can try to help students develop their values and expectancies in different subjects. However, an individual can also experience a decline in their values and expectancies for different subjects.[94] For example, students tend to value math more in elementary school than they do in high school.[95] Wigfield and Eccel's model describes that this can be due to two main reasons; first that children become better at self-assessment through criticism and comparison and can therefore highlight weaknesses in their abilities and in what they value.[96] The second explanation is that the school environment changes over the years of elementary and high school by becoming more competitive, which leads to students adjusting their expectancies for achievement.[97]

16.2.2 Raising Value in the Classroom

A first question to ask when examining ways to increase student value towards class material is what makes value something worth spending time on? In 2012, a research study by Gregory Liem and Bee Leng Chua was done to examine expectancy and value in the classroom and which were more effective in student raising motivation and performance. The study consisted of a sample of 1664 Indonesian high school students in Civic Education classes in West Java.[98] Selected from a total of six schools, the 1664 students included 812 males and 852 females from the Year 7 to Year 12.[99] In order to assess whether expectancies or values were more influential, Liem and Chua gave the students a set of questionnaires that assessed what the students expected from themselves in their civic education classes, how they valued the class, their future goals, their civic capital, and factors such as gender and school level.[100] Overall, the questionnaires showed that though expectancies were effective, values had a much stronger effect on individual students' motivation and performance (304). This means that in a teaching setting, it is important to try to make connections to the different values that may be present in students. As discussed earlier, Wigfield and Eccles' model identifies four different values; utility value, intrinsic value, attainment value, and cost.

1. Strengthening Utility and Attainment Values

In Liem and Chua's study, it was also found that motivation to learn and interest in material in the civic education class were especially strong if the student's future and career goals were related to civic education.[101] This means that as the subject material had a direct

94 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 76.

95 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 77.

96 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 77.

97 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 77.

98 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33, 290.

99 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33, 291.

100 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33, 291.

101 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33.

quality of usefulness to those students, they possessed a higher utility value for the subject material.[102] Furthermore, the direct utility value the students shared with the material also raised a higher attainment value, meaning that it was important for them to do well in that class[103]. Therefore an effective way to get students more motivated to engage with certain material is to teach them why education is important, why the specific lesson is useful to them, and how it connects to the future role they will play in society. Though university students have a better understanding of which courses offer utility value, high school and elementary students may need extra help from teachers to explain why the connection is useful to them. For example, for high school students some ways to engage utility value is to discuss any university programs or future career goals they may be interested in and make explain how that course is relevant to them; such as explaining that a programming class can provide a good knowledge base for any who want to go into Information technology. For activities such as essay writing, this may make a student more eager to learn and motivate them to do well in the class; especially as students are starting to look into universities. Engaging utility value in elementary students may be extra beneficial for the students as an early understanding of why education of certain material is important may increase the students overall desire to learn and engage in schooling. As elementary teachers work more closely with the same group of students in every subject, they have a unique opportunity to appeal to their students as to why certain material is important. One of the best ways to do this is to be selective of what material is chosen to teach and how to teach it while still staying within curriculum, which can also be taken into account for high school students. For example, Jere Brophy of the University of Michigan states there are three significant steps that can be taken to aid in this.[104]

Step	**Significance**
1. Curriculum Development	Careful selection of curriculum to make sure everything the students are learning is worth learning while still following school requirements.[105]
2. Scaffolding Application	Apply scaffolding techniques to make sure students are given plenty of opportunities to develop new skills and learn for themselves how to apply what was learned while making sure they are applying their knowledge in beneficial ways.[106]
3. Lesson Framing	Frame Lessons in a way that makes sure to explain the value and application of all material and skills being taught. [107]

102 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33.

103 Liem, Gregory, & Chua, Bee Leung. (2013). Educational Psychology: An International Journal of Experimental Educational Psychology, 33.

104 Brophy, J. (2008). Developing Students' Appreciation for What Is Taught in School. Educational Psychologist, 43(3), 132-141.

105 Brophy, J. (2008). Developing Students' Appreciation for What Is Taught in School. Educational Psychologist, 43(3), 132-141.

106 Brophy, J. (2008). Developing Students' Appreciation for What Is Taught in School. Educational Psychologist, 43(3), 132-141.

107 Brophy, J. (2008). Developing Students' Appreciation for What Is Taught in School. Educational Psychologist, 43(3), 132-141.

Overall, explanation and understanding is the key to engaging student's utility and attainment value by having students understand how to apply the skills they are learning and why they should want to succeed in learning them.

2. Engaging Intrinsic Value

As stated earlier, intrinsic value is the level of interest or enjoyment a student finds in lesson material. Intrinsic Value is closely related to the Self-Determination Theory aspect of intrinsic motivation that was described earlier, as whenIan individual finds intrinsic value in a task, it can become intrinsic motivation. Intrinsic value and intrinsic motivation can be very varied depending on the individual as all individuals have their own specific interests. This also means that what an individual finds intrinsic value in cannot be changed with extrinsic factors. Therefore, as teachers cannot change what a student finds interest in, one of the most effective ways for a teacher to raise student intrinsic value is to build and maintain a good relationship with their students. Overall, studies show that an emotionally and academically supportive teacher can lead to higher interest and intrinsic motivation, and therefore higher academic effort. A study conducted by Julia Dietrich a, Anna-Lena Dicke , Barbel Kracke and Peter Noack with math teachers shows how positive and negative relationships with teachers can affect both the individual and the classroom.[108] On an individual level, a supportive teacher led to higher positive associations with intrinsic value, effort, and long-term development in math;[109] while an unsupportive teacher led to a negative association and lower development. On a classroom level, a shared perception between students of a teacher as supportive led to a positive association of class levels of intrinsic value and motivation, with increased skill development over the year.[110] However, if a class deemed a teacher unsupportive, class levels of motivation were lowered.[111] This shows that it is overall beneficial try to provide students with emotional and academic support. However, this is further developed by good relationships with multiple teachers, as it leads to positive comparison.[112] Dietrich et al's paper describes this **Comparative Process** as comparing one's own achievements with their own achievements in other classes or with other students.[113] This process can also occur between experiences with other teachers. For example, if a student finds the teacher of one grade or subject to be less supportive than

108 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

109 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

110 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

111 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

112 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

113 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

another teacher, their motivation in the class of the less-supportive teacher may decrease.[114] This shows that while it is important to ensure that a teacher is creating an emotionally and academically supportive environment, it is equally important that all teachers and staff work together to ensure that they are all setting a similar teaching standard for their students.

3. Overcoming Cost Of all of the values described in Wigfield and Eccle's model, cost is the most unique as it is influenced by both intrinsic and extrinsic factors. Though engagement of the other values may limit the amount of negatives a student identifies in a task by increasing its importance, many of the qualities of a task that influence an individual student to make decisions are outside of the teachers control. This increases as students get older and begin to be in charge of more decisions, for example a high school or university student picking their courses. An article by Jessica Flake et al describes how cost can be split into four identifications, Task Effort Cost, Outside Effort Cost, Loss of Valued Alternatives Cost, and Emotional Learning Cost.[115] The chart below is an adaptation of a chart shown in Flake's article that explains how different costs lead to different decisions and behavior.

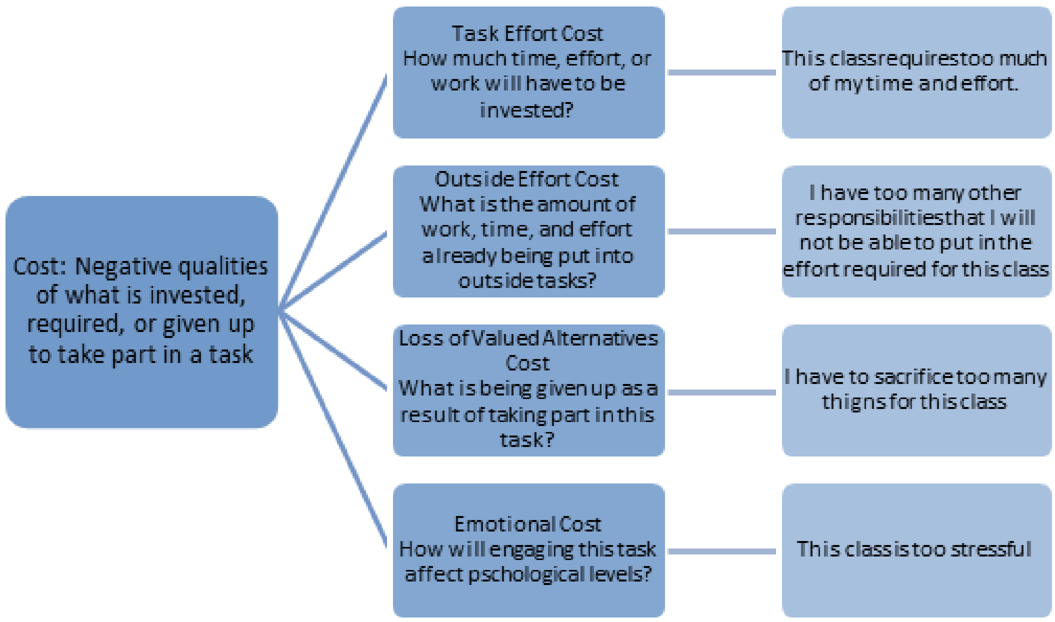

Figure 30 Adapted from work by Jessica Flake et al, in "Measuring cost: The forgotten component of expectancy-value theory"

114 Dietrich, Julia, Dicke, Anna-Lena, Kracke, Barbel, and Noack, Peter. Teacher support and its influence on students' intrinsic value and effort: Dimensional comparison effects across subjects. Institute of Educational Science, Jena. (2014) 45-54

115 Flake, Jessica, Barron, Kenneth, Hulleman, Christopher, McCoach, Betsy, and Welsh, Megan. "Measuring cost: The forgotten component of expectancy-value theory" Contemporary Educational Psychology. 41, 232-244.

116

Though teachers may not be able to limit what cost values a student might be influenced by, learning how these costs affect student's decisions can provide a deeper understanding of why students make specific choices. This can then better prepare a teacher to cater to the needs of individual students and identify specific problems.

16.2.3 Raising Expectancy in the Classroom

Though the Wigfield and Eccle's model of Expectancy-Value theory focuses more strongly on values, expectancy and ability beliefs are still fundamental the theory's application. As mentioned earlier, building on student values within the classroom is an effective way to also raise expectancy. However, there are still other ways that expectancies can be built upon. Furthermore, as expectancy and ability beliefs are considered to be more domain specific over activity specific,[117] they can be improved in a much more general way than values. For example, one of the most applicable ways to raise expectancy in the classroom is by building on base skills.

The Importance of Reading Programs

Improving students' expectancy and motivation in reading is one of the most effective and easily applied ways to increase an individual's overall expectancy. As reading is a base skill, a higher expectancy in reading skills can then make a student more confident in their overall learning abilities. A study by Christopher Nkechi showed that the implication of **Extensive Reading Programs**; a program that requires students to read several books over a span of a few months, were beneficial in increasing motivation through raising self-expectancy in reading.[118] Many researchers have done studies showing that these programs are extremely beneficial for students whose first language is not the language being taught, with many examples using English as the second language. However, Nkechi showed that these Extensive Reading Programs are also extremely beneficial for students who already speak the language being taught, using native English speakers in his study.[119] One of the main aspects of the Extensive Reading Program used in Nkechi's study was Literary Circles. **Literary Circles** is a group activity that uses scaffolding strategies by assigning each group of students with a novel to read, and then requiring each student to go through a rotation of assigned roles.[120] These roles not only encourage the students that might otherwise be disengaged or unwilling to read the novel in order to keep up with their group, but require the students to find meaning and message in their readings.[121]

116 Flake, Jessica, Barron, Kenneth, Hulleman, Christopher, McCoach, Betsy, and Welsh, Megan. "Measuring cost: The forgotten component of expectancy-value theory" Contemporary Educational Psychology. 41, 232-244.

117 Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. Contemporary Educational Psychology, 25, 72

118 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.

119 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.

120 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.

121 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.

For Nkechi's study, 96 students were split into groups and rotated through three to four novels.[122] Each student was then asked to fill out a questionnaire about their expectations for the program both before and after completion of the program. Once the students completed their program after several months, the results showed that the program overall raised student expectancies and beliefs in their reading ability.[123] Overall, the study showed that Extensive Reading programs help students become more capable in different aspects of language and how to use their capabilities in different forms of media and activities.[124] These ER programs also help develop vocabulary, which is significant as in order to make sense and meaning of texts an individual needs a 97-98% vocabulary coverage.[125] Though lessons can target and teach certain specific words, these reading programs supply students with general vocabulary and how to recognize it.[126] Extensive Reading programs also supply a student with more exposure to grammatical laws, which can provide deeper examples after the basics have been taught to them.[127] As reading provides a base from which to learn many different subjects, increase in expectancy in reading abilities can also help raise expectancy in other subjects where reading in order to understand subject material is required. Therefore, as a whole these programs are easily implemented in a classroom and are successful in increasing students expectancies in reading and comprehension in all subjects.

16.3 Goal Orientation Theory

Early conceptualizations of goal orientation theory are derived from James A. Eison's work on dimensions of student's learning and grade orientations.[128] Eison looked at the structure of student's educational and personal differences; he viewed them in relation to learning for genuine acquirement of knowledge, versus performing for attaining high grades.[129] Subsequently, Dweck postulated similar ideas categorizing mastery and performance goal orientation.[130] Dweck's work established goal orientation theory as a two-dimension construct wherein students either approach situations with the motivation to master and acquire

122 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
123 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
124 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
125 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
126 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
127 Christopher, N. M. (2014). Expectances and Outcomes of an Extensive Reading Programme Carried out among University Students. Arab World English Journal, 5(3), 154-169.
128 Eison, J A. (1982). Educational and personal dimensions of learning and grade-oriented students. Psychological Reports, 51, 867-870.
129 Eison, J A. (1982). Educational and personal dimensions of learning and grade-oriented students. Psychological Reports, 51, 867-870.
130 Fan, J., Meng, H., Billings, R S., Litchfield R C., & Kaplan, I. (2008). On the role of goal orientation traits and self-efficacy in the goal-setting process: distinctions that make a difference. Human Performance, 21, 354-382.

new skills, or perform in order to gain approval and do better in comparison to others.[131] People have different reasons for setting goals and as such, each person approaches their goals differently. **Goal-orientation theory** seeks to explain the underlying implications of motivation in academics.[132] Students are categorized by their mastery goal orientations or performance goal orientations.[133] A **mastery goal orientation** reflects genuine purpose as people work towards mastering a set of skills in order to accomplish a task.[134] Students with mastery goal orientations pursue goals for their own sake.[135] It is important for teachers to structure lessons that assist students in obtaining a mastery goal orientation. Teachers can accomplish this by relating learning to personal growth and by co-constructing objectives that are relevant to the student's interests.[136] Consequently, by focusing on personal growth in the learning process, teachers can increase intrinsic motivation which activates a mastery goal orientation.[137]

Studies have also found students that adopt mastery goal orientations demonstrate more adaptive self-regulatory behaviors and social attitudes, which contribute to an increased interest in learning.[138] Teachers must be willing to continually adjust their methods and instructions in order to create optimal learning conditions. In doing so, they create an environment that aligns with their student's goal orientations. The instructional approach must avoid tasks that encourage memorization and rehearsal, for example.[139] However, how can teachers ensure their students are learning appropriate information without incorporating tests and exams? Teachers can facilitate in-class discussions, group projects, papers, and presentations in order to gauge the level of understanding and also the amount of content being absorbed by students.[140]

Performance goal orientations highlight how well an individual can demonstrate success in tasks and understanding.[141] Performance-oriented individuals are competitive and focused on personal gain prompted by extrinsic rewards.[142] Furthermore, mastery and per-

131 Fan, J., Meng, H., Billings, R S., Litchfield R C., & Kaplan, I. (2008). On the role of goal orientation traits and self-efficacy in the goal-setting process: distinctions that make a difference. Human Performance, 21, 354-382.

132 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

133 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

134 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

135 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

136 Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. Psychology in The Schools, 39(3), 279-291.

137 Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. Psychology in The Schools, 39(3), 279-291.

138 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

139 Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. Psychology in The Schools, 39(3), 279-291.

140 Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. Psychology in The Schools, 39(3), 279-291.

141 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

142 Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived competence: Impact on students' achievement behavior. Psychology in The Schools, 39(3), 279-291.

formance goals can be divided into subcategories of avoidance.[143] The former, describes students who wish to avoid misunderstanding tasks, lessons, or instructions; the latter, describes students who wish to avoid appearing incompetent during performance.[144] Overall, students with **mastery avoidance** and **performance avoidance** goals fear failure.[145] Teachers must avoid creating a class atmosphere that is high risk and high reward. That is, they must place less emphasis on external motivation and achievement in relation to others.[146] The structure of the classroom is contingent on the teacher's representations of goals, values, and beliefs; for example, does the teacher focus on how well students perform in comparison to one another, or how the students improve throughout the year?[147]

Students can have adaptive goal orientations because they engage in multiple goal paths.[148] Studies also identify a combination of learning and performance cues that exist outside the classroom; two prime examples are the ways in which parents and peers influence student motivation.[149] Consequently, teachers need to be aware of how parents and peers contribute to shaping of a mastery goal orientation. [150] In a longitudinal study conducted by Juyeon Song, Mimi Bong, Kyehyoung Lee, and Sung-il Kim, surveys were administered to assess variables in learning and home environments that influenced student's motivation; psychological attitudes students felt towards school were included in the assessment as well.[151] Subsequently, the data was used to measure the degree of perceived support from parents and teachers; they found that certain types of support promoted different types of goal orientations.[152] Parents and teachers that stressed achievement increased test anxiety, compared to parents and teachers who supported students with emotional encouragement.[153] The preceding study supports the notion that teachers need to foster intrinsic

143 Madjar, N., Kaplan, A., & Weinstock, M. (2011). Clarifying mastery-avoidance goals in high school: Distinguishing between intrapersonal and task-based standards of competence. Contemporary Educational Psychology, 36(4), 268-279.

144 Madjar, N., Kaplan, A., & Weinstock, M. (2011). Clarifying mastery-avoidance goals in high school: Distinguishing between intrapersonal and task-based standards of competence. Contemporary Educational Psychology, 36(4), 268-279.

145 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

146 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

147 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

148 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

149 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

150 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

151 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

152 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

153 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

motivation in the classroom.[154] They can do so by continuing to nurture student's emotional development so there is no discrepancy between the care and support they receive at home and at school; in this way, teachers are also able to combine the student's home and school lives representing a comfortable space for students to develop their learning.[155] Moreover, offering emotional support shows student's that they are worthy of care and this can reverse adverse effects of achievement pressure.[156]

Another study by Javier Fernandez-Rio, Jose A. Cecchini, and Antonio Mendez-Gimenez tested cooperative intervention programs against traditional teaching programs in order to find out which method generated more intrinsic motivation.[157] The study participants were university students between their early twenties and early forties.[158] The participants were split into either an experimental condition in which they were taught through cooperative reciprocal learning, or they were placed in the control condition wherein traditional unilateral instruction was applied. [159] The cooperative intervention program influenced positive perceptions of competence and enhanced intrinsic motivation.[160] In addition, cooperative learning encouraged students to work with one another and problem solve together.[161] If applied in a classroom setting, cooperative learning supports mastery goal orientations through peer to peer interaction as they learn to work together and not against each other; as they are required to solve problems and work through differences to achieve a common goal.[162]

Both of the studies presented above hold important implications for the classroom. Finding the source of motivation can also assist in guiding future goals, achievement goals, social goals, and personal well-being goals towards a more mastery oriented goal state.[163] Par-

154 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

155 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

156 Song, J., Bong, M., Lee, K., & Kim, S. (2015). Longitudinal investigation into the role of perceived social support in adolescents' academic motivation and achievement. Journal Of Educational Psychology, 107(3), 821-841.

157 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

158 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

159 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

160 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

161 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

162 Fernández-Río, J., Cecchini, J. A., & Méndez-Giménez, A. (2014). Effects of cooperative learning on perceived competence, motivation, social goals, effort and boredom in prospective primary education teachers. Infancia Y Aprendizaje / Journal For The Study Of Education And Development, 37(1), 57-71

163 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.

ents and peers are significant influences in a student's motivation and as such, teachers must learn to implement their influence in the class. The studies presented above provide teachers with strategies and techniques to approach their class with. Applying social goals in particular, can create more opportunities for peer to peer involvement and can foster a cooperative class climate as well.[164] Feeling comfortable and connected to peers helps students discover meaning which enhances the development of a mastery goal orientation.[165] The sociocultural framework helps teachers investigate motivation through its use in cross-cultural contexts.[166] It enables teachers to identify aspects of the class climate that sustain mastery; for example, by allocating more time for group work and discussions.[167] Parent, teacher and peer involvement are intertwined; teachers must always keep this in mind so they can understand their students and their intentions for learning. Consequently, teachers can support mastery by guiding future goals, achievement goals, social goals, and personal well-being goals if they involve all aspects of the student's home, school, and social life.[168]

Assessment and intervention are two methods in goal-orientation theory that can help identify and shape the types of goal orientations that will persist in the class.[169] One way teachers can assess whether a mastery or performance goal orientation exists is by applying interventions such as the Likert scale.[170] Questionnaires help teachers get a feel for the class' impressions and expectations. Surveys also assist teachers in acquiring important information about their student's beliefs regarding success in the class.[171] Teachers can use this data to reorder their instructional process and better explain a path to meaningful success. Surveys are beneficial because they can vary in specificity and target information.[172] For example, asking students to share their aspirations and motivations can provide insight into student conceptualization of the learning process and therefore, assist teachers in setting classroom objectives that support a mastery goal orientation. In the same way mastery goal orientations can balance performance goal orientation, qualitative methods can complement quantitative methods.[173] In applying a diverse range of methodology such as open and structured observations, talk-aloud protocols, conversation analysis, life history

164 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.
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167 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.
168 Wosnitza, M., & Volet, S. (2012). Editorial introduction: Multiple goals in learning contexts. Applied Psychology: An International Review, 61(4), 513-519.
169 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
170 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
171 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
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and ethnography, teachers can gain a fuller understanding of the nature and origins of goal orientations.[174]

16.3.1 Goal Structures

There are two types of **goal structures** that align with the mastery and performance goal orientations.[175] The goal structure however, refers to the environment and the ways in which outside conditions can affect student's motivation, cognitive engagement and achievement.[176] It emphasizes the specific goals to be achieved in the classroom by way of instruction and practice.[177] The teacher must be cautious when organizing the curriculum as the types of tasks delegated and marking process influence goal structure.[178] In addition, the level of freedom students are given to explore and group arrangement, both contribute to forming a particular classroom goal structure.[179]

As noted above there are two types of goal structures known as **mastery goal structure** and **performance goal structure**.[180] A mastery goal structure embodies a learner focused environment wherein the standards and policies encourage students to try hard and do their best.[181] Teachers can create a mastery goal structure through clear explanations of the objectives; for instance, by telling students the purpose of performing tasks is to expand their knowledge.[182] Teachers that offer choice in their activities, such as allowing students to pick their own essay or presentation topics, piques interest by targeting subjects students are passionate about. Students are taught to value themselves as well as the learning process in this way as well.[183]

174 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

175 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

176 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

177 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

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A performance goal structure creates an atmosphere of rivalry and competition.[184] Success comes from obtaining extrinsic rewards and performing competently in various tasks.[185] Teachers can better shape their classrooms by determining which goal structures foster approach and avoidance goals.[186] For example, mastery goal structures foster mastery approach goals.[187] Teachers can administer anonymous surveys and the questions can help indicate whether students acquire more of a mastery or performance goal orientation. In addition, because goal structures usually mirror the environmental conditions, they are observed as impacting the specific goal orientations that students adopt.[188] Applying this to a classroom setting, teachers must remain cognizant of the goals students perceive as being important in the class because they will correspond to their personal goal orientations.[189]

Research has proposed that teachers who placed higher worth on learning and working hard resulted in students viewing their environment as mastery structured; therefore, students were more likely to assume a mastery goal orientation.[190] Teachers can implement classroom contracts at the beginning of the school year to solidify the working conditions. Cultivating mastery goal structure enhances student drive for more challenging work and they are better able to adapt in order to succeed.[191] Students learn to effectively employ learning strategies in the presence of mastery goal structures as well.[192] Self-report measures assist teachers in identifying connections and discrepancies within student's goal structures and goal orientations; they are able to analyze reported levels of choice, effort and persistence in order to understand a student's adaptive motivational engagement.[193] Ultimately, mas-

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187 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

188 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

189 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

190 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

191 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

192 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

193 Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. Journal of Educational Psychology, 96(2), 236-250.

tery goal structures promote mastery goal orientations that encourage intrinsic motivation, cognitive engagement and achievement.[194]

16.3.2 Mastery Goal Orientation and Performance Goal Orientation

Goal orientations originate in schemas and can be made purposeful in context.[195] Students perceive cues and prompts from the situation that leads them to adopt either mastery goal orientations or performance goal orientations.[196] Asking student's questions about their past can trigger positive intrinsic experiences that reactivate their schemas for mastery goals.[197] By asking students to draw upon experiences of happiness and success during their academic careers, teachers place more of an emphasis on mastery goal orientation that can be similarly attained in the class.[198] Questions that require deep reflection also help students continually adapt and challenge their goals to coincide with their mastery goal structures.[199] Students can recognize differential emphases on mastery goal orientation and performance goal orientation.[200] Subsequently, they align their perspectives and behaviors accordingly.[201]

Tasks, authority, recognition, grouping, evaluation and time are all aspects of the class setting that influence goal orientation.[202] The following examples illustrate the implications and relationships to instruction.

Tasks

Teachers must consider what they are asking their students to do when assigning specific tasks.[203] What is the outcome they wish to obtain? If teachers are asking students to listen to a lecture and soon after write a quiz, students will adopt a performance goal orientation.[204] The demand level and structure of such a task places external pressure

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203 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
204 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

on students and detracts from a meaningful experience.[205] In order to prevent this from happening, the teacher can engage students through a more flexible task structure.[206] For example, allowing students to participate in an online discussion forum allows them to go at their own pace and use their creativity.[207] Discussion forums are powerful because students can internalize input from their peers in order to create meaning.[208]

Authority

Authority refers to the teacher's dominancy or openness towards the structure of the class rules and regulations.[209] Strict regulations and rules reflect intolerance for change insinuating students are not active participants in decision-making for their own learning.[210] However, teachers can create contracts with students in order to layout guidelines and responsibilities.[211] Furthermore, instructors can assign a date in the middle of the school year to request feedback and make revisions if necessary.[212] In this way teachers demonstrate their concern for student's wellbeing and personal growth.[213]

Recognition

Recognition addresses the outcomes and actions that must be attended to in order to foster mastery goal structures.[214] Extending effort, taking risks, being creative, sharing ideas and learning from mistakes are all acceptable and functional behaviors to encourage within the classroom.[215] In addition, teachers should express praise in private because publically commending students can foster competition and undermine the abilities of others.[216]

Grouping

Grouping takes different dynamics into consideration.[217] Criteria includes appreciating differences by grouping students with different domains of interests together; in doing so,

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208 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
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214 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
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students are given the opportunities to share, interact and interpret perspectives outside their own.[218] Groups represent the inherently social climate embedded in the class.[219] Mastery is co-constructed as teachers and peers participate in guided meaning making.

Evaluation

Evaluation communicates much about task, teacher and overall course objectives.[220] Therefore the manner in which evaluation is carried out holds vast implications for both instructors and students.[221] Teachers must avoid comparing students based on final outcomes and they can do so by evaluating based on progress, creativity and mastery of skills.[222] Much like recognition, evaluations should also be conducted in private.[223] Teachers can implement weekly progress reports and students can track their personal growth. Allowing students to measure their mastery of skills also allows the teacher to gauge what types of adjustments and provisions could be offered.

Time

Time is a critical factor in establishing a mastery goal structure and mastery goal orientation appropriately.[224] Time restrictions communicate completion over quality. For this reason, teachers should be accommodating by letting students work at their own pace.[225] Teachers must also be open to allocating time according to the level of task difficulty.[226] For example, although some students can complete their work by the end of class, other students may feel anxious from the time pressure and thus, require more time. Moreover, teachers can leave more class time to complete work, but allow students to take the material home as homework if work remains incomplete.[227] Mastery goal orientations maintain a stronger motivation to learn because they nurture personal growth in the learning process while fostering an ongoing desire to improve.[228]

Tasks	Authority	Recognition	Grouping	Evaluation	Time
Allowing student to choose their own topics for research	Instructor is open to collaborating with students	Identifying creativity and learning from mistakes	Grouping by diversity; pairing students with a variety of learning strategies	Holistic approach reviewing progress and development; encouraging reflection	Allocating an adequate amount of time for learning and structuring knowledge

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227 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.
228 Kaplan, A., & Maehr, M. L. (2007). The contributions and prospects of goal orientation theory. Educational Psychology Review, 19(2), 141-184.

16.3.3 Mastery Avoidance and Performance Avoidance

Mastery avoidance goals and **performance avoidance goals** are concerned with the image one reflects.[229] For example, students with a desire to avoid performing poorly and appearing incompetent in comparison to others are concerned with performance avoidance goals; whereas, students concerned with mastery avoidance goals strive to avoid misunderstanding the task or material presented.[230] Performance avoidance goals have been tied to negative outcomes and low achievement.[231] Generally, performance orientations are less adaptive than mastery orientations regardless of the approach or avoidance orientation that results.[232] Moreover, in relation to the self, performance avoidance goals are associated with negative emotions and overall, wellbeing. Subsequently, students characterized by mastery avoidance fear becoming incompetent as a task and strive to evade it at all costs.[233] Akin to performance avoidance goals, findings have revealed that mastery avoidance goals are also linked to maladaptive outcomes including poor implementation of cognitive strategies and procrastination.[234] It is not enough to encourage mastery goal structures and mastery goal orientations in the class; teachers must also understand the roles that avoidance orientations play and their implications for instruction.

16.4 Summary of Motivation

The purpose of this chapter is to demonstrate how motivation can be increased in the classroom through certain popular theories such as the Self-Determination Theory, the Expectancy Value Theory, and the Goal Orientation Theory. In general, we can see that a good reason to encourage intrinsic motivation is because it leads to increased levels in both psychological health and academic success. Setting the context for learning is an important aspect of the teaching environment because it influences the goals set out for the class. Encouraging intrinsic motivation supports student's genuine purpose and passion to master skills. In the self-determination theory we saw that intrinsic motivation is triggered once students feel fulfilled in three psychological needs which are autonomy, competence, and relatedness. In the expectancy value theory we looked at how a student's performance and

229 Madjar, N., Kaplan, A., & Weinstock, M. (2011). Clarifying mastery-avoidance goals in high school: Distinguishing between intrapersonal and task-based standards of competence. Contemporary Educational Psychology, 36(4), 268-279.

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232 Madjar, N., Kaplan, A., & Weinstock, M. (2011). Clarifying mastery-avoidance goals in high school: Distinguishing between intrapersonal and task-based standards of competence. Contemporary Educational Psychology, 36(4), 268-279.

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choice are influenced by what they expect of themselves as well as what they value. More importantly, we look at how to increase expectancy and value in the classroom in order to raise motivation. In the goal-orientation theory we saw that evaluations hold important implications in the classroom by allowing time for reflection on the development of mastery. Through this chapter we hope that present and future educators can use these applications as a way to increase motivation in the class.

16.5 Suggested Reading

Motivational Beliefs, Values, and Goals

Eccles, Jacquelynne, & Wigfield, Allan. (2002). Motivational Beliefs, Values, and Goals. Annual review of Psychology, 53. 109-132.

Expectancy-Value Theory of Achievement Motivation

Wigfield, Allan, & Eccles, Jacquelynne. (2000). Expectancy-Value Theory of Achievement Motivation. *Contemporary Educational Psychology*, 25, 68-81.

The Contributions and Prospects of Goal Orientation Theory

Kaplan, A., & Maehr, M. L. (2007). The Contributions and Prospects of Goal Orientation Theory. *Educational Psychology Review*, 19(2), 141-184.

Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement

Wolters, C. A. (2004). Advancing Achievement Goal Theory: Using Goal Structures and Goal Orientations to Predict Students' Motivation, Cognition, and Achievement. *Journal of Educational Psychology*, 96(2), 236-250.

Intrinsic Versus Extrinsic Goal Contents in Self-Determination Theory: Another Look at the Quality of Academic Motivation."

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. Educational Psychologist, 41(1), 19-31. doi:10.1207/s15326985ep4101_4

16.6 Glossary

Ability Beliefs: Ability Beliefs are the beliefs an individual has on how capable they are at certain kinds of tasks.

Attainment Value: Attainment Value is the value an individual finds in a certain task or activity from recognizing that success in that activity is important to them.

Autonomy: Autonomy is the ability to be self regulated and self initiating of ones' own behaviour and actions.

Cognitive Evaluation Theory (CET): The Cognitive Evaluation Theory is a sub section of the Self Determination Theory that was presented by Deci and Ryan (1985). It states that any event that becomes interpersonal or relational, and helps to promote the feeling of both competence and autonomy, will in turn cause intrinsic motivation.

Competence: Competence is the ability to attain different outcomes both externally and internally by using the environment they are surrounded by.

Cost: Cost is the negative qualities that an individual attaches to certain activities or tasks. Examples of this include missed opportunities from selection of that task over others, and the amount of effort the activity will take.

Curriculum Development: Curriculum Development is the careful selection of curriculum and content to ensure that everything students are being asked to learn is worth learning.

Expectancy Value Theory: Expectancy Value Theory is a theory first developed by Atkinson that defines performance and choice as being influenced by the certain values and self-expectations an individual has for certain activities.

Extensive Reading Programs: Extensive Reading Programs are programs that require students to read several books over a span of a few months, and are beneficial in increasing motivation through raising self-expectancy in reading.

Goal-Orientation Theory: Goal-orientation theory explains the reasons and choices individuals make that maintain motivation. The theory states that individuals have two major goal orientations; mastery goal orientations and performance goal orientations.

Goal Structure: Goal structures embody the learning environment. Goal structures are shaped by the language used by an instructor, the assigned tasks, and the incentives employed to facilitate learning.

Intrinsic Value: Intrinsic Value is the level of enjoyment and interest an individual finds in a specific activity or task.

Lesson Framing Lesson Framing is the structuring of lessons in a way that makes sure to explain the value and application of all material and skills being taught.

Literary Circles: Literary Circles is a method used in Extensive Reading Programs that uses scaffolding strategies by splitting students into groups, assigning each group of students with a novel to read, and then requiring each student to go through a rotation of assigned roles. Each group typically reads more than one novel together.

Mastery Avoidance: Mastery avoidance is the desire to avoid misunderstanding tasks and information.

Mastery Goal Orientation: Mastery goal orientation focuses on intrinsic growth and development. Individuals who acquire a mastery goal orientation are genuinely motivated and value the learning process.

Mastery Goal Structure: Mastery goal structures influence mastery goal orientations. Mastery goal structures foster learner focused environments based on intrinsic motivation.

Performance Avoidance: Performance avoidance is the desire to avoid performing poorly and appearing incompetent in comparison to others.

Performance Goal Orientation: Performance goal orientation focuses on extrinsic rewards such as grades, prizes, and praise. Individuals who acquire a performance goal orientation only wish to appear competent in relation to others.

Performance Goal Structure: Performance goal structures influence performance goal orientations. Performance goal structures foster competitive environments based on extrinsic reward.

Relatedness: Relatedness is the level of connection one feels from their social environment.

Scaffolding Application: Scaffolding Application is the application of scaffolding techniques to ensure that students are given opportunities to develop new skills and learn for themselves how to apply the skills they have learned.

The Self- Determination Theory: Self- Determination Theory , first introduced by Edward L. Deci and Richard M. Ryan, and is a sub section of motivation that primarily looks at two different types of motivation. It states that each type of motivation is built upon a reason or goal that eventually develops into a certain behaviour.

Utility Value: Utility value an individual finds in a task or activity related to the degree to which an individual finds a certain task or subject to be useful to any short term or long term goals.

Wigfield and Eccles' Model of Expectancy Value Theory: Wigfield and Eccles' model of the Expectancy-Value theory states that expectancies and values are influenced by an individual's beliefs in their abilities, which tasks they define difficult or simple, goals, and past learning.

This chapter examines the role of attribution and emotion in teaching and learning. We will be discussing attribution theory, the four stages of the attributional process, methods for helping students cope with emotions, attributional retraining and implications for instruction. Any event that occurs in our everyday lives can be interpreted in a variety of ways, depending on what we identify as the cause of the event. Our causal attributions have consequences for our emotions and behaviours which, in turn, affect learning and achievement. Attribution theory classifies emotions and links them to types of attributions. As educators, we can take our student's affective and behavioural responses into consideration to ensure that they know how to cope with their emotions. In addition to our student's emotions, we should also be aware of our own feelings and how they are expressed towards our students. Attribution theory can be applied in the classroom environment by providing attributional retraining to students identify and change their maladaptive attributional responses.

16.7 Attribution Theory

We often come across events in our lives that can be interpreted in several different ways. The explanation that we come up with to describe the cause of an event is referred to as an **attribution**. [235] The way an event is attributed causes us to react with a variety of responses. To study how people interpret events taking place in their lives, researchers

235 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education

use **attribution theory**. Attribution theory gives insight into why people have different responses to the same outcomes.

To illustrate the theory, imagine that two students take a math test and both end up receiving 60 percent. One student is very disappointed with herself and vows to create a study group in order to earn a better grade for the next test. She also goes to her teacher for extra help. The second student is angry when she sees her test grade and goes to her friends to see how they did. When she discovers that a few of her friends also performed poorly, she attributes her failure to a poorly written test. Although the outcomes of the situation are the same for both students, the way they interpret and respond to the experience is very different. Later on in the chapter, we will take a more in-depth look into how different attributions affect the way we cope with failure. We can gain a deeper understanding of why people make specific attributions, what the most common attributions are, what types of **affective responses** are elicited and the effect that attributional judgments have on our behaviour by studying the **attributional process**.

16.8 Importance of Attributions as a Predictor of How People Cope with Failure

The significance of attributions is highlighted in the study "Importance of Attributions as a Predictor of How People Cope with Failure" done by Follette and Jacobson. [236] The purpose of this study is to replicate and expand on the research of Metalsky et al. (1982), which focuses on the reformulated learned helplessness model (RHL). Measuring general attributional style, specific attributions for examination performance and the prediction of motivational deficits, this study aims to emphasize the significance of attributions to help predict how people cope with failure in a classroom setting. We will be referring back to this study throughout the attribution theory section of this chapter.

One hundred and ten subjects from an upper division, undergraduate psychology course participated in the study. There were 28 men and 82 women. The participants were asked to complete the Beck Depression Inventory (BDI; Beck, 1967), the Expanded Attributional Style Questionnaire (EASQ; Peterson & Seligman, 1984) and an additional questionnaire including the following questions: "What grade do you expect to get on the next exam?", "What grade would make you happy?" and "What grade would make you unhappy?" The questionnaire period was labelled as Time 1. Following this, the students completed an adjective checklist (Zuckerman & Lubin, 1965). It was used to assess three types of moods, including anxiety, hostility and depression. This assessment took place 12 days after Time 1 and 2 days before the actual examination. Seven days after Time 2, students completed the last step in the study, designated as Time 3. Their actual examination grades were returned along with the final package of questionnaires. The package included the checklist for assessing mood, two forms soliciting the students' attributions for their examination performance, a questionnaire asking about their future plans to help prepare the next examination and a request asking them to report their actual grade. The study concluded with a final debriefing of the participants.

236 Follette, V. M., & Jacobson, N. S. (1987). Importance of attributions as a predictor of how people cope with failure. Journal Of Personality And Social Psychology, 52(6), 1205-1211. doi:10.1037/0022-3514.52.6.1205

The materials used in this study include the Expanded Attributional Style Questionnaire, Mood Affect Adjective Check List, Exam attributional measures and the Planned Behaviours Questionnaire.

The EASQ distributed to the students measures attributional style for negative hypothetical events. The participants were asked to imagine themselves in each situation and write down a possible cause for the event. There was an equal distribution of both affiliative and achievement situations. Examples include, “You have been looking for a job unsuccessfully for some time” and “You meet a friend who acts hostilely to you”. The participants were then asked to rate the cause of each situation using a 7-point Likert scale. The first three dimensions are internal-external (ranging from completely due to others to completely due to my own efforts), stable-unstable (ranging from will never be present again to will always be present) and global-specific (ranging from influences only this situation to influences all situations). Peterson and Seligman added a fourth dimension, control-no control that asked subjects of the study to rate the degree of control that they believed they would have in each event. The calculated score of this study was only based on the first three scales.

The Mood Affect Adjective Check List Today Form (MAACL; Zuckerman & Lubin, 1965) is comprised of 132 items that are used to detect the subjects’ moods based on three dimensions: depression, anxiety and hostility. In addition to measuring depressed mood at one point in time, the MAACL was also used to assess the change in participants’ mood over a short period of time in this study.

Students’ attributions for their grade on the examination were measured in two ways. Firstly, participants were given an indirect probe, which requested that they list their thoughts and feelings about their performance on the exam. There were several boxes on the form, in each of which subjects were asked to list one thought or feeling. The participants were told that they did not have to fill in all the boxes. This method of examining attributions allowed for more spontaneous thinking and was potentially less reactive compared to some of the instruments traditionally used in attribution research. For the second part of the exam attributional measures, the subjects were then asked to rate the cause of their examination performance with the Likert ratings that were used in the EASQ. The cause of the event was rated on the four dimensions: internal-external, stable-unstable, global-specific, and control-no control dimensions. For each of the student’s responses to the indirect probe, two trained undergraduate coders rated whether an attributional thought was developed. Statements that explained possible causes for a participant’s examination performance were coded as attributions. Examples include: “The test was deceptively easy,” “My score reflected the fact that I had two midterms and an assignment due on the same day,” and “I should study harder.”

The Planned Behaviours Questionnaire (PBQ) was designed by the authors specifically to use in this study. Participants were asked to give an estimate of the number of hours they spent studying for the examination they had just completed. Following this, they were then asked to estimate the number of hours they intended to spend studying in preparation for the next exam. Finally, the questionnaire was concluded with this final question: “Do you intend to do anything different from what you did to prepare for this exam when studying for any future exams in this class? “Please list anything new that you plan to do in preparation for the next exam” The new behaviours listed were counted to see how many participants chose the same method in order to study for the next exam in this class.

The regression analyses of the study were comprised of several factors. The preexamination MAACL depression score was a covariate that was entered in into the equation first. Next, the degree of stress was added into the equation. This variable was the difference between the score that would make the participant happy and the actual examination grade that they received, based on the traditional 0.0-4.0 grading scale. The greater the discrepancy between the two grades, the higher the stress score the participant received. The third component that was entered into the equation was the composite attributional style variable. This variable was calculated by taking the sum of internal-external, stable-unstable and global specific dimensions for hypothetical situations on the EASQ. The final and most important component entered into the equation was the product vector of the interaction between attributional style and stress level to test the diathesis-stress model of depressed mood. Table 1 and Table 2 can be found with the study here. [237]

Additional results of the study showed that under high stress conditions, the tendency to make internal, stable and global attributions resulted in greater depression. For students that received a grade within close proximity to the grade that would make them happy, their attributional styles did not have an effect on their mood. Because no correlation was found between the attributions made for hypothetical events and real life stressors, a similar correlation was calculated for the study. The results showed that only the attributions made based on real life situations were useful in explaining variability in mood.

16.9 The Four Stages of the Attributional Process

The attributional process is comprised of four main components. One is outcome evaluation, the process of determining whether or not an outcome is favoured. The second is attributional responses, the explanations we attribute to causing the result. The third is affective responses, the emotional responses that follow the interpretation of the outcome and the last is behavioural responses, the course of action that we take to respond to the experience. One main aspect of the attributional process to keep in mind is that specific events do not trigger behavioural reactions directly. These responses only take place after the outcome is cognitively interpreted. All four of these stages can be observed in the previously mentioned study.

16.9.1 Outcome Evaluation

Outcome evaluation refers to the process by which we determine whether an outcome is desired or not. These evaluations are based on several criteria. One is the individual's prior history to encountering similar outcomes. An example of this could be a student that consistently excels in math class, but receives an average test score on his final exam. He could interpret this outcome as undesirable. Another aspect of outcome evaluation is performance feedback. A student that falls below a pre-established standard may view his performance as unfavourable. Evaluations of various outcomes are also dependent on the characteristics of the person, such as the need for success, the perceived value of the

237 Follette, V. M., & Jacobson, N. S. (1987). Importance of attributions as a predictor of how people cope with failure. Journal Of Personality And Social Psychology, 52(6), 1205-1211. doi:10.1037/0022-3514.52.6.1205

task and the expectations of others. The final standard for outcome evaluation is based on cues from others. When a student regularly exceeds expectations, submitting an average assignment may be deemed unfavourable by their teacher, while his classmates can turn in work of the same quality and receive praise from the teacher. [238] These four components make up the criteria for outcome evaluation. Using our previous example from above, we can say that both of the students deemed their math test outcome unfavourable, leading them to make their own attributional responses.

16.9.2 Attributional Responses

The second step of the attributional process is explaining the outcome with a particular cause. Follette and Jacobson's study shows examples of various attributional styles using the hypothetical situations of the EASQ and the exam attributional measures. Examples from the study show attributions based on internal and external sources, stable and unstable conditions and global-specific influences. We can also consider our previous example. Upon seeing her mediocre test mark, the first student attributes her poor performance to her lack of preparedness. The second student responds by putting the blame on the quality of the test written by her teacher. The difference in the two students' responses can be better explained by the **locus of control**.

Locus of Control

Attributional responses are interpreted in three dimensions. The first dimension is the locus of control, which defines the outcome as being caused by an internal or external source. [239] One example of an internal cause is mood. The performance of a student can be affected by mood, which is controlled by the student himself. An external variable affecting performance may be the student's parents. This is an example of an external variable because the student's parents have an effect on his performance but the student himself has no control over the situation. In reference to the study, both internal and external attributions were made about the students' examination scores. One student attributes their score to having two midterms and an assignment due on the same day. This student attributes their failure to an external source rather than considering a lack of preparedness. An example of an internal cause from the study is a student that attributes their below average test score to the minimal effort that they put into studying for the exam.

Stability

The second dimension of attributional responses is stability. It is defined by how consistent the factor is when encouraging success. Various aspects of performance such as ability, effort and luck can be ranked in terms of how stable each condition is. The dimension of stability is frequently connected to a person's expectancy of success. If a student attributes their

238 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education

239 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education

success to a typically stable variable such as ability, it is highly plausible that past success will occur again. On the other hand, if a student attributes their success to a more random cause such as luck, there is a much smaller chance of seeing repeated success. Participants of the study were asked to rate the cause of an event ranging from never being present again to always being the reason for this situation to occur.

Controllability

Controllability is the third and final dimension of the attributional responses. It describes the degree to which the individual can influence the cause behind the outcome. Several factors such as effort and strategy use can be highly controlled whereas ability and interest are considered less controlled. Uncontrollable causes, such as the difficulty of a task and luck do not contribute to an individual's repeated success. There is a strong connection between the controllability dimension and the amount of effort and persistence an individual puts into completing a task. Outcomes deemed more uncontrollable tend to encourage anxiety and avoidance strategies while more controlled variables can lead to increased effort and persistence.that appear from the matrix can elicit numerous affective and behavioural responses.

16.9.3 Affective Responses

The various attributional combinations that result from the three dimensions produce different, though highly predictable emotional responses. The locus of control is most commonly linked to the affective response an individual experiences after a specific outcome. Drawing back on our previous example, the first student attributes her poor performance to lack of preparedness, which is an internal cause involving the amount of effort put into the task. This results in the student feeling a sense of disappointment or shame because effort is a controllable factor. With these same conditions, pity is most appropriate to be elicited by others. In contrast, the second student interprets her mediocre grade as being caused by an external factor. She experiences anger because the situation has external, controllable and stable causes. Other combinations of the three dimensions can produce different results. For a student feeling gratitude, it is most likely due to an external, uncontrollable and unstable factor such as an easy test. For all the emotional responses that are elicited, they are followed by a behavioural course of action. Follette and Jacobson's study showed that participants displayed feelings of disappointment following the reveal of their exam scores.

16.9.4 Behavioural Responses

The understanding of an outcome determines what an individual will do after the situation is interpreted. For attributions in which the locus of control is the prominent dimension, the individual elicits internal feelings of confidence, satisfaction and pride. The behavioural responses resulting from an external locus are help seeking in a positive manner, learned helplessness, avoidance, and lack of persistence when the situation is interpreted negatively. With attributions critically relating to stability, the behavioural response elicited commonly results in higher success expectancies. In turn, the individual develops higher levels of task engagement, seeks out challenges more often and performs to a higher standard. When attributions are more closely linked to controllability, the individual becomes more persistent and puts in a greater amount of effort to complete a task. The two students from our above example display contrasting behavioural responses to their same outcome. The first student vows to put in more work to receive the grade she deserves. In the future, if she succeeds in earning a higher grade on her next math test, she can attribute her success to her increased effort and persistence. In turn she will feel more confident and proud of her abilities. For the second student, her attributions cause her to feel anger due to an external source. Because her interpretation of the event is negative, it is highly predictable that she will develop a sense of learned helplessness, become avoidant towards taking math tests and lack persistence in preparing for test taking. Drawing on the study "Importance of Attributions as a Predictor of How People Cope with Failure," students showed different behavioural responses based on what they attributed their test scores to. Responses from the study included: "I will ask the teacher what I did wrong," "I plan to do the reading earlier in preparation for the next exam," and "I will stay on campus to study with my friends that are also in the class." [240] These are some of the behavioural responses that can occur due to a variety of attributions.

16.10 Emotions

Emotion is a state of feelings. It represents human reactions and responses to the stimuli. [241] It can foster humans well-being, or can contribute to psychological and physical function. There are two main types of emotions that can be classified: positive emotions and negative emotions. Positive emotions can include happiness, compassion, gratitude, hope, interest, enjoyment, joy, love and pride. [242]Whereas negative emotions can include anger, fear, disgust, sadness, anxiety, shame, hopelessness and boredom. [243] These two emotions both consist of a pattern of cognitive, physiological and behavioural reactions to events that have relevance to important goals such as learning. In order to understand the reason why people respond to learning differently, we could look at the impact of emotions. There are four types of components: attribution response, emotion, learning and achievement. We will first look at how emotion is a response to learning, and vice versa. Different learning patterns, styles and outcomes that people are attributing will represent different emotions. Also, different emotions will impact different academic achievements.

Positive Emotions	**Negative Emotions**
happiness	sadness
joy	fear
gratitude	disgust
hope	hopelessness

240 Follette, V. M., & Jacobson, N. S. (1987). Importance of attributions as a predictor of how people cope with failure. Journal Of Personality And Social Psychology, 52(6), 1205-1211. doi:10.1037/0022-3514.52.6.1205

241 Valiente, C., Swanson, J., & Eisenberg, N. (2011). Linking Students' Emotions and Academic Achievement: When and Why Emotions Matter. Child Development Perspectives, 6(2), 129-135.

242 Valiente, C., Swanson, J., & Eisenberg, N. (2011). Linking Students' Emotions and Academic Achievement: When and Why Emotions Matter. Child Development Perspectives, 6(2), 129-135.

243 Valiente, C., Swanson, J., & Eisenberg, N. (2011). Linking Students' Emotions and Academic Achievement: When and Why Emotions Matter. Child Development Perspectives, 6(2), 129-135.

Positive Emotions	Negative Emotions
interest	anxiety
enjoyment	boredom
pride	anger

16.10.1 Attribution and Learning about Emotions

Learning and Emotion

In the **Learning Theory**, it states that effective learning is depending on emotional responses. In different learning environment and situations, it will trigger different emotions in learning. Individuals differ in emotional responses to situations. When the learners are feeling comfortable and in control with the learning environment, learners will have a better performance. It is because the learners would adapt the environment when they are learning. They would feel comfortable and help increase the learning process. In contrast, if learners are feeling uncomfortable and not in control of the environment, the learner will not perform as well. [244] It is because the learners can not adapt the learning environment while learning, which negatively affects the learning process. Therefore, they may perform worse. In the learning environment, it is necessary to have certain emotions present: Learners must be able to control and overcome negative emotions like fear, anxiety and sadness. Therefore, positive emotions such as the sense of accomplishment and enthusiasm can be increased. It is because negative emotions are negatively affecting the learning and positive emotions are positively affecting the learning. This mean that, positive emotions are more likely to achieve higher academic performance while negative emotions are more likely to achieve lower academic performance.

In a study of *The relations between students' approaches to learning, experienced emotions and outcomes if learning*, it stated that there is a relationship between the emotions and academic performance in students experience. [245] The sample of this study was studying the first year biology course in University of Sydney. They are all age 18 to 25 years. The participants took the *The Revised Study Process Questionnaire* to self-report their learning strategy and learning motives. The researchers linked emotions with intrinsic and extrinsic motivation, which are associated to learning performance. The study showed that students with anger and boredom avoided engaging in learning the resulting learning outcome. Also, students with anxiety and shame reduced their intrinsic motivation in learning activities that lower their academic achievement. Students who were angry and frustrated were less likely to adopt strategies in learning and have a more negative learning outcome. In contrast, all students with positive emotions engaged in learning, being motivation during activities and adopted strategies in learning, which have a more positive learning outcome. This means that, motivation and self-efficacy are also related the students' emotions in learning. The following table shows different emotions affect learning patterns and styles and results different learning outcomes in the study.

244 Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2, 1158-1163.

245 Trigwell, K., Ellis, R., & Han, F. (2011). The relations between students' approaches to leaning, experienced emotions and outcomes if learning' Studies in Higher Education, 37(7), 811-824.

Emotions	Learning patterns and styles	Learning outcomes
Pride, hope, confidence, enjoyment, optimistic and proud	• prepare the assessment for the course • contribute course materials • make sure everything is going well for the course • feeling pride and confident of the result • follow the progress in the course	increase academic performance
Frustration, anger and boredom	• feeling bored of the course • get angry with the course • get annoyed when trying the learning activities for the course	decrease academic performance
Anxiety and shame	• ashamed thinking for the assessment • become panicky about the course • feeling embarrassed for not contributing to learning activities • ashamed of not preparing for course • do not contribute to class discussion • do not ask question during class	decrease academic performance

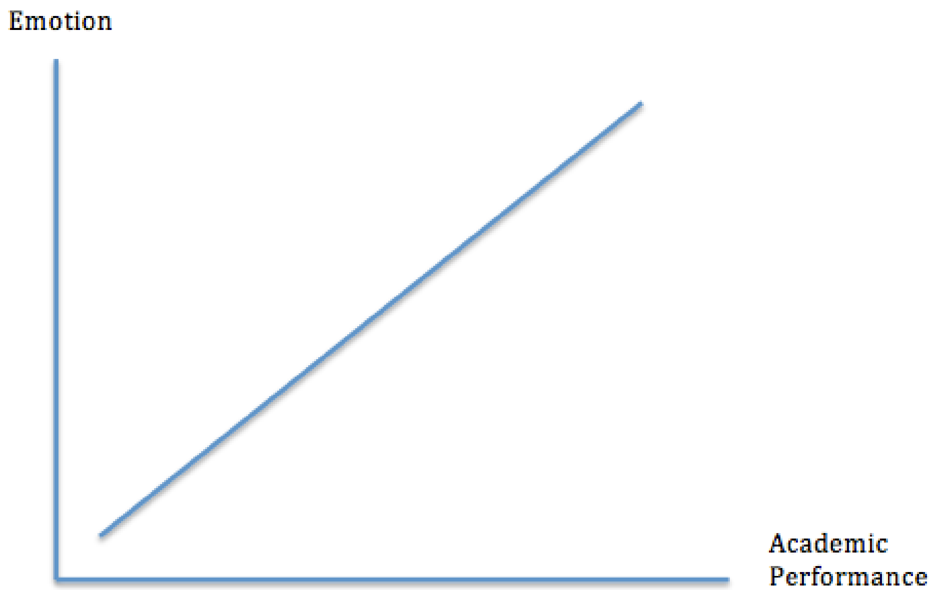

Figure 31 A graph of emotion and academic achievement. As students experienced more positive emotion, their academic achievement will increase. While students experienced more negative emotions, their academic achievement will decrease.

Attribution and Emotion

Rainer Reisenzein, a psychologist in University of Greifswald, who interests in computational belief-desire theory of emotion. He focuses research on theoretical and empirical questions related to emotion and motivation by interdisciplinary orientation toward philosophy and cognitive science. In one of his attributional approach studies, he addresses that our belief is based on the causes of the events that determine emotion and behaviors. He also states that the attributional theory of emotion provides a cognitive analysis for the cause of emotions. The appraisal dimensions related to causal attribution is also generally the appraisal theory of emotion. [246] Different from other cognitive appraisal theories, the attributional theory of emotion provides not just the analysis of the cognitive causes of emotions, but also emphasizes the effects of the emotions, especially focusing on the functional effects in emotions. There are two effects in emotions. First, the motivational emotion effect. It means that emotions evoke people's action tendencies to the situation as appraised. Second, the communicative emotion effect. It means the emotions provide information about people's experiences in situation appraisals and action tendencies to the environment. [247] It can show that attribution is related to emotions. Moreover, the impact of attributions and emotions are connected in learning behavior, which in turn, influences

246 Reisenzein, R. (2014). The Attributional Approach to Emotion and Motivation: Introduction to a Special Section of Emotion Review. Emotion Review, 6(4), 332-335.
247 Reisenzein, R. (2014). The Attributional Approach to Emotion and Motivation: Introduction to a Special Section of Emotion Review. Emotion Review, 6(4), 332-335.

subsequent academic achievement. Self-control is one of the characteristic in attribution. Individual differences in self-control associates different self-regulatory abilities. It is defined as the capacity to modify one's internal responses of impulses, emotions, thought and behaviors. [248] The conceptualization of self-control guides individuals towards goals and standards. This mean that, self-control can alter learners to achieve their desired goals. [249] In King et al's 2014 study, it investigated how self-control is related to students' experience of academic emotions by taking individual differences for the examination. It found that self-control is positively predicts positive academic emotions. Having higher self-control can predict more positive emotions, with better engagement and higher achievement in school. In the **Control-Value Theory**, control and values-related appraisals are the predictors of **achievement emotions**. When learners have a high control-related appraisal and high value-related appraisal, they will be more likely to experience positive academic emotions. When learner has a low control-related appraisal and low value-related appraisal, they will be more likely to experience negative academic emotions. [250] . Figure 1 shows the basic propositions of the control-value theory.

Furthermore, self control has proved that it can be a negative predictor of behavioral and emotional disaffection. It can inhibit learners to display disengaged behaviors and emotions. This means that self-control had a direct affect on academic achievement, which will be discussed later.

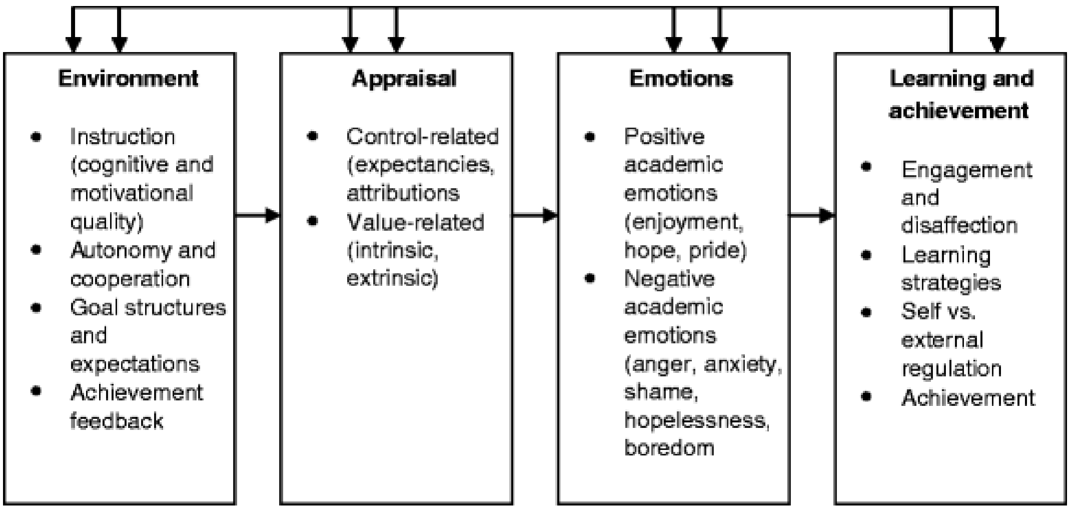

Figure 32 Fig. 1 Basic propositions of Control-Value theory of achievement emotions

248 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

249 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

250 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

16.10.2 Emotions and Attributional Responses

Different attributions in individual can predict emotions. A study from Follette and Jacobson shows that different learning styles and patterns that attribute to examination could predict emotion reactions. [251] They examined that the causal attributions were predictive of depressed mood in college students who experienced the negative event. They found that internal, global and stable attributional responses have a tendency toward depression. [252] In order to understand how emotions and attributional responses are related, individuals need to understand more about their own self. [253]

In 2006, Bar-On addressed that understanding of yourself and others, relating well to people and adapting to attribute with the immediate surroundings will help you to be more successful in dealing with environmental demands. Adapting attribution associates to our **emotional intelligence (EI)**. Emotional Intelligence is an ability to monitor one's own and other people's emotions. It can discriminate different emotions and label them appropriately and to use the emotional information to guide thinking and behavior. [254] There are three components that contribute to EI: persistent effort, locus of control and self-efficacy. If learners are high in these three components, they will have a high EI and they will more likely to be successful. In contrast, if learners are low in those three components, they will have a low EI and they will more likely to have failure and emotion problem. To maintain and develop a high EI, learners can focus on their stress management, which is emotional management and regulation. [255] There are two elements in stress management: stress tolerance and impulse control. Learners need to manage and control emotions effectively and constructively to achieve the stress management.

Attributions vary along three dimensions: locus of control, stability and controllability. Each dimension is related with a type of affective response. Different combinations of the dimension will have different emotional reactions. [256] This means that, different combinations in attributions dimensions will result different emotions. In Weiner's attribution theory, the three dimensions shows different emotion results. For example, internal, controllable and stable factors will experience pride and confidence; external, uncontrollable and unstable factors will experience gratitude; external, controllable and stable will cause anger; and internal, uncontrollable and stable will cause a feeling of shame. As different attributional responses will cause different emotions, in turn, it is affecting the academic achievement as well. The following table shows attributional dimension emotions.

251 Follette, V., & Jacobson, N. (1987). Importance of attributions as a predictor of how people cope with failure. Journal of Personality and Social Psychology, 52(6), 1205-1211.

252 Follette, V., & Jacobson, N. (1987). Importance of attributions as a predictor of how people cope with failure. Journal of Personality and Social Psychology, 52(6), 1205-1211.

253 Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2, 1158-1163.

254 Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2, 1158-1163.

255 Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2, 1158-1163.

256 Bruning, R., Schraw, G., & Norby, M. (2011). Cognitive Psychology and Instruction, Fifth Edition. Pearson.

The three dimensions	Internal		External	
	Stable	*Unstable*	*Stable*	*Unstable*
Controllable	Gratitude	Guilt	Anger	Frustrated
Uncontrollable	Shame	Interest	Boredom	Lucky

Figure 33 Different combinations of attributional dimension results different emotions.

16.10.3 Emotion and Academic Achievement

Emotion and psychological state can determine learning productivity. Higher learning productivity will more likely to have a more positive emotion. [257] As positive emotions can stimulate self-motivation, it is saying that learner's self-control would be stimulated as well. [258] Learners that have a higher self-control are more successful in school because it is also relating how learners feel in school, and which of the emotions are affecting school activities. [259] In addition, to study the relationship between emotions and academic achievement, academic emotions are involved. Academic emotions are identified in enjoyment, hope, pride, anger, anxiety, shame, boredom and hopelessness. [260] Different emotions can be classified into different valence and activation circumstances. Positive-activating emotions are enjoyment, hope and pride; the positive-deactivating emotion is relief; negative-activating emotions are anger, hope and pride; and negative-deactivating emotions are hopelessness and boredom.

Emotions can also facilitate academic engagement, which in turn, influences subsequent academic achievement. [261] Positive emotions are more likely to increase learning engagement, which is positively to achieve a higher academic grade. In contrast, negative emotions are more likely to be disengaged from schooling process, which is negatively to receive a

257 Matuliauskaite, A., & Zemeckyte, L. (2011). Analysis of interdependencies between students' emotions, learning productivity, academic achievements and physiological parameters. Science - Future of Lithuania, 3(2), 51-56.

258 Matuliauskaite, A., & Zemeckyte, L. (2011). Analysis of interdependencies between students' emotions, learning productivity, academic achievements and physiological parameters. Science - Future of Lithuania, 3(2), 51-56.

259 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

260 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

261 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

lower academic grade. [262] Learners who passively withdraw and feel boredom and anxiety in school will increase disaffection. Therefore, they will be more likely to experience low academic achievement. Emotions and academic achievement have a direct relation. Reason why learners who experience low school outcome are because their negative emotions promote withdrawal and disengagement in school. As learners who experience positive emotions will engage in their studies, which is beneficial to their academic career. However, there are exceptions too. Emotions and academic achievement can be affected inversely.

King et al.'s study examined the possibility that positive emotions lower academic achievement. There is a **diminishing return** on emotions and achievement. When the learner's positive emotions achieved to the optimal level of academic score, his or her academic achievement will return to the marginal. However, differences are individual as different people experiences different circumstances. [263] Moreover, a study found that students in China who dispose negative emotions such as anger would increase their grade point average (GPA). Yet, there are no relation between anger and GPA. [264]Furthermore, lacking school attention has shown that positive emotions would increase. However, the experimenter explained that positive emotions are difficult to recognize. Even though experiments can be recorded in a digital way, many positive emotions share a similar facial expression. There are no significant differences that can be recognize in positive emotions, as a result, the outcome might not be accurate. Also, many studies stated that positive emotions usually appear after a solving problem task, which people are less likely to be aware of. Negative emotions are generally to be viewed as more troublesome in children's development and functioning. This is saying that, negative emotions are more likely to have investigating attention.

In conclusion, emotion is associated with academic competences. Individual differences in emotions are engaging into different attribution styles. Self-control, self-motivation, engagement, locus of control and stability are affecting learners and which behaviors they present. Positive emotions are more likely to increase academic achievement, while negative emotions are less likely to decrease academic achievement. Emotions are related to academic success because it contains a useful information to guide and predict cognition and actions. In addition, to help low academic achievement learners to improve their learning, educators should encourage students to minimize the experiences of negative emotions. Students should engage in positive thinking to attribute for their academic styles. Furthermore, student can seek help from family and professionals. To discuss more about how students attribute learning and emotions, a classroom setting can be looked at.

262 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

263 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

264 King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.

16.11 Attributions and Emotions in the Classroom

Students all bring different emotions and attributions with them into the classroom. Although many of these students may bring in positive attributions, equally as many students may carry negative attributions with them into their academic lives. The teacher plays an essential role in helping students figure out their emotions at school, why they feel them, and how they could possibly improve. By helping students learn about their emotions in the classroom, the students are better able to focus on how emotions and what other extraneous factors may affect how they learn. Once students understand how their emotions affect their learning, they are better able to create a learning environment and figure out which strategies for dealing with their emotions work best. It is important that teachers show students' how emotions affect how they attribute both positive and negative situations and to learn about unfavorable behaviors and attributions early on so that they are better able to learn to avoid them throughout their academic career.

16.11.1 Attributional Retraining

One of the main ways teachers can help students improve their mindset is by **attributional retraining** which is helping students get a better understanding of their attributional responses and how to change their response so that they are more encouraged to stay focused. The main focus of attributional retraining is to shift student's focus from their ability shown to the effort put forth in the classroom.[265] By doing this it emphasizes to students that their performance and success or failures in class are due to controllable factors such as their effort. Whereas if students attributed their successes and failures on something uncontrollable such as their ability, they would quickly become discouraged after receiving negative feedback or a low score as many students attribute one's ability with self-efficacy. As a result, attributional retraining could help assist students in motivation, task persistence and achievement levels. There are many ways that teachers can help students understand their attributions. One of the main ways this can be done is simply by reminding the students that their scores are not attributed to their ability. School is becoming increasingly competitive and many students are focused on the marks that they are receiving. By constantly reminding students that any low mark they are receiving is attributed to their effort in the classroom, it may encourage them to try harder during their next assignment.

There are four main steps to attributional retraining. The first step is getting individuals to identify undesirable behaviors that they may have. These behaviors could include things like task avoidance. Being able to identify these behaviors early allows these behaviors to be easily evaluated and changed. It is important for both the student and the teacher to work together on identifying these behaviors early on. By not identifying these problems early, students may lose learning opportunities that could be easily fixed. The second step is evaluating the underlying negative behavior. This could be evaluating how serious the situation and behavior may be and what could be causing the student to have such behaviors. Generally these could be due to internal factors, which require immediate attention or could be caused by extraneous factors that may be hindering that student's performance at that

265 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

moment. The third step is considering how to change the student's attributional response. It is important to figure out what is best for the student and what kind of attributions could take its place. By implementing the wrong new attribution, it could potentially hinder the student's performance further. Depending on the student, finding a new attribution could be a difficult task or it may be very clear. Every student is different. And the last step is implementing the new attribution, which must be done by finding the most suitable way to implement the new attribution. It is not beneficial for students to implement the new attribution if it does not work well with their learning style. Students and teachers must work collaboratively to ensure that the new attributions being implemented are what is most suitable for the student.[266]

16.11.2 Understanding Our Own Emotional Reactions

Teachers should be wary of how their students perceive success and failure and which ones make negative attributions after experiencing failure. Showing negative emotion is normal, however some emotions can be perceived as more harmful than others. It is important for the teacher to educate and remind students that learning how to redirect their attributional thinking can change their emotions.[267] However it is equally as important to teach students about emotional intelligence, which is learning to understand one and others emotions, relating to people, and learning to deal with environmental demands by adapting to the new surroundings.[268] By teaching emotional intelligence, students and teachers are better able to understand their emotions in the classroom and why they feel them in different situations. Students would also learn to control their emotions during both success and failures in and around the classroom. It is important to emphasize positive emotions as it has been seen to have more positive effects on students. The broaden-and-build theory states that positive emotions can help expand a student's engagement in activities as well as encourage students to delve deeper into learning materials and expand their focus whereas negative emotions narrow the focus of students and do not allow for optimal learning.[269] Having positive emotions towards learning provides a better learning environment for students, which may allow for more positive attributional thinking when feedback is given. Although it is important to emphasize positive emotions, it is also important to remind students that it is okay to feel negative emotions as well. Negative emotions are a regular occurrence in the classroom and should not be discouraged. All students handle situations differently and showing negative emotion might be a way for the student to cope with a situation that they are not used to. As educators, it is important to figure out with the student why they may be feeling this negative emotion and how to best handle it.

266 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

267 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

268 Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2(2), 1158-1163.

269 Naude, L. n., Bergh, T., & Kruger, I. (2014). 'Learning to like learning': an appreciative inquiry into emotions in education. Social Psychology Of Education, 17(2), 211-228.

16.12 Implications for Instruction

16.12.1 Effects on Students

One of the most important things educators can do is begin discussing attributions and their effects from an early age. It is an integral part of the classroom and is something that should be focused on. By explaining to students the subtle differences between attributing something to ability rather than lack of effort, you remind them that knowledge is not innate and is something that can be learned.[270] This is especially important when students are first beginning school so that it builds a strong foundation for them as they progress through the grades. It should also be reminded to students throughout the school year as students can often become discouraged when they find tasks difficult or receive unfavorable marks. Since school is becoming increasingly competitive in terms of admission standards to post secondary institutions, it is important to remind students constantly that although grades are important, they are not tied to a low mark that they may receive.

Commonly, students may find that they experience difficulty in the classroom, which is due to many controllable factors. These factors may include a lack of prior knowledge, and automaticity.[271] It is important to remind these students that the difficulty they experience is due to extraneous factors and not themselves so that they do not become discouraged when learning new material or understanding new concepts. By creating a student-centered approach in the classroom, we are creating a learning environment where personal growth and change are prioritized.[272] This kind of approach allows the students to be less frustrated when they do not understand a concept right away or when they receive negative feedback. The emphasis of this approach is that knowledge can always be learned and is not dependent on your innate ability or prior knowledge. By approaching learning in this kind of way, it is teaching and instilling in students to be persistent and to keep trying even if it takes them longer to understand concepts or they do not succeed the first time around. Students may also seek help if they believe that what is holding them back is an environmental factor rather than a personal one.[273] This is because they do not hold their difficulties personally but rather believe other things cause them. Whereas many students may not seek assistance in class if they are struggling because they do not want to be perceived as incompetent in the eyes of their peers or their professor. It is important to instill early on in students that the difficulties they face are due to controllable factors.

There are many extraneous factors that could be affecting student performance. Students may be struggling in class for many different reasons. One of the main reasons that students could be struggling is by not knowing how to best apply appropriate strategies that maximize their learning potential. As educators it is important to try to help students learn what methods work best for them in acquiring new information. Another reason that

270 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

271 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

272 Naude, L. n., Bergh, T., & Kruger, I. (2014). 'Learning to like learning': an appreciative inquiry into emotions in education. Social Psychology Of Education, 17(2), 211-228.

273 Weiner, B. (1979). A theory of motivation for some classroom experiences. Journal Of Educational Psychology, 71(1), 3-25.

students could be struggling is lack of prior knowledge. If students are unable to best apply learning strategies and it is not noticed by an educator, students may fall behind and not have the appropriate prior knowledge to learn new concepts. It is important as an educator to remember that these extraneous factors are controllable causes which may be hindering the student's ability to reach their fullest potential. Reminding the students that these things can be changed as well is important so that the students may not become discouraged for something that can be fixed. Monitoring and discussing with students regularly what may be affecting their performance is important as it allows the teacher to have a better understanding of how the student is doing and how it can be bettered.

When teachers are providing feedback to students, it is important to be mindful of how it is given. Students who have a lower self-esteem may benefit from feedback that is given privately rather than in front of the class. It may also be beneficial when directing praise in front of the class as it may cause provide low-ability cues to students unintentionally.[274] One way to effectively provide feedback is to provide information-oriented feedback rather than performance-oriented feedback. **Information-oriented feedback** emphasizes how a student's performance can improve where as **performance-oriented feedback** emphasizes how a student is progressing in relation to their peers.[275] If students are provided feedback in relation to the other students, they may attribute their lower score to their ability and become discouraged in class, as they may not be progressing as quickly as some of the other students. As educators it is important to try to keep students from comparing themselves to each other as students will be discouraged and feel negatively about school. But by providing feedback basked solely on the students' progress, it allows for personal growth rather than comparison to others, which is more beneficial for students with low self-esteem. This also teaches students that education is about personal progress and knowledge acquisition rather than comparing themselves to other students. The lack of comparison may keep students motivated to continue pursuing new knowledge.

According to the control value theory, emotions are directly related achievement, cognitive, motivational processes.[276] Generally positive emotions are correlated with an increase in students' motivation while negative emotions reduce students' motivation. It is important that students use these positive emotions to attempt to become intrinsically motivated in school. When students are intrinsically motivated, they are more likely to persist when they encounter difficult problems or concepts in their learning. Teachers are a large part of helping students develop these behaviors. It is important that teachers create a learning environment that sets a positive example for the student. Students are greatly influenced by the teacher and the environment of the classroom. By creating a positive learning environment, students may feel more inclined to be positive about their learning. The teacher student relationship is also one of the most important things that can help students academically. By having positive, nurturing and supportive teachers, students are able to develop self-confidence and a sense of self-determination, which will in turn affect their learning behaviors.[277] Once students are intrinsically motivated to do well in school, they

274 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

275 Bruning, R. H., Schraw G. J., Norby M. M., (2011) Cognitive Psychology and Instruction. Boston, MA: Pearson Education.

276 Naude, L. n., Bergh, T., & Kruger, I. (2014). 'Learning to like learning': an appreciative inquiry into emotions in education. Social Psychology Of Education, 17(2), 211-228.

277 Seifert, T. L. (2004). Understanding student motivation. Educational Research, 46(2), 137-149.

will be more likely to create positive attributions between themselves and what they are learning.

However it is important to remember that all students begin with different attributions and ways to deal with them and they learn and process information differently. Techniques used in helping students change their attributions and learn to control their emotions vary greatly between students. As with all techniques, it is important for the teacher and student to work collaboratively in finding out what works best for that individual. One of the ways that this can be done is by discussing with the student different learning strategies that may work best for them and having the teacher monitor the student in class to see if it is effective. This can also be done through trial and error of different techniques until one is found to be most effective for that student or group of students. Once an effective method is found, it can be implemented not only in academic situations, but also in all aspects of a student's life. By learning what methods works best and really understanding the student, it creates an easier learning environment that is more beneficial for everyone involved.The most important aspect is merely teaching students about their attributions and how it affects them in the classroom. Learning how to affectively attribute their successes and failures will help to further their academic career. Even though it may take some time to fully understand their attributions, the mere knowledge of it will help students to become aware of why they may feel a certain way in class. It definitely will take time for students to fully learn what methods work best for them but by teaching them about their attributions early, they are better able to carry this knowledge with them throughout their academic career.

16.13 Suggested Readings

1. Zahed-Babelan, A., & Moenikia, M. (2010). The role of emotional intelligence in predicting students' academic achievement in distance education system. Procedia - Social and Behavioral Sciences, 2, 1158-1163.
2. Valiente, C., Swanson, J., & Eisenberg, N. (2011). Linking Students' Emotions and Academic Achievement: When and Why Emotions Matter. Child Development Perspectives, 6(2), 129-135.
3. King, R., & Gaerlan, M. (2013). High self-control predicts more positive emotions, better engagement, and higher achievement in school. European Journal of Psychology of Education Eur J Psychol Educ, 29, 81-100.
4. Follette, V. M., & Jacobson, N. S. (1987). Importance of attributions as a predictor of how people cope with failure. Journal Of Personality And Social Psychology, 52(6), 1205-1211. doi:10.1037/0022-3514.52.6.1205
5. Trigwell, K., Ellis, R., & Han, F. (2011). The relations between students' approaches to leaning, experienced emotions and outcomes if learning' Studies in Higher Education, 37(7), 811-824.
6. Matuliauskaite, A., & Zemeckyte, L. (2011). Analysis of interdependencies between students' emotions, learning productivity, academic achievements and physiological parameters. Science - Future of Lithuania, 3(2), 51-56.
7. Naude, L. n., Bergh, T., & Kruger, I. (2014). 'Learning to like learning': an appreciative inquiry into emotions in education. Social Psychology Of Education, 17(2), 211-228.

16.14 Glossary

- **Affective responses**: the emotional responses that follow the interpretation of the outcome
- **Behavioural responses**: the course of action is taken to respond to the experience
- **Controllability**: the degree to which a factor can be influenced
- **Attribution**: explanation to describe the cause behind an event
- **Attributional responses**: the explanations attributed to causing a specific result
- **Attribution theory**: the study of how people interpret various events
- **Locus of control**: defines the outcome as being caused by an internal or external source
- **Outcome evaluation**: the process by which an outcome is considered a success or a failure
- **Stability**: how consistent the factor is in encouraging success
- **Learning theory**: a conceptual frameworks on how information is absorbed, processed, and retained during learning
- **Control- value theory**: relationship between level of controllability and value and the achievement in emotions
- **Achievement emotions**: the mental state of feeling that attribute to achievement
- **Emotion Intelligence**: ability to identify, use, understand, and manage emotions in positive ways to relieve stress, to communicate effectively and to overcome challenges
- **Diminishing Return**: a decreasing effect on a product that passing to marginal level after the optimal point
- **Attributional Retraining**: helping students better understand their attributional responses
- **Information-oriented Feedback**: feedback regarding how an individual student's performance can be improved
- **Performance-oriented Feedback**: feedback regarding how a student is progressing in comparison to their peers

16.15 References

In order for education to be the most successful, educators need to understand not only the various ways in which intelligence and knowledge is acquired, but also the beliefs surrounding them which are held by students and teachers. These beliefs are influenced by hope and impact students' behaviors and what they believe they can achieve academically. The way teachers view these beliefs will influence the way they structure their classrooms and curriculum, which in turn has an effect on students educational experiences. This chapter will further explain hope and the beliefs about knowledge and intelligence and the impact they have on learning.

16.16 Beliefs

16.16.1 Implicit and Explicit Beliefs

Beliefs are personal opinions about the environment and the self. Each person holds both implicit beliefs and explicit beliefs. **Implicit beliefs** are subliminal beliefs that influence an individual's behaviour [278]. For example, an international student who attended schools that only taught in Chinese, might develop an implicit belief that he or she has poor English pronunciation. Subsequently, this belief causes him or her to avoid reading or speaking aloud in an English-speaking school. In addition, implicit beliefs help the construction of an **implicit theory**, which involves an individual making unspoken speculations about the causes of an event [279]. As an example, the aforementioned international student might state that he cannot pronounce English words properly because English is not the student's mother tongue and the student's family does not speak English at home. Consequently, the student has implicitly attributed his failure of pronouncing English words to both innate ability and practice. **Explicit beliefs** are conscious beliefs that impact a person's behaviour [280]. For example, a student who is consciously aware of his or her excellent speaking and writing in English class might develop an explicit belief that he or she has proficiency in English.

It is important to transform implicit beliefs to explicit beliefs because many attributions that people place upon their learning performance are implicit [281]. The unconsciousness of certain beliefs will likely prevent people from discovering the reasons behind behaviors which might not be effective and/or healthy. In order to reflect on and to modify one's beliefs, an individual should spend time trying to express their implicit beliefs to themselves and to the people around them. For example, a person can write in a journal or participate in group discussions [282].

16.16.2 Development and Effects of Beliefs

Before we can understand how to change beliefs, it is important to understand how beliefs come to exist. It has been found that for many teachers, beliefs are derived as a result of their own personal experiences in education growing up [283]. As a result, elementary teacher who are pre-service, enter programs with preconceived beliefs and attitudes towards education

278 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
279 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
280 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
281 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
282 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
283 Baş, G. G. (2015). Correlation Between Teachers' Philosophy of Education Beliefs and Their Teaching-Learning Conceptions. Education & Science / Egitim Ve Bilim, 40(182), 111-126. doi:10.15390/EB.2015.4811

and how it should be approached [284]. Beliefs about knowledge and intelligence is very important in classroom environments, as it provides the structure and base for organizing these environments [285]. They impact how a teacher designs his or her classroom in terms of curriculum, methods, techniques and skills [286]. Even the teaching of specific subjects such as math is impacted by the way teachers view knowledge and intelligence, as discovered by Stohlmann et. al (2014), which will be discussed later in this section [287]. One area of beliefs teachers may hold is in regards to the roles of students and how information is attained. One theory, described by Bas (2015) is that teachers maintain either a **traditional view**, or a **constructivist view** about education [288]. On the one hand, the traditional view is where teachers act as the authority figure towards students who are passive recipients of knowledge. On the other hand, a constructivist view sees the teacher as a guide who helps students in obtaining knowledge, in this view students are active participants in their own learning [289]. A similar but more detailed view is the epistemological belief which consists of four categories, in which students progress through in their educational development [290]. These categories include dualism, multiplism, relativism, and commitment [291]. Dualism acts similarly to a traditional view, while multiplism shares views with a constructivist perspective.

16.16.3 Changing Beliefs of Students and Teachers

It can be very difficult for people to change their beliefs and attitudes, Brownlee et al. (2001) found this to be especially true the more a belief is connected with other beliefs within an attitude structure [292]. Whether information has been acquired as **affective knowledge**, which is subjective and based on emotional reactions or as **cognitive knowledge**, which

284 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

285 Baş, G. G. (2015). Correlation Between Teachers' Philosophy of Education Beliefs and Their Teaching-Learning Conceptions. Education & Science / Egitim Ve Bilim, 40(182), 111-126. doi:10.15390/EB.2015.4811

286 Baş, G. G. (2015). Correlation Between Teachers' Philosophy of Education Beliefs and Their Teaching-Learning Conceptions. Education & Science / Egitim Ve Bilim, 40(182), 111-126. doi:10.15390/EB.2015.4811

287 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

288 Baş, G. G. (2015). Correlation Between Teachers' Philosophy of Education Beliefs and Their Teaching-Learning Conceptions. Education & Science / Egitim Ve Bilim, 40(182), 111-126. doi:10.15390/EB.2015.4811

289 Baş, G. G. (2015). Correlation Between Teachers' Philosophy of Education Beliefs and Their Teaching-Learning Conceptions. Education & Science / Egitim Ve Bilim, 40(182), 111-126. doi:10.15390/EB.2015.4811

290 Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing Epistemological Beliefs in Pre-service Teacher Education Students. Teaching In Higher Education, 6(2), 247-268. doi:10.1080/13562510120045221

291 Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing Epistemological Beliefs in Pre-service Teacher Education Students. Teaching In Higher Education, 6(2), 247-268. doi:10.1080/13562510120045221

292 Brownlee, J., Purdie, N., & Boulton-Lewis, G. (2001). Changing Epistemological Beliefs in Pre-service Teacher Education Students. Teaching In Higher Education, 6(2), 247-268. doi:10.1080/13562510120045221

is knowledge obtained objectively and rationally, will also impact the difficulty of changing ones beliefs [293].

While beliefs may be difficult to change, it is still possible to achieve with the proper understanding of how to implement beneficial change. When it comes to changing beliefs which have been attained through affective knowledge or cognitive knowledge, how the information was originally obtained plays a significant role in how the belief should be challenged. It has been found that information which is obtained through cognitive knowledge, is resistant to change through affective means and vice versa [294]. This means that information which has initially been obtained through cognitive means, is more prone to change through cognitive means, and information initially obtained through affective means, is more susceptible to changing beliefs through affective means [295].

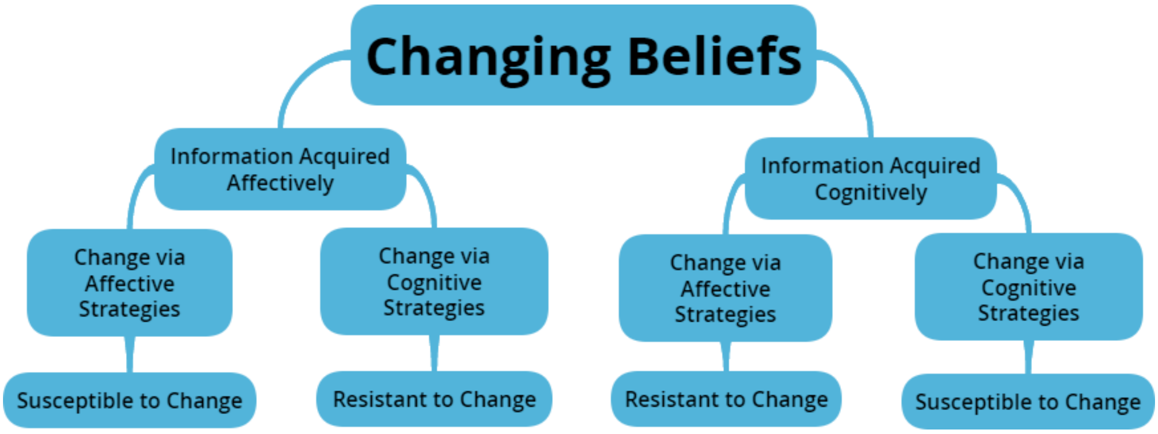

Figure 34 Figure 1 Changing Beliefs Mind Map

Another way in which beliefs can be changed was found in a study which compared techniques teachers in the US used, with techniques used by teachers in China [296]. It was found that Chinese teachers had a greater coherent understanding of the concepts and were therefore better able to provide flexibility in their explanations, these teachers were also better able to provide meanings to their students [297]. In contrast, teachers from the US were procedure based, and were not able to provide the same rich explanations to their students [298]. US teachers beliefs about the best approach to teaching math changed once

293 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971

294 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971

295 Edwards, K. (1990). The interplay of affect and cognition in attitude formation and change. Journal Of Personality And Social Psychology, 59(2), 202-216. doi:10.1037/0022-3514.59.2.202

296 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

297 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

298 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

they were able to see the difficulties students had when they were taught only procedurally and not conceptually, and when a change in student learning was evident [299]. While it may be difficult to change student or teachers views about knowledge and intelligence may be difficult, by providing environments where students and pre-service teachers are able to reflect on their own beliefs and shift into new modes of thought, a change in belief can be possible [300].

16.17 Beliefs about Intelligence

16.17.1 Intelligence

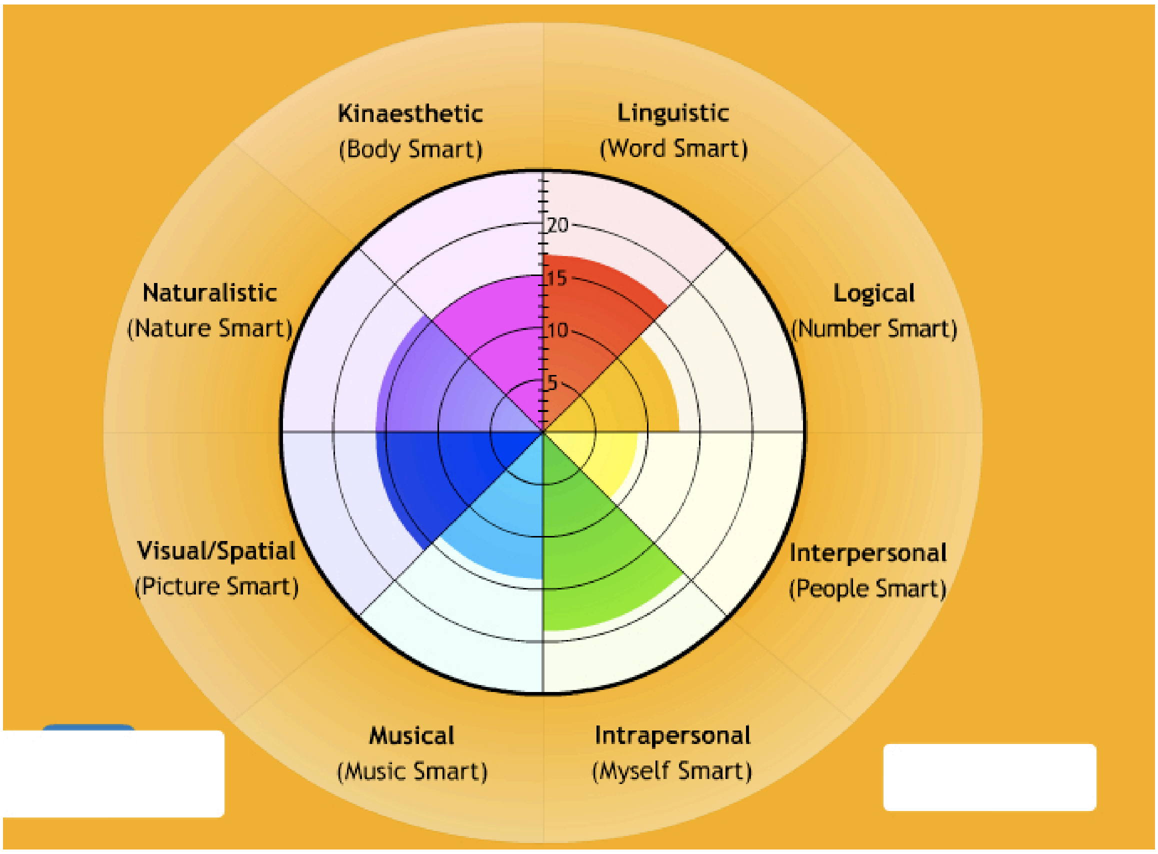

Figure 35 Figure 2 Gardner's Multiple Intelligences

299 Stohlmann, M. M., Cramer, K. C., Moore, T. T., & Maiorca, C.C. (2014). Changing Pre-service Elementary Teachers' Beliefs about Mathematical Knowledge. Mathematics Teacher Education & Development, 16(2), 4-24

300 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971

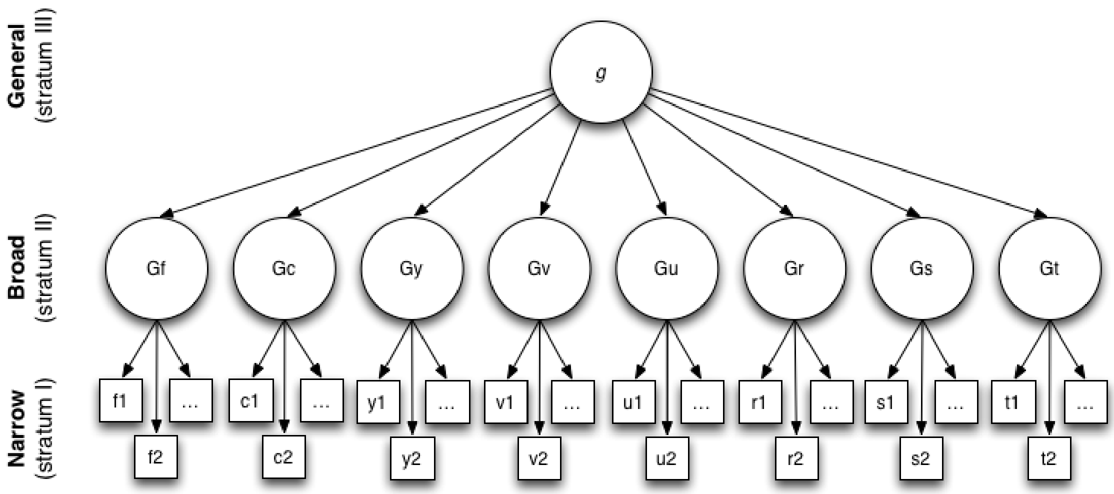

Figure 36 Figure 3 Carroll three stratum model of human Intelligence

Intelligence can be defined in multiple ways. According to Sternberg, intelligence is based on three components: adjusting to, shaping and choosing an environment [301]. It is also related to discovery and invention[302]. Throughout history researchers studied intelligence to determine its nature and outcomes. In addition, social and cultural factors influence the ways people interpret intelligence [303]. Moreover, intelligence is viewed as a general ability or as multiple abilities. For instance, Gardner's theory of multiple intelligences involves seven intelligence aspects: logical-mathematical, spatial, bodily-kinesthetic, verbal, musical, interpersonal and intrapersonal intelligence (refer Figure 2) [304]. Similarly, Sternberg discovered three types of intelligence: emotional, creative and practical intelligence[305]. Lastly, Carroll's hierarchy of intelligence represents intelligence as a general ability that is made up of broader abilities, which can be further broken down into more specific abilities (refer to Figure 3) [306].

16.17.2 Entity and Incremental Theory

Two implicit theories of intelligence pioneered by Dweck are known as the **entity theory** and **incremental theory**. The entity theory presents the belief that intelligence cannot be changed; whereas, the incremental theory demonstrates that gradual modifica-

301 Sternberg, R. J. (2014). Teaching about the nature of intelligence. Intelligence, 42176-179. doi:10.1016/j.intell.2013.08.010
302 Sternberg, R. J. (2014). Teaching about the nature of intelligence. Intelligence, 42176-179. doi:10.1016/j.intell.2013.08.010
303 Sternberg, R. J. (2014). Teaching about the nature of intelligence. Intelligence, 42176-179. doi:10.1016/j.intell.2013.08.010
304 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lindif.2014.03.001
305 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001
306 Sternberg, R. J. (2014). Teaching about the nature of intelligence. Intelligence, 42176-179. doi:10.1016/j.intell.2013.08.010

tions of intelligence are possible [307]. Entity and incremental theorists differ from each other based on their understanding of an individual's behaviour [308]. For instance, entity theorists explain a person's behaviour due to his or her genetically determined characteristics [309]. Incremental theorists however, focus on identifying certain factors such as, intentions, necessity, previous behaviour and emotions, which give rise to an individual's behaviour [310]. Consequently, entity and theorists have different responses toward negative consequences. Individuals who believe in the entity theory will have a higher chance of demonstrating helplessness when they are facing challenges in terms of their performance [311] . Furthermore, they will attribute their poor performance to their unchangeable traits; therefore, they feel that they have no control over their intelligence. On the other hand, those who believe in the incremental theory of intelligence will likely use controllable factors to counter negative effects to improve their performance [312].

	Entity Theory	**Incremental Theory**
Intelligence is Changeable	No	Yes
Explanation of Behaviour	Genetics	Intentions, necessity, previous behaviour, emotions
Reaction to Negative Consequences	Helplessness, giving up	Persistence, problem-solving by regaining control

As mentioned earlier, intelligence can be viewed as multiple abilities. Furnham conducted a study recently on entity and incremental beliefs about the multiple intelligences. The goals of the study was to see whether students believe that each of the fourteen intelligences is changeable or fixed and whether personality (e.g. Big Five and CORE self-beliefs) has a role in these entity and incremental beliefs[313]. The fourteen intelligences were divided into three categories: abstract, skillful and classical[314]. Abstract intelligences, such as naturalistic, sexual and intra-personal intelligences are easier to change[315]. In addition, skillful intelligences, such as musical and creative intelligences are less easy change because they are believed to be based on innate ability as well as practice[316]. Moreover, classical

307 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.

308 Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. Psychological Inquiry,6(4), 267-285. doi:10.1207/s15327965pli0604_1

309 Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. Psychological Inquiry,6(4), 267-285. doi:10.1207/s15327965pli0604_1

310 Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. Psychological Inquiry,6(4), 267-285. doi:10.1207/s15327965pli0604_1

311 Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. Psychological Inquiry,6(4), 267-285. doi:10.1207/s15327965pli0604_1

312 Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. Psychological Inquiry,6(4), 267-285. doi:10.1207/s15327965pli0604_1

313 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001

314 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001

315 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001

316 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001

intelligences which include verbal and logical intelligences are easy to change[317]. The CORE self-beliefs in the study were measured based on self-esteem, self-efficacy, internal locus of control and emotional stability[318]. Regardless of holding incremental beliefs, high CORE self-beliefs help people see that intelligence can be increased because these beliefs cause a person to see that change and improvement are possible[319]. The study also demonstrated that people who are introverts are more likely to hold entity beliefs; whereas, people who are extroverts are more likely to hold incremental beliefs. Furthermore, the openness personality trait appeared to promote incremental beliefs[320]. Overall, Furnham's study raises awareness for the need to understand the diversity of students in the classroom when observing their entity and incremental beliefs about intelligence. The multiple intelligences model along with the entity and incremental theories help educators to pinpoint students' beliefs about a specific intellectual ability, which can be useful since different disciplines request different skills. Also, educators can gain knowledge on what types of intelligences are harder to change from a student's perspective. Although the study only found correlations between personality traits, such as openness, extraversion and CORE self-beliefs and incremental beliefs about intelligence, it might still be useful to try to promote these traits and see if they are of any help to students' incremental beliefs.

16.17.3 Goal Orientation and Learning Performance

Initially, Dweck and Leggett stated that the implicit theories of intelligence give rise to two separate goal orientations, which are known as the **performance orientation** and the **mastery orientation**. The performance orientation involves the belief in the entity theory and the display of proficiency; whereas, the mastery orientation includes the incremental theory and the desire to improve one's proficiency[321]. This goal orientation model suggests that people are either performance-oriented or mastery-oriented. Over time researchers discovered that people could be performance-oriented and learning-oriented at different degrees depending on the task[322]. Additional features were added to this model, such as approach and avoidance[323]. Both of these components are applicable to performance and learning orientations. As a result, research on the beliefs about intelligence throughout history has led to the creation of four goal orientations that influence learning performance:

317 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001
318 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001
319 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001
320 Furnham, A. (2014). Increasing your intelligence: Entity and incremental beliefs about the multiple 'intelligences'. Learning And Individual Differences,32163-167. doi:10.1016/j.lind'if.2014.03.001
321 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
322 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.
323 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.

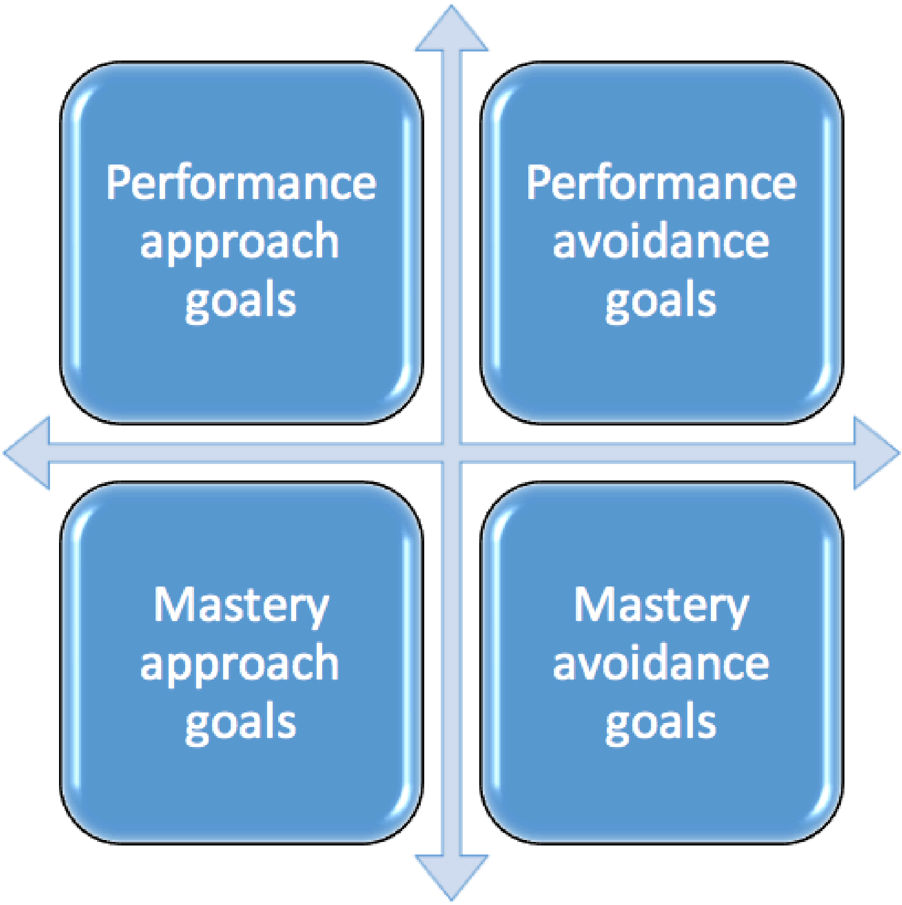

Figure 37 Figure 4 Goal Orientations

- **Performance-approach goals**

Concentrate on the desire to show proficiency by making other people targets for competition[324]. For example, a student decides to work and pay attention in class because he or she wants to get the top grade, subsequently the grade gives him or her the motivation to study. However, once this grade is no longer achieved, the student will likely lose interest in learning.

- **Performance-avoidance goals**

Focus on the finding ways to avoid tasks that will likely reflect failure when compared to others[325]. For instance, a student wants to do well in a class because they do not want to lose and be embarrassed. However, if the student cannot perform well, then he or she will

324 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

325 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

choose to avoid any task that they cannot succeed in. Subsequently, they will likely miss many learning opportunities.

- **Mastery-approach goals**

Bring about a commitment to improve competence and to engage in meaningful learning, in which understanding is highly valued[326]. For example, a student chooses to learn by obtaining a strong understanding of the knowledge that is imparted in the classroom. The student will take the time to self-regulate his or her learning by posing questions to teachers when confused or when they want to learn something new and improving their understanding and knowledge through consistent discussion with teachers and classmates.

- **Mastery-avoidance goals**

Give rise to hiding from inadequacy in relation to the self and to an undertaking[327]. For instance, a student does not believe that he or she has the ability to learn and understand something. As a result, the student often thinks negatively of him or herself by saying ”I am not smart” or ”This question is too hard”. Overall, they believe that they cannot improve their ability which means they cannot deal with the difficult task at hand.

16.17.4 Western and Chinese Beliefs about Intelligence

Beliefs about intelligence are mostly tied to the Western culture. However, these western beliefs are often not applied to other cultures, such as the Chinese culture, which is a significant problem because schools contain students from various cultures. In addition, Sternberg stated different cultures will have some dissimilar interpretations of intelligence, which in turn leads to varying behaviours. We dedicated a section for differences between Western and Chinese beliefs about intelligence because the recent success of Chinese students in international, academic assessments has produced a desire to discover whether the Western beliefs about intelligence affect these students' learning performances[328].

Chen and Wong's study compare Western and Chinese students' beliefs about intelligence and their academic performance. In the Chinese cultural context, performance-approach goals are very common because the schools promote competition, which in turn encourages a social hierarchy that forces students to obtain high academic achievement [329]. Moreover, the academic achievement in Chinese culture is viewed as a child's obligation to his or her

326 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

327 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

328 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

329 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

family [330]. Consequently, Chinese students are constantly competing to honour their families. Furthermore, mastery goals are prevalent as well because the Chinese culture values Confucian philosophy, which promotes self-development and self-fulfillment [331]. The results from the study demonstrated that like Western students, Chinese students who hold incremental beliefs are more likely to utilize mastery goals, which help them build effective learning strategies. Subsequently, these students' academic performance are likely to be more successful [332]. However, the study showed that Chinese students' academic achievement might be due to their use of performance-approach goals. Also, even though performance-avoidance goals are often negatively associated with learning, it is positively correlated with mastery goals in Chinese students [333]. Overall, the desire for self-development, competition and avoidance of failure in the Chinese culture give rise to the positive correlations between mastery, performance-approach and performance-avoidance goals. Unlike Western students, Chinese students might be able to obtain academic success with both performance and mastery goals[334]. More research will need to be conducted to prove this phenomenon because the current study has a limitation of the participants being university students with high academic success. Therefore, future research should involve middle and high school students with varying academic achievement.

Wang and Ng's study focused on grade seven and ten Chinese students' implicit beliefs about intelligence and school performance. The results of the study showed that Chinese students viewed the changeability of intelligence and school performance separately and that the two have a role in developing helplessness [335]. The Chinese culture emphasize the importance of effort over ability in terms of academic achievement, but this does not necessarily mean that they automatically believe that intelligence is changeable [336]. In fact effort can be associated with improving performance or counteracting substandard intelligence in Chinese students[337]. Also, Wang and Ng found that Chinese students believed that

330 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

331 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

332 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

333 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

334 Chen, W., & Wong, Y. (2015). Chinese mindset: Theories of intelligence, goal orientation and academic achievement in Hong Kong students. Educational Psychology, 35(6), 714-725. doi:10.1080/01443410.2014.893559

335 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

336 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

337 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

school performance was more changeable than intelligence[338]. Therefore, Chinese students might be more likely to avoid helplessness and might even have higher academic achievement than Western students[339]. This is because Western students view intelligence and school performance as related. Western students that hold entity beliefs about intelligence focus mainly on innate ability, which in turn hampers their academic achievement. For example, if they believe that intelligence is fixed, then their school performance cannot be changed. Lastly, the study found that like Western students, Chinese students that strongly believe that intelligence or school performance are not changeable, will more likely develop helplessness[340].

16.18 Hope

For a student to reach a high level of hope, two components are necessary. These are **agencies** which is goal-directed determination, and **pathways** which is the planning of ways to meet goals [341]. Agencies are also referred to as willpower or 'will' and pathways are also commonly referred to as 'ways' for one to reach their goals [342]. Mellard, Krieshok, Fall and Woods (2013) provide an example for understanding how pathways and agencies work by considering a highschool dropout working in the food industry who wants to earn more money. He may consider pathways such as working hard at his current job and try to get promoted, look for a better paying job for his current skill level. He may also consider a larger goal, but break it up into smaller achievable goals such as obtaining his GED, then getting a certification in trades. He would then move onto the agency stage, where he would choose one of his options and put it into action with thoughts such as "I'm capable of getting my GED". If he were to encounter obstacles such as requiring transportation to get to school, he would use the same patterns and consider possible pathways such as asking a classmate for a ride or taking public transit [343]. In order for high hope to develop both components must be present as neither alone is sufficient [344]. External agents can influence hope as well, as external resources can help people increase the perceived pathways and agencies rather than thinking goal setting and hope are only individual pursuits [345].

338 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

339 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

340 Wang, Q., & Ng, F. F. (2012). Chinese students' implicit theories of intelligence and school performance: Implications for their approach to schoolwork. Personality And Individual Differences, 52(8), 930-935. doi:10.1016/j.paid.2012.01.024

341 Snyder, C. R., Hoza, B., Pelham, W. E., Rapoff, M., Ware, L., Danovsky, M., et al. (1997). The development and validation of the Children's Hope Scale. Journal of Pediatric Psychology, 22, 399–421.

342 Adelabu, D. H. (2008). Future time perspective, hope, and ethnic identity among African American adolescents. Urban Education, 43, 347–360.

343 Mellard, D. d., Krieshok, T., Fall, E., & Woods, K. (2013). Dispositional factors affecting motivation during learning in adult basic and secondary education programs. Reading & Writing, 26(4), 515-538. doi:10.1007/s11145-012-9413-4.

344 Snyder, C R. Journal of Counseling and Development : JCD73.3 (Jan 1995): 355

345 Bernardo, A. B. I. (2010). Extending hope theory: Internal and external locus of trait hope. Personality and Individual Differences, 49, 944–949. doi:10.1016/j.paid.2010.07.036.

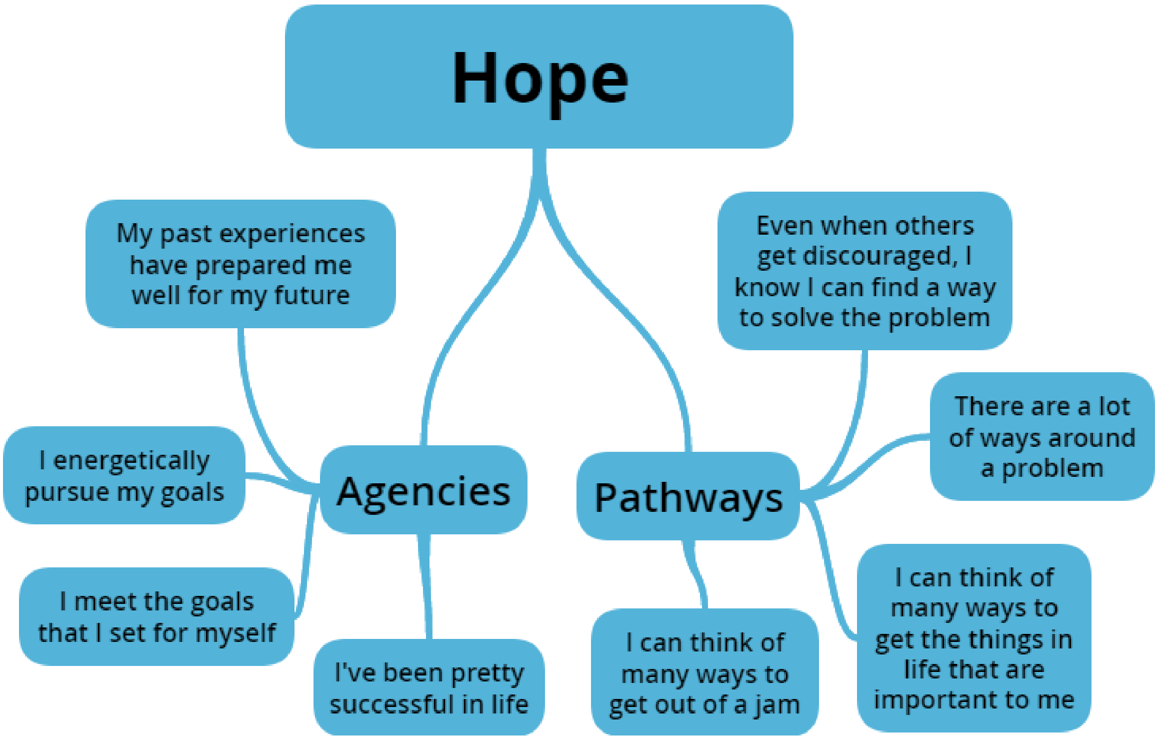

Figure 38 Figure 5 Hope Mind Map[a]

a Snyder, C. R., Harris, C., Anderson, J. R., Holleran, S. A., Irving, L. M., Sigmon, S. T., et al. (1991). The will and the ways: Development and validation of an individual-differences measure of hope. Journal of Personality and Social Psychology, 60(4), 570–585

16.18.1 Benefits of Hope

There has been lots of research to show that **high hope** has several benefits for students mental well-being. It has been shown to increase optimism and happiness in students, and students with high hope are less likely to have anxiety or depression as students who have low hope [346]. Higher hope has also shown to increase academic achievement, especially in students around the 7th grade [347]. Research has also shown that these students are more likely to prepare to achieve academically by studying more and getting involved in extracurricular activities [348]. When students have a higher level of hope they are also more likely to set more challenging goals for themselves at school [349], and focus on success over

346 Ryzin, M. M. (2011). Protective Factors at School: Reciprocal Effects Among Adolescents' Perceptions of the School Environment, Engagement in Learning, and Hope. Journal Of Youth & Adolescence, 40(12), 1568-1580. doi:10.1007/s10964-011-9637-7

347 Adelabu, D. H. (2008). Future time perspective, hope, and ethnic identity among African American adolescents. Urban Education, 43, 347–360

348 Adelabu, D. H. (2008). Future time perspective, hope, and ethnic identity among African American adolescents. Urban Education, 43, 347–360

349 Ryzin, M. M. (2011). Protective Factors at School: Reciprocal Effects Among Adolescents' Perceptions of the School Environment, Engagement in Learning, and Hope. Journal Of Youth & Adolescence, 40(12), 1568-1580. doi:10.1007/s10964-011-9637-7

failure [350]. This alternative focus leaves these students to perceive they will be successful at attaining the challenging goals they set for themselves [351].If students however, fail to obtain this perception they are likely to experience learned-helplessness. This maladaptive strategy commonly develops in performance-oriented students who have experienced failure and come to believe that anything they try will result in failure [352]. As a result, these students refuse to engage in tasks because they assume they will not succeed [353]. By failing to participate in anything, these students prevent themselves from being successful and therefore have a difficult time increasing their levels of hope for future accomplishments. The overwhelming research shows the importance of increasing levels of hope in students, not only for the benefits of mental well-being but also for the effects it has on students academic performance.

16.18.2 Importance of Hope in the Education Process

It is important for parents and educators to create resilient learners by encouraging students to not only succeed but also stumble and fail [354]. By doing so, students are able to recognize failure as something which they can overcome and learn from. It is also important to encourage a realistic understanding of a student's potential [355]. Students who create goals which are too far out of their capacities are likely to fail more frequently and decrease their level of hope. Goal related experiences in general can be beneficial in increasing a student's level of hope [356], especially By creating goals which are realistic but still maintain some level of challenge, students are able to achieve goals and increase their level of hope for future challenges. Another recommendation to increase hope is to promote mastery goals in teaching [357]. It is also beneficial for students to have role models to encourage students to stay mentally energized to continue to pursue their goals and assist in finding pathways to achieve them [358].

350 Snyder, C R. Journal of Counseling and Development : JCD73.3 (Jan 1995): 355

351 Ryzin, M. M. (2011). Protective Factors at School: Reciprocal Effects Among Adolescents' Perceptions of the School Environment, Engagement in Learning, and Hope. Journal Of Youth & Adolescence, 40(12), 1568-1580. doi:10.1007/s10964-011-9637-7

352 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson

353 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson

354 Addison, B. B. (2012). Academic care, classroom pedagogy and the house group teacher: 'making hope practical' in uncertain times. Pastoral Care In Education, 30(4), 303-315. doi:10.1080/02643944.2012.688064

355 Addison, B. B. (2012). Academic care, classroom pedagogy and the house group teacher: 'making hope practical' in uncertain times. Pastoral Care In Education, 30(4), 303-315. doi:10.1080/02643944.2012.688064

356 Ryzin, M. M. (2011). Protective Factors at School: Reciprocal Effects Among Adolescents' Perceptions of the School Environment, Engagement in Learning, and Hope. Journal Of Youth & Adolescence, 40(12), 1568-1580. doi:10.1007/s10964-011-9637-7

357 Phan, H. H. (2013). Examination of Self-Efficacy and Hope: A Developmental Approach Using Latent Growth Modeling. Journal Of Educational Research, 106(2), 93-104. doi:10.1080/00220671.2012.667008

358 Snyder, C. R., Hoza, B., Pelham, W. E., Rapoff, M., Ware, L., Danovsky, M., et al. (1997). The development and validation of the Children's Hope Scale. Journal of Pediatric Psychology, 22, 399–421.

16.19 Beliefs about Knowledge

16.19.1 Models of Knowledge

Epistemological beliefs are the beliefs about what knowledge is and how one acquires that knowledge (Otting)Epistemological beliefs are the individually based systems of beliefs that are more or less independent from one another. They differ according to the age and the nature of education [359] Younger learners are said to be more naïve, for instance, they quickly accept the knowledge without questioning it. Older learners, however, approach the knowledge in a more critical manner. In addition, one's type of the education affects one's epistemological beliefs. For example, the people who are in the soft sciences (e.g. psychology) approach the type of knowledge with uncertainty, which means that there are several answers or ways to solve a problem. On the other hand people in the hard sciences (e.g. chemistry) approach knowledge with the belief that it is fixed, thus there is one answer and not the several answers [360]. Epistemological beliefs predict numerous aspects of academic performance, including comprehension, cognition in different academics domains, motivation, learning approaches and self-regulation. Therefore, it is important for the teachers to understand epistemological beliefs. This subsequent sections will discuss the three different models of knowledge that were suggested by Perry, Schommer and Kitchner&King.

Perry's dualist and relativist model of knowledge

Perry states that students pass through two stages of knowledge which are the dualistic and the relativistic.[361] The **dualist** knowledge is when the knowledge is either right or wrong. There is no ambiguity. As the students' progress, they tend to now think in a **relativist** manner. This approach states that knowledge can be evaluated based on personal experience. There is no one answer but rather the knowledge is uncertain. Knowledge approaches are very important because they affect how the students approach learning. Students who are in the dualistic stage are most likely to be looking for the fact-oriented information when they are studying. They study like they are memorizing the information and they do not take time to break down the information so that they could deeply understand it. This is different from the student who use the relativistic approach. When they are studying they tend to search for context-oriented information. This means that they break down the information through paraphrasing, constructing what they have understood and they also summarize their information. This leads to the students who use the relativist approach to learning, to do better in their classes when they are getting graded.

Schommer's four dimensions of knowledge

Schommer came up with four separate dimensions about knowledge [362] The first one was **simple knowledge** this is when knowledge is organized in bits and pieces, meaning that for

359 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.

360 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.

361 Dahl, T., Bal., M.,& Turi, A.L. (2005) Are Student's beliefs about knowledge and learning associated with their reported use of strategies? British Journal of Educational Psychology 75, 257–273

362 Schommer, M. 1993. Epistemological development and academic performance among secondary students. Journal of Educational Psychology, 85: 406 – 411

one to understand it, it has to be broken down into smaller simple parts. The second one was **certain knowledge** which is the belief that knowledge is absolute, for example the student believes that there is one answer. The third one is **fixed ability** is the belief that one's ability to learn is innate and cannot be changed for example the student will believe that it is either they are born to grasp materials. The fourth one is the **quick learning** which is the belief that learning is fast process or it completely does not occur. The earlier research that was done by Schommer, showing the effects that these beliefs had on the individuals learning were as follows: those who believed that knowledge was certain & simple tend to not use critical thinking skills, self-regulating skills and meta cognitive skills which resulted in them not acquiring the deeper knowledge since they were not questioning what they were learning[363]Those who believed that knowledge was fixed resulted in students engaging in superficial learning because they was no deep and thoughtful thinking when they were tuckling materials that were presented to them. This resulted in them giving up when they were faced with challenges [364] Those who believed in quick knowledge, were presented with a text and told to write a conclusion, most of them tent oversimplify the conclusion. Meaning that they just scrapped on the surface without asking themselves why they would think that would be the conclusion [365]

Kitchener and King's Reflective model

This is framework of work was coined by Kitchener and King, in which explains the different stages that the students go through in seven stages of reflective knowledge. These seven stages are dived into three stages which are **pre-reflective judgment** (stages 1 to 3 knowledge is certain), **quasi- reflective judgment** (stages 4 and 5 knowledge is not certain)and **reflective judgment** (stages 6 and 7 knowledge is context based) [366]. This model is important in that it focuses on the reasoning behind the answers of the open-ended questions and also the individual's problem solving skills. Also, the model is affected by the age, education level and major that one is in. Consequently, this is significant in the learning process because those who believe that knowledge is simply something that is handed done from authority learn differently from those that believe that knowledge is constructed. The studies that were done about the different stages show that those who value the teacher's expertise and think that knowledge is certain tend to follow a more traditional manner of learning [367]. This means that they wait to be handed over materials by the teacher. However, students that are in stages 6 and 7 recognize that knowledge is something that is personally constructed and not handed down by an expertise. These students are able to challenge their learning environments and are more open to the collaboration of information with the other students, because they also believe that peers like teachers can be a source of knowledge.

363 Dahl, T., Bal., M.,& Turi, A.L. (2005) Are Student's beliefs about knowledge and learning associated with their reported use of strategies? British Journal of Educational Psychology 75, 257–273

364 Dweck, C. S., & Leggett, E. L. (1988). A socio-cognitive approach to motivation and personality Psychological Review, 95, 256–273

365 Dahl, T., Bal., M.,& Turi, A.L. (2005) Are Student's beliefs about knowledge and learning associated with their reported use of strategies? British Journal of Educational Psychology 75, 257–273

366 Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. Review of Educational Research, 67,88–140

367 Bruning, R., Schraw, G. & Norby, M. (2011). Cognitive psychology and instruction. Boston, MA: Allyn & Bacon/Pearson.

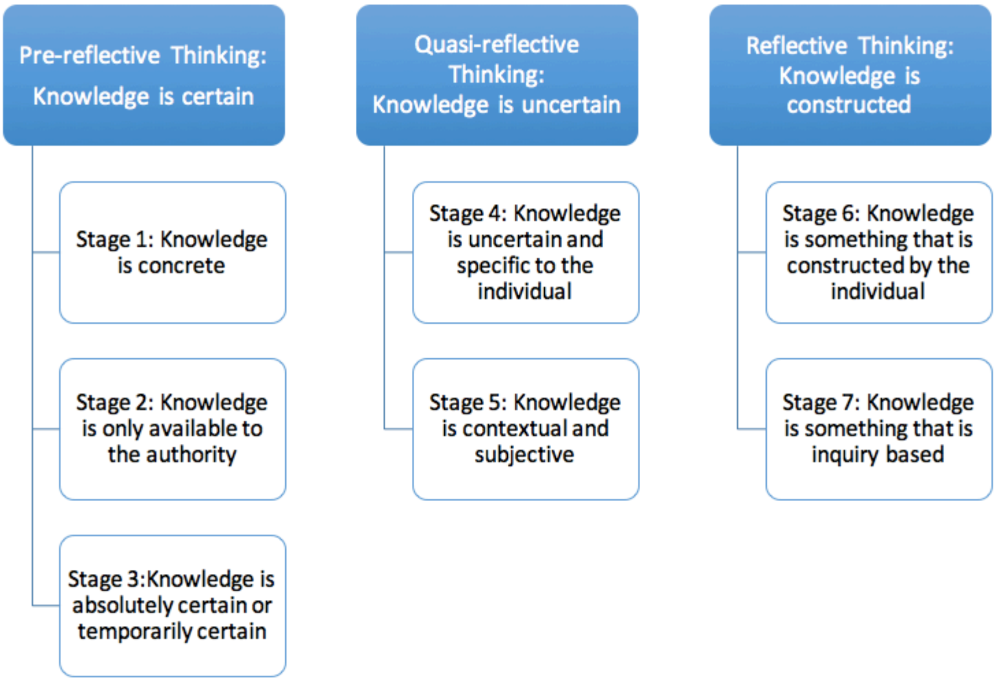

Figure 39 Figure 6 Reflective Thinking Model

16.19.2 Western Culture vs Eastern Culture

There are cultural differences in the beliefs in epistemology. [368] The two views that are going to be discussed are the Western culture and Eastern culture. The Western culture emphasizes more on the Socratic view, in which the students are taught to question and challenge the information that they are given. Therefore they are more active in their learning because they are expected to reflect on the given information. The Eastern view of learning is mainly based on the Confucius. This is the belief in the student's effort and willingness to learn. The students were expected to respect the authority that is imparting information to them because they are seen as the ones that are always correct and needs to be constantly followed and be obeyed if one wants to learn. Learning is not something that the students just do, but they do it for a purpose. Most of the time the purpose of learning was for the students to go work as civil servants [369]. These differences in cultural beliefs does not mean that these students are in the different stages of knowledge but rather that they have different ways to acquire knowledge. It is important that the teacher does not become bias about this views, by thinking that those students who value the what the

368 Hardy,C.,&Tolhurst,D.,(2014). Epistemological Beliefs and Cultural Diversity Matters in Management Education and Learning: A critical review and Future Direction. Academic of Management Learning & Education, 13(2) 265-289

369 Hardy,C.,&Tolhurst,D.,(2014). Epistemological Beliefs and Cultural Diversity Matters in Management Education and Learning: A critical review and Future Direction. Academic of Management Learning & Education, 13(2) 265-289

authority is says without questioning it or those who come from the Eastern culture are in the early stages of knowledge.[370].

16.20 Application to Instruction

16.20.1 Awareness and Discussion of Beliefs

It is important for educators to be aware of the various beliefs relating to knowledge and intelligence. By making students aware of what their beliefs are, through group discussions and reflection journals, teachers are better able to help students identify and change their beliefs [371]. Moreover, teachers should also explicitly teach students how beliefs about intelligence and knowledge affect learning. For example, if someone believes intelligence is something which is fixed, they will be less likely to pursue in learning when faced with a challenge [372]. In addition, if someone believes knowledge is fixed, then they are less likely to reflect or question their thoughts because they think what they know is always true. Similarly, these beliefs can change the opportunities in which we expose ourselves to [373]. If an individual does not believe they have the knowledge or intelligence required for a certain career opportunity, they are not likely to attempt to pursue that career. With appropriate belief strategies, nearly all students can attain a high academic achievement as these strategies can encourage students to use previous knowledge and develop advanced critical thinking skills [374]. In this respect, classroom environments play a significant role in shaping students beliefs as they can enhance beliefs already held by students, challenge them, or introduce new ideas [375].

Not only is it important to be aware of the different beliefs about intelligence and knowledge held by students, but teachers should be aware that these beliefs change as the students age. For example, elementary school students tend to believe intelligence entails capacities based on cognition. This is determined by how much knowledge an individual possesses and how well they read and comprehends visuospatial relationships [376]. These students believe intelligence involves non-cognitive factors, such as communication and interaction skills, work habits, and athleticism [377]. High school students however pay more attention not only to a person's cognitive abilities when judging an individual's intelligence but also

370 Tweed, R. G., & Lehman, D. R. 2002. Learning considered within a cultural context. Confucian and Socratic approaches.American Psychologist, 57, 89 –99.
371 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971
372 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971
373 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971
374 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971
375 Bruning, R., Schraw, G., & Norby, M. (2010). Cognitive psychology and instruction (5th ed). Pearson Merrill Prentice Hall, Upper Saddle River, NJ. ISBN: 978-0132368971
376 Jones, B. D., Byrd, C. N., & Lusk, D. (2009). High school students' beliefs about intelligence. Research In The Schools, 16(2), 1-14.
377 Jones, B. D., Byrd, C. N., & Lusk, D. (2009). High school students' beliefs about intelligence. Research In The Schools, 16(2), 1-14.

their performance [378]. Jones' study presents five themes of how high school students define intelligence: knowledge, skills and abilities; academic effort; achievement; decision making and personal characteristics [379]. Taking the age of the student into consideration is important in understanding how they perceive intelligence. If teachers are aware of these beliefs, they can better recognize how it impacts students learning and organize their classroom environments and curriculum accordingly.

Epistomological knowledge is also believed to depend on the age and experiences of the child. According to studies done by Perry, as children progress through levels of education, so did their level of knowledge. As individuals mature, their beliefs about the complexity of knowledge, the justifications of knowledge and the effort required to obtain knowledge began to change. This finding is important for teachers to understand that acquiring critical thinking and justification of knowledge that is seen in the higher stages of reflective thinking or relativistic stage comes with age and experience. Therefore teachers should not rush to impose critical thinking, instead they should offer patience and support and take small steps when introducing critical thinking [380]. The belief of intelligence being fixed or incremental also affects the academic achievement of the student and their motivation. Students who believe intelligence to be incremental see intelligence as something that requires effort. These students see failing a test a result of not putting in enough effort in studying, improving would require the motivation to applying more effort. This is different from students who believe intelligence is something that is fixed, which led to learned helplessness and lack of motivation to succeed in the next test. With these students teachers need to teach students that school is about effort and intelligence is not something which is fixed [381].

16.20.2 Development of Reasoning Skills and Reflective Thinking

Teachers need to ensure that they give information that challenge their student's epistemological views [382]. Epistomologial beliefs influences the learning of the individuals. Those who believe that learning is something that is complex, uncertain,effortful and requiring justification tend to do well with their academics [383].This is because they know that their motivation changes their learning. They are also open to exploring the new ideas, and go out there to find deeper contextual information.These are the learners who are in the higher stages of the reflective thinking and those who are believed to be in the relativistic stage [384]. The beliefs in the epistemological knowledge is something that should be taught to the teachers as well. This is because the teachers beliefs about knowledge and how it is acquired

378 Jones, B. D., Byrd, C. N., & Lusk, D. (2009). High school students' beliefs about intelligence. Research In The Schools, 16(2), 1-14.

379 Jones, B. D., Byrd, C. N., & Lusk, D. (2009). High school students' beliefs about intelligence. Research In The Schools, 16(2), 1-14.

380 Zhao, Q., Zhang, J., & Vance, K. (2013). Motivated or paralyzed? Individuals' beliefs about intelligence influence performance outcome of expecting rapid feedback

381 Zhao, Q., Zhang, J., & Vance, K. (2013). Motivated or paralyzed? Individuals' beliefs about intelligence influence performance outcome of expecting rapid feedback

382 Bendixen, L.D.(2002).A process model of Epistemic belief change. In Hofer, B.K., and Pintrich PR.(eds). Personal Epistemology: The

383 Erdamar, G., & Alpan, G., (2013) Examining the epistemological beliefs and problem solving skills of preservice teachers during teaching practice. Teaching in Higher Education, 18 (2), 129-143

384 Zhao, Q., Zhang, J., & Vance, K. (2013). Motivated or paralyzed? Individuals' beliefs about intelligence influence performance outcome of expecting rapid feedback

affects the student's learning process [385]. The teacher's beliefs about teaching are deemed important because they may be used to filter and interpret information, frame tasks, and guide action [386]. The teachers who believed that they were the only source of information that their students had, structured the class in a non-discussion one. This led to their students believing that knowledge was certain, and the only sources of knowledge was from the authority. This differs from the teachers that believed that knowledge is constructive, this led to them designing the classroom in a more collaboration manner. The teachers would encourage students, to think critically about the information that they were given. The teacher also encouraged the student's engagement with others because they knew that this will help in making them more open to the new ideas. This also encouraged the students in their reflective thinking. Therefore it is important that the teachers are trained not to have the traditional view of thinking because this in turn influences the students.

16.20.3 Cultural Diversity

Figure 40 Figure 7 Canadian Mosaic Wall

British Columbia's new curriculum has developed three competencies that students should strive for during their education. One of the competencies that relates to the cultural diversity of the beliefs about intelligence and knowledge is the positive personal and cultural identity competency:

385 Braten.L.,& Ferguson. L.,(2015). Beliefs about sources of knowledge predict motivation for learning in teacher education. Teaching and Teacher Education, 13-23

386 Erdamar, G., & Alpan, G., (2013) Examining the epistemological beliefs and problem solving skills of preservice teachers during teaching practice. Teaching in Higher Education, 18 (2), 129-143

"[T]he awareness, understanding, and appreciation of all the facets that contribute to a healthy sense of oneself. It includes awareness and understanding of one's family background, heritage(s), language(s), beliefs, and perspectives in a pluralistic society. Students who have a positive personal and cultural identity value their personal and cultural narratives, and understand how these shape their identity. Supported by a sense of self-worth, self-awareness, and positive identity, students become confident individuals who take satisfaction in who they are, and what they can do to contribute to their own well-being and to the well-being of their family, community, and society." [387]

The multicultural classroom in Canadian schools require educators to be open-minded and flexible when helping students develop their cultural identity and their beliefs. Figure 7 demonstrates the multicultural society that exists in Canada today. As mentioned earlier in this chapter, the Western and Eastern cultures have a different view on intelligence and knowledge. As a result, children need to be taught explicitly about how cultural identity affects their beliefs about intelligence and knowledge

In terms of beliefs about intelligence, cultural differences give rise to different goal orientations which in turn causes academic performances to vary. Therefore, teachers should evaluate the beliefs and goal orientations of each individual student in a private session to ensure that they are positive and useful. Unfortunately, there might be occasions, in which students have negative beliefs and ineffective goal orientations because of the cultural context they live in. For example, in Chen and Wong's aforementioned study, there appears to be a positive correlation between performance-approach, performance-avoidance and mastery goals. In addition, these goals each seem to help Chinese students' academic achievement. However, an important point to keep in mind is that this correlation is most likely based on the Chinese students' desire of self-development, competition and avoidance of failure. Educators should strive to encourage self-development to enable students to taken on mastery goals, but competition and avoidance of failure are not features of a good learning environment. There is a lot of stress that comes with competing and avoiding failure. Even if academic achievement is obtained, educators need to be cautious. It might be more effective to promote an incremental view of intelligence in the classroom because students holding this view are more likely to focus on their own improvement and to learn for the sake of mastery and enjoyment. Subsequently, students are more likely to feel confident and satisfied with their learning.

As for beliefs about knowledge. cultural differences lead to different ways of developing and utilizing knowledge. As mentioned earlier, the Western and Eastern cultures have differing views of knowledge. Therefore the teacher should be willing to have a multicultural classroom. For instance, one that has both the Socratic view and Confucian view and be able to teach the students to implement one or the other depending with the situation and the class that they are taking. The Socratic view is important for the social sciences classes in which the students are supposed to question what they are learning since there is no right or wrong answer. The Confucian view is helpful in learning the hard sciences. such as physics, which adhere to the laws,meaning that the student has to grasp the fundamental facts. The teacher should create a classroom that is group based so that the students can

387 Positive personal and cultural identity competency profiles. (n.d.). Retrieved March 02, 2016, from `https://curriculum.gov.bc.ca/sites/curriculum.gov.bc.ca/files/pdf/PPCICompetencyProfiles.pdf`.

be able to share their different beliefs and critically think about them [388]. Overall, teaching children the Socratic and Confucian approaches explicitly can help students have a better understanding of how cultural affects beliefs and thinking, which in turn prepares them to collaborate with people in a multicultural society. Additionally, other cultures' beliefs can also be researched and it is highly encouraged that teachers keep themselves updated to ensure that they are considering the effects of culture in their classrooms.

16.21 Suggested Readings

Bernardo, A. B. I. (2010). Extending hope theory: Internal and external locus of trait hope. Personality and Individual Differences, 49, 944–949. doi:10.1016/j.paid.2010.07.036.

Haimovitz, K., Wormington, S. V., & Corpus, J. H. (2011). Dangerous mindsets: How beliefs about intelligence predict motivational change. Learning And Individual Differences, 21(6), 747-752. doi:10.1016/j.lindif.2011.09.002

OECD (2009), "Teaching Practices, Teachers' Beliefs and Attitudes", in OECD. , Creating Effective Teaching and Learning Environments: First Results from TALIS, OECD Publishing, Paris. DOI: 10.1787/9789264068780-6

16.22 Glossary

Affective knowledge: Information acquired subjectively, based on emotional reaction.

Agency: Goal-directed determination, willpower.

Beliefs: personal opinions about the environment and the self

Certain knowledge: belief that knowledge is absolute

Cognitive knowledge: information acquired objectively and rationally.

Constructivist view: teachers are guides in helping students obtain knowledge, students are active in their own learning

Dualist knowledge: belief that knowledge is either right or wrong

Entity theory: the belief that intelligence cannot be changed

Epistemological beliefs: beliefs about what knowledge is and how one acquires that knowledge

Explicit beliefs: conscious beliefs that impact a person's behaviour

Fixed ability: belief that one's ability to learn is innate and cannot be changed for example the student will believe that it is either they are born to grasp materials

388 Dahl, T., Bal., M.,& Turi, A.L. (2005) Are Student's beliefs about knowledge and learning associated with their reported use of strategies? British Journal of Educational Psychology 75, 257–273

High hope: occurs when both agencies and pathways are present, students believe they have ability of attaining their goals.

Implicit beliefs: subliminal beliefs that influence an individual's behaviour

Implicit theory: involves an individual making unspoken speculations about the causes of an event

Incremental theory: demonstrates that gradual modifications of intelligence are possible

Intelligence: a person's capacity to adjust to, shape and choose an environment

Mastery-approach goals: bring about a commitment to improve competence and to engage in meaningful learning, in which understanding is highly valued

Mastery-avoidance goals: give rise to hiding from inadequacy in relation to the self and to an undertaking

Mastery orientation: includes the incremental theory and the desire to improve one's proficiency

Pathways: planning of ways to reach one's goals

Performance-approach goals: concentrate on the desire to show proficiency by making other people targets for competition

Performance-avoidance goals: focus on the finding ways to escape tasks that will likely reflect failure when compared to others

Performance orientation: involves the belief in the entity theory and the display of proficiency

Pre-reflective judgment: the stages in which knowledge is certain

Quasi-reflective judgment: the stages in which knowledge is uncertain

Quick learning: the belief that learning is fast process or it completely does not occur.

Relativist knowledge: belief that knowledge can be evaluated based on personal experience

Reflective Judgement: the stages in which knowledge is content based

Simple knowledge: knowledge is organized in bits and pieces, meaning that for one to understand it, it has to be broken down into smaller simple parts

Traditional views: teachers act as an authority figure while students are passive recipients of knowledge.

16.23 References

17 Technologies and Designs for Learning

In order to best use technology for teaching and learning, teachers and designers need to understand its potential benefits and pitfalls. This chapter examines theories about how cognitive processes are affected by multimedia learning environments and evidence-based principles for designing such environments. The first section introduces cognitive load theory and describes how the cognitive demands of a multimedia environment affect how students learn from it. The second section introduces the four component instructional design model which offers research-based guidance for designing materials and technologies to facilitate learning of complex skills. Finally, this chapter will look at how technology can be used to facilitate collaborative learning.

17.1 Cognitive Load Theory

Cognitive load theory is an important aspect when looking at technology in the educational setting. **Cognitive load theory** is a theory proposed by John Sweller and focuses on working memory and instruction.[1] Our working memory is only capable of processing a limited amount of information at one time[2] When designing instructional tools working memory's limitations is something that needs to be kept in mind, especially when factoring technology into instruction. The reason behind this is that if too much information is presented simultaneously working memory can become overloaded will either to fail to take in all of the information being presented or will shut down completely and take in none of the information. Sweller proposed that there are three types of cognitive load: intrinsic, extraneous, and germane. Through understanding the differences between these three types of cognitive load we should be able to analyze how multimedia presentations are helpful for learning or if they cause cognitive load issues [3]

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1 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

2 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

3 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

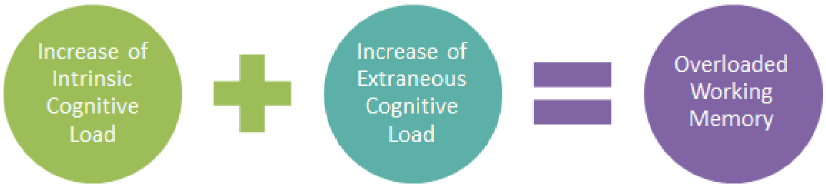

Figure 41 How Cognitive Load Affects Working Memory

17.1.1 Intrinsic Cognitive Load

Intrinsic cognitive load refers to mental processing that is essential to completing a task.[4] Intrinsic cognitive load according to Sweller is something that cannot be changed by instructional design but needs to be taken into account by instructional designers[5] Any material that is being learned places intrinsic cognitive load on working memory, the level of difficulty is what changes how much pressure is put on the working memory[6] If a student's level of expertise is high in the topic being learned then intrinsic cognitive load will still affect working memory just not as much as if the student had little to no knowledge on the topic in question[7] In this case the level of previous knowledge and understanding of the topic in question needs to be taken into account when presenting a class with new information. For example if a person already had some knowledge about oranges, a lesson on the parts of oranges would cause less intrinsic cognitive load than if they didn't know anything about oranges.

17.1.2 Extraneous Cognitive Load

Extraneous cognitive load is mental processing that does not promote learning and which can be eliminated by changing the design of a task.[8] Extraneous cognitive load

4 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

5 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

6 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

7 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

8 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

is entirely determined by instructional design[9] For example in a multimedia presentation extraneous cognitive load is the sounds, pictures, text, and animations that could be used to present the material. The more that the working memory has to attend to the less likely it is going to retain the information presented[10] Extraneous cognitive load is manageable, good instructional design lessens the load while poor design can increase the load. For example, a teacher is doing a lesson on the life cycle of a butterfly and decides to use a slide show on the smart board. In the slide show the teacher outlines all the relevant information about each part of the cycle but they add an animation of the butterfly evolving through the stages. In this case the extraneous cognitive load would increase because the students have to pay attention to the relevant information while being distracted by the animation.

17.1.3 Germane Cognitive Load

Germane cognitive load the amount of working memory devoted to processing the amount of intrinsic cognitive load associated with the information presented and is associated only with a learner's characteristics[11] He notes that germane cognitive load does not cause an independent strain on working memory rather, it is directly associated with intrinsic and extraneous cognitive load levels. For example if we assume that a student's level of motivation stays constant they have no control over their level of germane cognitive load[12] So what does this have to do with instruction? According to Sweller, this means that if lessons are created to allow working memory to focus on intrinsic cognitive load, by reducing extraneous cognitive load, germane cognitive load is increased and the level of learning increases as well.

17.1.4 Research and Implications

Intrinsic and extraneous cognitive load are relational, in other words if both are high then working memory can become overloaded[13] The implications are that because only extraneous cognitive load can be controlled instructional designers need to work to keep it low so as not to overload working memory when the intrinsic cognitive load is high[14] According to the theory, in order to reduce extraneous cognitive load we should take advantage of long term memory's vast capacity by drawing on existing schemas and creating new ones, thereby

9 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

10 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

11 Sweller, J. (2010). Element Interactivity and intrinsic, extraneous, and germane cognitive load. Educational Psychology Review 22(2), 123-138. doi: 10.1007//s10648-010-9128-5

12 Sweller, J. (2010). Element Interactivity and intrinsic, extraneous, and germane cognitive load. Educational Psychology Review 22(2), 123-138. doi: 10.1007//s10648-010-9128-5

13 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

14 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

reducing the strain on working memory[15] These include: presenting goal free problems, useful redundancy, modality, completion problem effect, split attention effect and others[16]

To start, goal free problems were designed by to change student activities to reduce extraneous cognitive load and to encourage schema production[17] They do this by reducing the chance a student will use goal related strategies to try to solve the problem. This is done by changing how a problem is worded so that students don't limit themselves to trial and error testing which, can take up a lot of working memory's capacity[18] For example, a math problem asks: a train is traveling at fifty kilometers per hour and travels a distance of 400 kilometers. How long did it take? If a student doesn't know the correct formula for calculating time when having the above information they will start a trial and error approach to finding the answer, which will increase extraneous cognitive load. However, if the question asked the student to show as many ways as you can to calculate the answer instead it will reduce the extraneous cognitive load on working memory.

The worked example effect is when a person studies already worked examples to learn how to solve a problem, this also reduces the trial and error approach to problem solving because it provides the student a way to create a schema on how to solve these particular types of problems[19] Unlike regular problems, worked problems focus a person's attention on the steps needed to solve a problem rather than on the problem as a whole, theoretically reducing extraneous cognitive load because nothing else needs to be attended to[20] In this case if a teacher gives students a new equation in math and then proceeds to provide them with a list some of examples where this equation can be used to solve problems the students have a resource to use when it comes to using the equation, which reduces cognitive load.

The theory behind useful redundancy is that if a student is presented with the same information but in different ways they will be more likely to remember it[21] The idea is that because it is the same information just presented in different ways the extraneous cognitive load will lessen because learners choose which way they prefer to attend to the information[22] However, research has since been conducted that brings this claim into question studies have shown that rather than promote deeper learning it lessens it[23]

15 van Merrienboer, J., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. Educational Technology Research and Development 53(3), 5-13

16 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

17 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

18 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

19 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

20 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

21 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

22 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

23 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

In a study conducted by Mayer, Heiser, and Lonn a series of experiments were conducted to investigate the redundancy effect in multimedia learning[24]. They define the redundancy effect as a multimedia learning situation where words are presented as text and speech and the learning is hindered by the dual presentation of information[25] In the first experiment 78 college students were tested on retention and transfer of information based on a multimedia presentation on the formation of lightening. The students were divided into four test groups. The no-text/no-seductive-details group received animation and concurrent narration, the text/no-seductive-details group received the presentation with added on screen text that summarized the narration. The no-text/seductive-details group received a presentation that contained text that had irrelevant but entertaining information. The last group received both an on screen text summary and entertaining irrelevant information[26] The results of this first experiment found that the students who received the on screen text summary remembered less on the retention test than those who did not have the on screen text. As well, students who received the seductive details also retained less than those who did not receive seductive details[27] This first experiment falls in line with the theory that over use of details on a multimedia presentation is detrimental to retention of information. They hypothesised that the redundancy effect caused by the on screen text could have been due to the increased cognitive load in the visual channel, or in the auditory channel. The second experiment set out to test this hypothesis by breaking the participants into three groups. The first group contained 36 students who received no added text to the presentation, the second contained 37 students who received a summary of the narration, and the third group contained 36 students who received a presentation with added word for word text of the narration[28] The results showed that the students who received no added text to their presentation remembered more than those who had the added text. They also found that there was no significant difference in retention between the two groups that had added text. The third experiment set out to discover what happens when video clips are added to multimedia presentations. In this experiment the video clips that were added contained information about lightening but that they were not relevant to the specific information presented in the original presentation[29] Thirty eight college students were divided into two groups, the no video clip group and the group that had video clips added to the presentation. They found that the students in the added video group did not remember any more than the no video group but the results failed to reach statistical significance[30] The last experiment conducted looked at whether adding video clips before or after a multimedia presentation boosts interest in the presentation. The results showed that adding video clips to the beginning of a presentation results in students remembering more of the presentation

24 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

25 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

26 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

27 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

28 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

29 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

30 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

although the results were not statistically significant[31] Overall, this study concluded that adding extra modes of presenting the same information reduced the amount of information that students will retain after seeing a multimedia presentation. When a learner has to divide their working memory to make sense of the information presented the extraneous cognitive load is increased which reduces the amount of information that can be learned. This is especially important when text is added to a presentation. Mayer, Heiser, and Lonn recommend that instructional designers should refrain from adding text when the information is presented orally in multimedia presentations[32].

Some theorize that those who work on instructional design can go further than only considering ways to reduce extraneous cognitive load. They feel that instructional design can be improved by creating ways to increase germane cognitive load in learners[33] By increasing a learner's germane cognitive load they feel that the learner's attention can be directed to the construction of schemas which in turn reduce the strain on working memory during the learning process.

17.1.5 Summary

In summary Sweller proposes that there are three types of cognitive load and all effect how our working memory is utilized when learning new information. The implications of cognitive load theory on the use of technology in instructional design is that technology can be an effective learning tool as long as guidelines are followed in order to reduce extraneous cognitive load on working memory. In particular teachers need to pay attention to the research conducted on redundancy effect so that they do not overload working memory with redundant information. One way in which technology can be utilized is to present information in ways that help with schema production, which reduces cognitive load by moving information into long term memory.

17.2 Four-Component Instructional Design

Four Component Instructional Design (4C/ID) is an instructional design model developed by van Merriënboer and his colleagues. It prescribes instruction for learning in a complex environment. The 4C/ID model is based on the idea that skills are learned most effectively by using them instead of just reading instructions from a text. It is important that the conditions of learning are similar to what the learner would encounter in real-world applications of the skill, and instruction emphasizes practice rather than information giving. The 4C/ID model consists four components: *(1) Learning Task*, *(2) Supportive Information*, *(3) Just-in-Time (JIT) Information*, and *(4) Part-Task Practice* (van Merriënboer, 1997;[34]; van

31 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

32 Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. Journal of Educational Psychology 93(1), 187-198.

33 Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

34 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

Merriënboer & Kirschner, 2007). These tasks are ordered from task difficulty, less complex to more complex. At the beginning of each four components, lots of scaffolding is required, and gradually reduce in amount of scaffolding as learners progress. In this section we will discuss researches and theories about how technology can support this theory of learning.

17.2.1 (1) Learning Task

Learning Task is represented as circles in Figure 1. Complex learning involves achieving integrated sets of learning goals. The 4C/ID model promotes use of learning tasks that are whole, authentic, and concrete. Learners participating in the online courses, other wise known as technology-based instruction, based on this model it is important to begin learning as a cluster of relatively simple , but meaningful tasks called **task classes**. It is impossible to provide highly complex learning tasks from the beginning of the training program because this will slow down excessive cognitive overload for the learner. This will lead to learning and performance impairments [35]. Once learners master the simple but necessary components, they progress towards more complex tasks. Complexity of a task is determined by the number of skills involved in task classes, how they relate each other, and amount of knowledge needed to perform them. While there is no increasing difficulty for the learning tasks within one task classes, they do differ with regard to the amount of support provided to learners. This support that a child receives is called scaffolding [36]. Scaffolding is used when needed in situations such as learners moving from the lowest level task classes to the top-level task classes. Dotted lines around the circles in Figure 1 represents the process of selection and development of suitable learning tasks for a child. Eventually, supports and scaffolding fades as a result. Fading support is due to the **expertise reversal effect**. It is the phenomenon where supports (e.g. coaching) and instructional methods (systematic steps) that works well for novices can have negative effects for advanced learners due to redundancies [37]. It also increases their cognitive load. Learning tasks stimulate learners to construct cognitive schemata by mindfully abstracting away from the concrete experiences that the learning tasks provide [38]. In learning, generalization and discrimination consists schemata to make them more in line with new experiences [39]. According to van Merriënboer, Clark, and Croock [40] these to-be-constructed schemata comes in two forms. *Mental Models*: that allows reasoning in the domain because they reflect the way in which the learning domain is organized. *Cognitive Strategies*: guides problem solving in the domain because they reflect the way problems may be effectively approached. Product-oriented and Process-oriented supports are the two ways to applying learning tasks in a classroom setting. Product-oriented support can be divided into highest or lesser degree. Highest

35 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

36 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

37 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

38 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

39 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

40 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

product-oriented support is a learning task that provides a case study or worked-out examples that confronts the learner with a given state , a desired goal state, and a solution, intermediate solutions, or both [41]. It is desirable to use accidents, success stories, or stories with unexpected ending to motivate student learning. In these learning tasks, learners are required to answer questions that stimulates deeper processing and the indiction of mental models from the given example materials. By demonstrating a real-life example, learners can get a clear impression of how a particular domain is organized. It is necessary to allow students to come up with their own conclusion/solution. More information can be retrieved from Figure 2. Process-oriented support is also directed towards the problem-solving process itself. A *modeling example* confronts the learner with an expert who is performing the task while explaining why the task is performed as it is performed. This is a hands-on experience allows children to retrieve information a lot easier than information gathered by reading texts. This method also helps retain information easier than other learning methods [42]. By studying by using the modeling example, learners can get a clear understanding of the systematic approaches and rules of thumb that even professionals use [43]. Thinking aloud may be helpful to bring the hidden mental problem-solving processes as well. Moreover, computer-based learning tools may invite learners to approach the problem at hand as an expert would do.

17.2.2 (2) Supportive Information

This type of information plays a role in developing complex skill using technology. Learners need information in order to work successfully on **nonrecurrent skills** (schemata-like controlled processes) aspects of learning tasks and to genuinely learn from those tasks [44]. Procedure-like automatic processes are called **recurrent skills** in the 4C/ID framework [45]. Complex cognition consists of both nonrecurrent and recurrent skills. Supportive information is provided to help learners master the nonrecurrent aspects of complex cognitive task. It provides a bridge between learners' prior knowledge and the learning tasks [46]. It is the information that teachers typically refer it to *the theory* and often presented during lectures or in study books . The goal of supportive information is to help learners acquire the different kinds of flexible schemata needed to cope with real life problems. Supportive information plays as an additional to or an elaboration of the previous information and help students to establish factual relationships between newly presented information elements and their prior knowledge [47]. It allows learners to do things that could not be done before. It has

41 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
42 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
43 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
44 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.
45 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.
46 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.
47 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

been shown that this type of elaboration process produces highly complex schemata that should allow for deeper understanding. Learners may study how databases are organized in order to develop useful mental models. Task performers further develop their mental models and cognitive strategies in order to improve their performance. For example, Tiger Woods makes extensive study of the layout of golf courses to develop mental models of how they are organized. Also by him watching videotapes of his competitors help him develop cognitive strategies of how to approach problems in this world (real-world) [48]. It is of utmost importance to stress non-arbitrary relationships. Methods that identify relevant relationships can be used in an expository fashion or in an inquiry fashion. *Expository methods* allows learners to explicitly present the non-arbitrary relationships. *Inquiry methods* ask the learners to discover the relationships. Within these two methods, experiential one is the most important relationship. It relates general and abstract knowledge to concrete cases [49]. The 4C/ID model furthermore distinguishes inductive and deductive strategies for presenting supportive information. There are two types of inductive strategies. *Inductive-Inquiry Strategy* is a method that presents one or more case studies and then asks the learners to identify the relationships between pieces of information illustrated in the case(s). However, this method is very time consuming and requires deep level of understanding although learners have no experience with the skill. Therefore van Merriënboer, Clark, and Croock (2002) [50] does not recommend using this method unless there is enough instructional time available. *Inductive-Expository Strategy* on the other hand, starts with one or more case studies and then explicitly presents the relationships between pieces of information that were illustrated in the cases. Merriënboer, Clark, and Croock (2002)[51] suggests using this approach by default since this strategy is more reasonable and time effective by starting with concrete, and recognizable case studies that works well for learners with little prior knowledge. *Cognitive Feedback* is known as a final part of supportive information. This refers to the nonrecurrent aspects of performance since nonrecurrent performances are never correct or incorrect, it is rather more or less effective. Cognitive feedback can only be presented once learners have finished one or more, or all, learning tasks. When feedbacks are well-designed, it should stimulate learners to reflect on the quality of their personal problem-solving processes and founded solutions [52].

17.2.3 (3) Just-in-Time (JIT) Information

In contrast to supportive information, JIT information is aimed at the recurrent aspects of complex skills. It is the prerequisite to the learning and performance of recurrent aspects of learning tasks or practice items. Automaticity depends heavily on consistency, and repetitive practice. JIT information gives learners the step-by-step guidance when needed then

48 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

49 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

50 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

51 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

52 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

fades quickly. The goal of JIT information is to make basic, but critical skills as automatic as possible, as soon as possible. Freeing cognitive resources, leading to more automaticity becomes crucial to advanced learners. It also provides a step-by-step knowledge, such as teachers or tutors directing learners almost acting as an assistant looking over their shoulder. JIT information is identical for many learning tasks, therefore it is typically provided during the first learning task for which the skill is relevant [53]. Similarly to scaffolding, JIT information goes through a principle called fading, that is a quick fade as learners gain more expertise in the learning material. Instructional method of JIT information mainly promote complication through restricted encoding of situation-specific knowledge into cognitive rules [54]. These rules are formed through multiple practice and this process is when information is necessary for forming the rules is directly available from our working memory. Applying this into a real-life situation, for instance, when one is learning golf, your coach will preferably explain how to hold a club, taking stances, and making swings out on the driving range while making first drives, and not during a lecture in a classroom [55]. This goes the same for learners in a classroom setting. *Information Displays* is organized in small units, this is considered to be essential because controlling the number of new information to bear minimum prevent processing overload during practice. In a real-life situation, for instance, a manual for complex machine may explain the steps one by one rather than assuming user's prior knowledge and only stating some of the steps. This approach should directly present information displays when the learners need the information to work on the recurrent aspects of a particular learning task[56]. However, in some situations this approach is not always helpful. Training for a job, for instance, learning aids such as on-line help system, checklists, and manuals are available and readily accessible. This is due to lack of direct presentation of JIT information when necessary. *Demonstrations and Instances* are the name for elements of the recurrent skill, also known as generalities. Just like rules can be applied in various situations, these are called *demonstrations*; for concepts, plans, and principle, on the other hand are called *instances* [57]. *Cognitive Feedback* is considered as a final part of JIT information which relates to feedback that is provided on the recurrent aspects of performance. This feedback should promote compilation, meaning that if rules are not correctly applied to the situation, learners are said to make an "error" [58]. These feedbacks are recommended to be presented as early as possible. This is for learners to correctly input the right information into their working memory. The 4C/ID model genuinely believe that errors are inevitable in learning and it also plays an important role in a sense that learners learn to recognize their own mistakes and errors, and learn how to recover from them.Well-designed feedbacks should inform the learner why there was an error and

53 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

54 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

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56 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

57 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

58 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

provide suggestions or hints of how to achieve their goal. It becomes crucial not to give out answers to encourage their learning process [59].

17.2.4 (4) Part-Task Practice

Learning tasks are designed to promote schema construction, and also facilitate compilation for recurrent aspects of the complex skills. The last component of 4C/ID model, part-task practice provides additional practice for selected recurrent skills in order to reach required level of automaticity. It is a way of automatizing procedural knowledge more rapidly while circumventing cognitive load problems resulting when learners try to develop skills while simultaneously trying to solve a problem. Expertise is ordinarily a slow-developing process that depends on extending practice to automatize the productions that directly control behavior. JIT information presentation aims at restricted encoding of newly presented information in rules [60]. Learners practice would be supported through appropriate JIT information until they achieve automaticity. van Merriënboer and his associates believed that some part-task practice can help reduce task complexity due to relatively short and spaced periods of it intermixed with work on complex, authentic tasks [61]. This pattern allows the learner to practice sub skills and relate them to the overall task. It is important that practiced items are divergent for all situation/environment that underlying rules can deal with. However, when a high level of automaticity of recurrent aspects are required, learning tasks may provide insufficient repetition to provide necessary amount of strengthening. This is when we need to include additional part-task practice [62]. Other situations such as learning in a general environment, part-task practice is not helpful to complex learning. Part-task practice promotes the compilation of procedures or rules and specially their subsequent strengthening. These are a very slow process that requires numerous practice items. Examples for part-task practice are multiplication tables or playing scales on musical instruments. It becomes critical to start part-task practice within an appropriate cognitive context since it has been found effectively only after learners were exposed to an easier version of the complex skill [63]. Task hierarchy indicates that either, they enable the performance of many other skills higher in the hierarchy, or it has to be performed simultaneously with many other coordinate skills [64]. Therefore, one should identify the first task class then initiate part-task practice.*Practice Items* for par-task practice encourages learners to practice number of times just like the saying, "Practice makes perfect". However, learners have to keep in mind that the whole set of practice items should be divergent, and be applicable in all situations. This will help develop a broad set of situation-specific rules. In cases such as highly complex algorithms, it may be necessary to work from simple to complex practice

59 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

60 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

61 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

62 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

63 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

64 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

items to decompose it into parts then gradually combine towards the whole task. This approach is called a *Part-Whole Approach* [65]. Right use of part-task practice will lead to accurate performance of a recurrent skill. Furthermore, extensive amount of overtraining may be necessary to make the skill fully automatic. For tasks that highly relies of automaticity, sometimes the ultimate goal is not be accurate. It is common, in such cases, that acceptable accuracy combined with high speed and performance skills as a whole is the goal. In order to reach this, the recurrent skills are first practiced under speed stress, then once the speed criteria is reached, the skill is practiced under time-sharing condition. Only then, the skll is practiced in the context as a whole task. In other words, performance criteria gradually change from accuracy, to accuracy combined with speed, to accuracy combined with speed under time-sharing conditions or high overall workload [66]. It is suggested that short, spaced periods of part-task practice or overtraining has better results than long, concentrated periods of part-task practice. Part-task practice is best intertwined with the learning tasks because this provides distrubuted practice and also enables the learners to relate the recurrent constituent skill to the whole complex skill [67].

17.2.5 Research and Implementation

Recent study on the effectiveness of learning environments using one-by-one-by-two pretest-posttest quasi-experimental design from Frederick K. Sarfo and Jan Elen (2007) concluded that 4C/ID method combined with Information and Communication Technology (ICT) showed the best result in learning gains [68]. The dependent variable was the learning gain which was calculated by subtracting pretest score from posttest scores. The independent variable was the tree treatment conditions. Three groups compared were; regular method of teaching vs 4C/ID learning environment with ICT vs 4C/ID learning environment without ICT. The sample consisted of 129 students selected from six Secondary Technical School in Ghana with the age mean of 18 and Standard Deviation of 1.3 years. Assessment tasks consisted of 26 pretest and posttest items; 13 retention and 13 transfer test. Result revealed a statistically significant difference between student's pretest and posttest in all three groups. With average pretest across all groups being 6.28, the average posttest across all groups were 14.39. Taking a closer look into the data presented by Frederick K. Sarfo and Jan Elen (2007), study claim that 4C/ID learning environment with ICT scored higher in both pretest and posttest [69]. Researchers conclude that these results indicates that the experimental

65 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

66 Salisbury, D.F., Richards, B.F., & Klein, D. (1985). Designing practice: A review of prescriptions and recommendations from instructional design theories. Journal of InstructionalDevelopment, 8(4), 9- 19.

67 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.

68 Sarfo, F., & Elen, J. (2007). Developing technical expertise in secondary technical schools: The effect of 4C/ID learning environments. Learning Environ Res Learning Environments Research, 207-221. doi:10.1007/s10984-007-9031-2

69 Sarfo, F., & Elen, J. (2007). Developing technical expertise in secondary technical schools: The effect of 4C/ID learning environments. Learning Environ Res Learning Environments Research, 207-221. doi:10.1007/s10984-007-9031-2

group was better able to solve problems that required reasoning, reflection and recall of procedures, facts and concepts [70].

Using this Four Component Instructional Design in a classroom setting will help students learn better specially in a complex environment. In order to apply this model, teachers who are teaching the material should be an expert in the field. This will help answer all questions that students may have and helps children understand the course material deeper. Additional support from media or technology specialist may be required. Most importantly, in this model, it becomes essential for teachers-students, and student-student to work as a collaborative team.

17.2.6 Summary

Four Component Instructional Design model is based on research on cognitive learning and expertise. It provides a framework for designing technology systems for developing complex skills. According to the model, experiences should be realistic and increasingly more authentic tasks; such as projects, cases, and scenarios. Instructions given to the learner should focus on practice and not information giving [71]. These components will be practiced until one achieves the required level of automaticity, without any scaffolding. Once children accomplished all four components, it can be said the one mastered the knowledge or activities. Most importantly, the 4C/ID model does not propagate the idea of errorless learning [72]. The 4C/ID model should be used to develop training programs for complex skills and when transfer is the overarching learning outcome. This model is not developed for teaching conceptual knowledge or procedural skills, and not useful for designing very short programs [73]. Despite all these studies, further research continues on Four Component Instructional Design model.

17.3 Collaborative Learning

Learning collaboratively through pieces of technology systems

As technology is becoming more advanced so are its uses in which individuals can gain and share information. **Collaborative learning** which is sharing and learning knowledge through peers/groups has become a focal point for different interactions through technology systems. Social interactions are an important factor in cognitive growth. Student interactions with their peers and teacher are among the most important of these exchanges.[74]

70 Sarfo, F., & Elen, J. (2007). Developing technical expertise in secondary technical schools: The effect of 4C/ID learning environments. Learning Environ Res Learning Environments Research, 207-221. doi:10.1007/s10984-007-9031-2
71 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.
72 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
73 Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
74 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

However, a question that comes up is how can technology help or incorporate these types of interactions. Ways in which good technology design can help students is to note how our cognitive system works, these are things such as attention, working memory, and long term-memory as well as how complex cognitive skills develop. An example of this is the need for supportive and JIT (just-in-time) information, coaching, and scaffolding for effective learning strategies. A key thing to remember is that a good design system works with our cognitive systems. This section will be broken down into different models of technology designs and how collaborative learning may or may not be effective within these systems, The different models in which it will be broken down are learning through/from experts, learning with peers, learning through inquiry, learning through creation, and learning through games. Collaborative learning is seen as a great tool for teachers and students when it comes to education and information being taught or shared. It allows students to experience what it is like working with other peers. However, although it can be seen as a great system to have and incorporate in classrooms it does have some flaws and are still being fully developed to be used in the most effective ways for teachers and students. Teachers should not heavily rely on these types of technology systems but they can be useful and informative.

One of the first things to consider when discussing various systems of technology and their possible implications is how do people learn? It is often seen that many students have trouble with learning information because they are more focused on memorizing rather than understanding.[75] However, Nobel Laureate Herbert Simon said a great piece that "the meaning of 'knowing' has shifted from being able to remember and repeat information to being able to find and use it." In order for students to develop a better understanding in subject matter they must have a deep foundation for factual knowledge, understanding facts and ideas in the context of a conceptual framework and organize knowledge in ways that facilitate retrieval and application. What does this mean exactly in terms of knowledge? Having a deep foundation of factual knowledge, students are aware of the information that is true and relevant to what they are learning. Understanding facts and ideas in the context of a conceptual framework, meaning students understand the material in the context that it is placed in, and how it relates to that topic. Organize knowledge in ways that facilitate retrieval and application, is helping students take that knowledge that they have or are learning and being able to apply it to other areas or topics. These requirements do however have some difficulties when it comes to implementing them in class or within the curriculum. It becomes difficult for teachers because students come into the classroom with these preconceived notions about what they already know. As well as, teachers have a set amount of information they need to teach, it becomes difficult when they have to go into depth in every topic or re-teach certain areas multiple times. As students progress through their school careers many teachers believe they are taught certain material from the previous years, this is not always the case. Some students may feel like they are behind, or are too afraid to ask questions and ask for help. This is where the incorporation of technology systems may be able to help or at least ease the pressure off teachers and allow students to use them within the classroom or on their on time. Now these technology systems are not to take the place of the teacher but rather complement the teacher's lesson. It is not their job to be the foundation for learning but instead they can act as a review to help students

75 Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn. Washington DC: National Academy Press. (pp. 1-50)

with exams or projects. Teachers who rely too heavily on these technology systems may lose a lot of material and interaction that the students can only receive from a physical being. Believing that technology can take the place of teachers is not the proper way of looking at the systems that are being created, they should be viewed as more of a tool to help aid those who take advantage of using them.

To give a brief descriptions about what these systems are-

Learning from Experts: Cognitive Tutors & Telementoring

The first type of technology system is learning from experts, two examples of this are known as cognitive tutors and telementoring. **Cognitive tutors**, is "a type of intelligent tutor that supports 'guided learning by doing'" [76]. Cognitive tutors are based around John Anderson's ACT theory. This theory contains three main principles, the first one is procedural-declarative distinction, the second one is knowledge compilation, and the third one is strengthening through practice. [77] The main focus of cognitive tutors is to monitor students learning as well as provide them with context specific feedback when a student needs it. The primary focus for cognitive tutors are in the areas of mathematics and computer programming. This is able to help students get a better understanding of material while working at their own pace they can also work with others to solve and work through the problems together. One study that was done with cognitive tutors, was a study done by Kenneth R. Koedinger, called Intelligent Tutoring Goes To School in the Big City. In this study "The Pittsburgh Urban Mathematics Project (PUMP) [had] produced an algebra curriculum that is centrally focused on mathematical analysis of real world situations and the use of computational tools. We have built an intelligent tutor, called PAT, that supports this curriculum and has been made a regular part of 9th grade Algebra in 3 Pittsburgh schools. PAT was useful because it was able to help students who had difficulty learning in classrooms. In the 1994-95 school year, the PAT curriculum expanded to include 10 lessons and 214 problem situations. Students are in the computer lab two days a week, working with PAT at a self-paced rate. Student time on the tutor will more than double (roughly from 25 to 70 days) compared to the 93-94 school year." [78] Telementoring or better known as 'e-mentoring' or 'online-mentoring' [79] provides students with the opportunity to work with another individual with problems they may be having with course material. Mentoring interactions occur with problems that students are having and questions that they think of. A downfall to telementoring is that students do not get to work with the same adult over and over again. Although they are collaborating they do not get to build a connection with the mentor as some students do with teachers. They do not get the physical one on one interaction with a teacher and the connection is different in comparison to virtually speaking/learning from an individual. This can also be a pitfall with cognitive tutors and learning through any software is not building a relationship with a teacher or mentor and feeling as if there is a disconnect.

76 Bollen, L., Harrer, A., Mclaren, B. M., Seawall, J., & Walker, E. (1995) Collaboration and Cognitive Tutoring: Integration, Empirical Results, and Future Direction

77 Anderson, J., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned: Journal of the Learning Sciences, 4(2), 167-207.

78 Anderson, J. R., Hadley, W. H., Koedinger, K. R., & Mark, M. A. (1997).Intelligent tutoring goes to school in the big city. International Journal of Artificial Intelligence in Education (IJAIED), 8, 30-43.

79 Anderson, J. R., Hadley, W. H., Koedinger, K. R., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. International Journal of Artificial Intelligence in Education (IJAIED), 8, 30-43.

Learning with Peers: Knowledge Forum & Starburst

Knowledge forum is a collaboration platform for students to build upon ideas. It places emphasis on community rather than the individual. Knowledge forum is a place where students or individuals can create databases where knowledge is built, this is where collaboration is highly involved. The main components of knowledge forums are what are known as notes and views. [80] A view is a way to organize the notes made by individuals, this can take the shape of a concept map, a diagram, or anything that visually adds structure. the notes appear within these structures. This is also great because it involves the concept of visually learning as well because through the diagrams and maps students are able to connect ideas and see how the connections are made. This is a way for students to all work together on a topic and provide information on a database that can continuously grow. However, knowledge forums are not the only place students and individuals should get their knowledge experience. Learning material through books, and lectures, as well as going on field-trips allows individuals to get a better understanding and perspective. Knowledge forum is just a database where the topic is shaped and evolves. Similar to knowledge forum starburst also provides a place for students to collaborate with others in sharing ideas through a database. However starburst the ideas spread out like a web getting larger and larger. These two systems mainly focus on peer interactions and collaboration among individuals in order for knowledge to build and grow. A study that was shown using knowledge forums was done by Carol and Yuen Yan Chan. In their study, which is taken directly from their article written: "The sample includes 521 secondary school students in Forms One to Six (ages 12–17) from eight secondary schools in Hong Kong. These participants were involved in a research project on computer-supported knowledge building. The sample includes 322 male and 199 female students, with 216 from junior high (Grades 7–9, ages 12–14) and 305 from senior high schools (Grades 10–12, ages 15–17). Students in Hong Kong are streamed into different bands according to their academic achievements; there were 267 students from high-band schools and 254 students from low-band schools.This study took place in the context of a University-School Partnership project on developing knowledge-building pedagogy for elementary and secondary teachers in Hong Kong. The context of the project included university researchers/mentors providing professional development to teachers. There were regular workshops throughout the year to help teachers better understand knowledge-building epistemology and pedagogy; groups of project teachers meeting to plan their curricula collectively; and classroom visits with university researchers and teachers. Regarding knowledge building pedagogy, in a typical knowledge-building classroom, students usually start by identifying areas of inquiry and putting forth their ideas and questions, 'making ideas public' for collective improvement is emphasized [81]. In Asian classrooms, it is particularly important for students to experience working together as a community. In this project, classroom and online discourse were integrated, with students contributing notes to Knowledge Forum as they engaged in collaborative inquiry – posing questions, putting forth ideas and theories, building on others' ideas, and co-constructing explanations to advance their collective knowledge. Data were collected from two question-

80 Scardamalia, M., & Bereiter, C. (2006). Knowledge building: theory, pedagogy, and technology. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 97–119). New York: Cambridge University Press

81 Scardamalia, M., & Bereiter, C. (2006). Knowledge building: theory, pedagogy, and technology. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 97–119). New York: Cambridge University Press

naires examining students' views of collaboration and online learning, and their preferred approaches to learning. After examining the questionnaire data, we excluded items on online learning that showed variable responses, and focused on the questionnaire items on knowledge-building and approaches to learning. We also employed students' usage statistics on Knowledge Forum derived from Analytic Toolkit to examine their online forum participation.The questionnaire, comprising 12 items, written in Chinese, examined students' views of collaboration aligned with the notion of knowledge building [82]. Students were asked to use a 5-point Likert scale to rate the questionnaire items that reflected their experience of collaboration while working on knowledge building. In assessing these items, the students could refer to both face-to-face and online collaboration To measure students' online forum participation, Analytic Toolkit was used to retrieve and analyze summary statistics on individual students' activity in Knowledge Forum. Analytic Toolkit Version 4.6 provides up to 27 analyses to show how students interact with each other in the Knowledge Forum database. We selected several of the most frequently employed indices from previous studies, including those that have been grouped into overall indices with good construct validity with quality of forum writing (e.g., van Aalst & Chan, 2007; Lee et al., 2006; Niu & van Aalst, 2009). The indices are as follows: (i) Number of notes written: This is included because it is the most commonly used index for measuring online participation. (ii) Scaffolds: This index refers to the number of scaffolds (thinking prompts) used. Knowledge Forum includes scaffolds such as "I need to understand", "a better theory", and "putting our knowledge together". Scaffolds help students to frame ideas and to signpost their ideas to others for interaction and dialogue. (iii) Revision: Students' attempts to revise their notes are recorded. From a knowledge-building perspective, revision shows a deeper approach to working with ideas. Instead of employing a linear approach, ideas are revisited and revised based on the contributions of the community. (iv) Number of notes read: The number of notes read has been considered important for assessing community awareness; one cannot engage in dialogue without knowing what others have written (Zhang et al., 2009). (v) Number of build-on notes: This index is different from the number of posted notes, and refers to responses to previous notes. This index provides more information about interaction among participants. (vi) Keywords: Students can include "keywords" when they write notes on Knowledge Forum. Other participants can use these keywords to search for related notes on similar topics. The use of keywords reflects domain knowledge and community awareness as students try to make their work more accessible to other members." [83]

Learning through Inquiry: Anchored Instruction & WISE

The best example of anchored instruction is known as The Adventures of Jasper Woodbury Series. These series are complex video-based problems and it was created so that each of the Jasper adventures are focused on a complex math-oriented problem that needs to be solved. Because such math problems are very complex they are often too difficult to solve alone. While working together, students are able to come up with more than one right solution, and are needed to provide evidence as to why they think theirs is correct. This involves

82 Scardamalia, M., & Bereiter, C. (2006). Knowledge building: theory, pedagogy, and technology. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 97–119). New York: Cambridge University Press

83 Chan, C. Chan, Y. (2010). Students' views of collaboration and online participation in Knowledge Forum. Computers & Education, Vol 57(1), Aug, 2011. pp. 1445-1457

collaboration among the students to come up with various solutions to the problems given because there is not only one right answer. Another way students can work together to solve problems is through what is called WISE (Web-based Inquiry Science Environment). Students work together in a web-based environment and discuss problems to do with global warming or recycling. With WISE teachers are able to play a supportive role and monitor what the students are providing as solutions. "WISE provides evidence and hints about the topic; notes, visualization, discussion, and assessment tools; and prompts for collaboration, reflection, and design of solutions" [84] The big ideas with anchored instruction are that students are learning by constructing understanding as well as learning in context. There is generative learning that occurs as well and this is where sub-goals are created. The big ideas with a program such as wise are that learning is intentional and students are integrating prior knowledge when answering questions.

Learning through Creation: Scratch

An example of learning through creation is the program Scratch. It is a website that media and visuals is the main component. In scratch students are able to work individually or as a group to make visuals in a program for an online community. They are able to share these visuals with one another. With Scratch the students are in control and are able to think with the use of objects, as well as create something from their own imagination. They can encompass audio alongside their visual creations. Students work together in creating these pieces and can share them in the classroom as part of a project, or teachers can base it off a theme or topic they are learning. This helps students think creatively and work collaboratively. An example of how Scratch can be used by teachers in their lesson plan is imagine you are in your 8th grade history class and for your final project you have to choose a topic that you have learned about within the semester and create a visual representation of it. Whether the project be completed in groups or done individually. You work with other members and decide to use the program Scratch, you begin to create different characters such as wounded men, and soldiers etc. You and your group members discuss ideas and begin to create each idea piece by piece. Slowly the image your group had in their mind is creatively coming to life. You are now able to see the piece of history you learned in a visual picture and you can share it with your other classmates.

Learning through Games: Quest Atlantis

Another way students can work collaboratively is through games, one game in particular is Quest Atlantis. This provides different scenarios and realms for students to venture through as they come across problems and tasks they have to choose from and solve. It is an engaging game however it may not fit in classrooms but rather in the spare time of students. The context is best for providing **situated learning**; this is learning that takes place from social relationships and connecting prior knowledge to new contexts.

Collaborative learning through the use of computer programs is another great way to get students engaged with materials. It does have setbacks in the ways in which they can be used and incorporated into classrooms. Teachers may not have enough devices for students to use as well as students can become unfocused and begin to just play around with the programs. For the programs that provide hints when there is a problem occurring, students

84 Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.

can just continuously be getting hints without even trying. Although there a positive to these technology systems, one must take into considerations the negative implications as well. As mentioned none of these systems should be the primary bases of students learning, instead they should be a supplementary add on for students and teachers to use.

17.4 Glossary

Cognitive Load Theory: a theory proposed by John Sweller and focusses on working memory and instruction.

Cognitive tutors: A type of intelligent tutor that supports 'guided learning by doing'

Collaborative learning: sharing and learning knowledge through peers/groups

Expertise reversal effect: phase where supports and instructional methods have negative effects on individuals due to increase in cognitive load

Extraneous Cognitive Load is the way working memory is affected by the material is presented

Germane Cognitive Load: the amount of working memory devoted to processing the amount of intrinsic cognitive load associated with the information presented and is associated only with a learner's characteristics.

Intrinsic Cognitive Load: refers to the way in which information is presented.

Nonrecurrent skills: tasks that are effortful, error-prone, easily overloaded, and require focused attention; =schemata

Recurrent skills: correspond to procedures; they occur with little or no effort, are data-driven, and require little or no conscious attention

Situated learning: learning that takes place from social relationships and connecting prior knowledge to new contexts.

Task classes: principle of working from a simple to complex or meaningful task

17.5 Suggested Readings

- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). How people learn. Washington DC: National Academy Press. (pp. 1-50)
- Chan, C. Chan, Y. (2010). Students' views of collaboration and online participation in Knowledge Forum. Computers & Education, Vol 57(1), Aug, 2011. pp. 1445-1457
- Sarfo, F., & Elen, J. (2007). Developing technical expertise in secondary technical schools: The effect of 4C/ID learning environments. Learning Environ Res Learning Environments Research, 207-221. doi:10.1007/s10984-007-9031-2

17.6 References

- Anderson, J., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned: Journal of the Learning Sciences, 4(2), 167-207.
- Anderson, J. R., Hadley, W. H., Koedinger, K. R., & Mark, M. A. (1997). Intelligent tutoring goes to school in the big city. International Journal of Artificial Intelligence in Education (IJAIED), 8, 30-43.
- Barab, S. A., Dodge, T., & Ingram-Goble, A. (2008). Reflexive play spaces: A 21st century pedagogy. *Games, Learning, and Society, Cambridge Univeristy Press, Cambridge, MA.*
- Bruning, R. H., Schraw, G. J., & Norby, M. M. (2011). Cognitive psychology and instruction (5th ed.) Pearson.
- Bollen, L., Harrer, A., Mclaren, B. M., Seawall, J., & Walker, E. (1995) Collaboration and Cognitive Tutoring: Integration, Empirical Results, and Future Direction
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn.* Washington DC: National Academy Press. (pp. 1-50)
- Craig, S., Gholson, B., & Driscoll, D. (2002). Animated pedagogical agents in multimedia educational environments: Effects of agent properties, picture features and redundancy. Journal of Educational Psychology, 94(2), 428-434. doi:10.1037//0022-0663.94.2.428
- Chan, C. Chan, Y. (2010). Students' views of collaboration and online participation in Knowledge Forum. Computers & Education, Vol 57(1), Aug, 2011. pp. 1445-1457
- Kevin O'neil, D., & Harris, J. B. (2004). Bridging the perspectives and developmental needs of all participants in curriculum-based telementoring programs. *Journal of Research on Technology in Education, 37(2),* 111-128
- Mayer, R.E., Heiser, J., & Lonn, S. (2001). Cognitive constraints on multimedia learning: When presenting more material results in less understanding. *Journal of Educational Psychology 93*(1), 187-198.
- Merriënboer, J., Clark, R., & Croock, M. (2002). Blueprints for complex learning: The 4C/ID-model. ETR&D Educational Technology Research and Development, 50(2), 39-64.
- Sarfo, F., & Elen, J. (2007). Developing technical expertise in secondary technical schools: The effect of 4C/ID learning environments. Learning Environ Res Learning Environments Research, 207-221. doi:10.1007/s10984-007-9031-2
- Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In R. K. Sawyer (Ed).*The Cambridge handbook of the learning sciences* (pp97-118). New York: Cambridge University Press.
- Salisbury, D.F., Richards, B.F., & Klein, D. (1985). Designing practice: A review of prescriptions and recommendations from instructional design theories. Journal of InstructionalDevelopment, 8(4), 9- 19.
- Schnotz, W., & Rasch, T. (2005). Enabling, facilitating, and inhibiting effects of animations in multimedia learning: Why reduction of cognitive load can have negative results on learning. ETR&D Educational Technology Research and Development, 53(3), 47-58.
- Sweller, J. (2010). Element Interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review 22*(2), 123-138. doi: 10.1007//s10648-010-9128-5.
- Sweller, J., van Merrienboer, J., & Paas, F. (1998). Cognitive Architecture and Instructional Design. Educational Psychology Review, 10(3), 251-296. doi:1040-726X/98/0900-0251S15.00/0

- van Merrienboer, J., & Ayres, P. (2005). Research on cognitive load theory and its design implications for e-learning. *Educational Technology Research and Development 53*(3), 5-13.

17.7 Citations

18 Problem Solving, Critical Thinking and Argumentation

19 Learning Science and Conceptual Change

Figure 42 Science_vision

Unlike other academic areas, when it comes to learning science, children develop experience based preconceptions about the world and how it works before they even enter a classroom. These naive concepts can be useful in helping them develop in a complex world, but can ultimately result in incomplete or incorrect knowledge about the natural world. In order to correct and reshape these pre-developed conceptions about science, we must first identify where the misconceptions lie, then work with students to break them down and rebuild them using hands on experiences to foster a deeper understanding of the materials. This can be an intricate and delicate process that takes time in order for students to evolve their thinking and successfully accommodate and assimilate new information into their existing schemata.

In this chapter we discuss how these naive preconceptions tend to develop in young people, how they differ from expert thinking, and how to identify and confront such notions so that students may be able to develop their scientific and critical thinking skills, ultimately changing their conceptions. We discuss effective teaching methods and essential elements of science instruction, as well as addressing some unique challenges to teaching science at different educational levels.

19.1 The Development of Naive Scientific Preconceptions

Children are naturally curious, constantly exploring their surroundings and questioning the world around them, which helps them to develop an understanding of the natural world and becomes their reference set when encountering new things in their environment. These naive scientific concepts, developed from personal observation and experience, tend to become strongly held and often incorrect beliefs by the time they begin school, which can make them resistant to complex and sometimes counter-intuitive scientific theories and principles.

19.1.1 Naive preconceptions

The persistence of naïve conceptions about the natural world which students bring with them to the classroom has been one of the most outstanding developments in understanding science learning. From a young age, people develop scientific thinking or curiosity. Even before entering school, children are frequently used to observing and questioning their everyday life experiences. Thus, this results in both children and even a lot of adults having **naïve theories**, which are well-formed but scientifically incorrect thoughts about how the world operates. [1] There are several examples of **naïve beliefs** about science. Firstly, prior to any formal instruction, the resistance of people's naïve conceptions to change is particularly evident in their own theories of motion. If people are asked to describe the motion of force on a ball tossed into the air, they tend to illustrate that the motion of force starts by going upwards with the ball as it ascends, and down as the ball falls. However, it is a typically incorrect reply; the correct answer would be that the motion of force is consistently downward, though the ball gains height before falling. Another example of naïve misconception related to biology is that children possess false beliefs and incomplete knowledge about scientific information. [2] When children are asked whether certain things are plants, they incorrectly responded that carrots, oak trees and grass are not plants. Since many people have already formulated misconceptions about science before learning formally in a classroom setting, it may be difficult to change or re-conceptualize these beliefs.

Wu and Wu[3] explored the development of epistemological beliefs about the nature of science in children. They described three levels of epistemological beliefs about science: 1)

1 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

2 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

3 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

Individuals at the novice level tend to know little about science. They hold naive preconceptions about experiments in science, they don't understand the difference between hypotheses and theories, and tend to think mostly about the procedure of an experiment and getting 'good' results, rather than thinking about what the experiment is supposed to be testing and whether it is an accurate measure, etc. They also tend to have strong beliefs about science, in that it is definitive and unchanging. 2) Individuals in the intermediate level have developed a basic understanding of the concept of hypotheses, and that theories are well tested, supported hypotheses. They define experiments as testing a hypothesis, and understand that science is uncertain. 3) Individuals at the expert level see that scientific inquiry is guided by theories, and that theories are a general explanation of a phenomenon. They understand the difference between testing a theory and testing a hypothesis within a theory.[4] Students who have dynamic epistemological beliefs tend to be more active learners than students with static beliefs. These students will tend to form better understandings of scientific concepts, and will rise in level more quickly.[5]

Wu and Wu[6] also described two different types of epistemology: **Formal epistemology** refers to individuals' beliefs about professional science, and **practical epistemology** refers to individuals' ideas about scientific knowledge and how they construct this knowledge from personal experiences. Based on these concepts of epistemological beliefs, Wu and Wu asked how these beliefs developed in children, and how they affected the development of inquiry skills. They listed three key inquiry skills involved in formulating students' scientific explanations: 1) Being able to identify causal relationships between variables, 2) being able to describe their reasoning process, and 3) being able to interpret data to use as evidence.[7] The researchers conducted an exploratory study to determine whether students improved their inquiry skills after a series of inquiry-based activities, what their practical epistemologies were before and after completing the activities, and what interactions there were between inquiry skills and practical epistemologies.

Participants in the study were two classes of fifth grade students. 34 students were chosen per class, and of those 34, 18 were girls and 12 were boys.[8] Students were given ten learning activities covering various physics topics to be completed over a period of five weeks, or 15 class periods. Students learned about effects of force, developed experiments to test the relationship between force and spring length, collected and analyzed data, and presented their findings. Since the students had not experienced this kind of learning before, the teacher used various scaffolding techniques, such as asking guiding questions, performing demonstrations, and giving feedback during activities, in order to support the students' learning. Researchers recorded observational data, administered pre and post-tests on explanation skills, and conducted interviews with students at the end of the five week period. Results from the data analysis showed that using inquiry-based activities

4 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

5 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

6 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

7 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

8 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

could improve students' explanation skills and develop their inquiry skills, allow them to put together experiments, use data to support their claims, recognize experimental errors, and better understand scientific questions, but their epistemological views about science remained at a novice level. Wu and Wu[9] concluded by suggesting that following inquiry-based activities with reflective discussions could help to change epistemological beliefs, but further research on this topic would still be necessary to support this hypothesis.

19.1.2 The difference between novice and expert thinking

There are several perspectives which look at people with novice and expert levels of scientific knowledge. Compared to novices, experts have superior ability to solve scientific problems efficiently and quickly. Experts in the field of science acquire wide-ranging knowledge and strategies which influence what they notice and how they organize, understand and signify information from their environment. Since they are trained and exposed to numerous opportunities for problem solving, they are able to build a variety of pertinent problem-solving schemata. This allows them to solve science problems much faster than novices. [10] Experts have the ability to perceive meaningful patterns of information and to easily retrieve important aspects of their scientific knowledge more flexibly as compared to the novices. This great recall ability can be explained in terms of **chunking** information. For example, novices may not use chunking as much when dealing with physics principles whereas experts use chunking to demonstrate a particular set of equations which correspond to a specific problem they may be faced with. The chunking ability is enhanced when familiar patterns are organized and gathered together in certain meaningful categories. However, novices do not have such ability to process or organize their thoughts with more complex problems.

When looking at the understanding of scientific theories, there is a significant difference between novices and experts that allows them to be separated into three sub-groups; for instance, children, adults, and scientists. Identifying essential skills in scientific reasoning includes a prominent comprehension of the main point of the theory, a clear differentiation of supporting and rebutting evidences, the ability to reason why the data, graph or diagrams support the theory, theory building, and precise reflection on the theory building process. [11] A few problems arose when searching for the differences between the groups: 1) There was a lack of domain-specific knowledge among the adult experts and 2) Children felt frustrated if they were not able to fully interpret the theories including the structures as well as the messages, and decipher how they could apply the theories.

19.2 Identifying and Changing Naive Beliefs

Teaching scientific concepts to children is more complex than simply teaching terms and facts. It is common for children to acquire a superficial understanding of scientific concepts

9 Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.

10 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

11 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

that enables them to recall relevant terms and even the gist of concepts presented to them. Unless they fully process the contradictions the new concepts may hold for their prior beliefs, their misconceptions will not change and their understanding of science will remain shallow. To insure that children fully learn scientific concepts, we must address any misconceptions that may block their comprehension.

19.2.1 Identify students' naive preconceptions

People's false beliefs about science will naturally be revealed as time passes and as they learn. However, one must be very cautious not to directly point out and disclose people's misconceptions. In order to be successful and not to hurt others' feeling, but to guide them in the right direction, teachers should prepare experience-based instruction which includes activities that will inspire the learners to change their preconceptions. It is important to expose students to more encouraging and dynamic activities. The major role of teachers is to assist students in expressing their thoughts and ideas about how they think and why they think that way. As a class, students will be able to exchange their own thoughts and compare others' with theirs; this process allows students to justify their own thoughts and to see other peoples' perspectives. Then teachers can clarify and explain their conceptions by providing adequate explanation.

19.2.2 Create conceptual conflict

Once an individual's preconceptions have been brought to their attention, they must be challenged in order to create cognitive disequilibrium within the individual, motivating them to assess and reconsider their beliefs on the subject. The way instructors can do this is by offering multiple views (perhaps those of several different students in the class), then asking probing questions about which explanation seems to be the most reasonable and getting the students to think about each scenario, rather than telling them which one is correct.[12] This form of questioning will help to stimulate discussion amongst students. Allowing time for students to discuss with each other is also important, as it exposes them to other students opinions and viewpoints.[13] The teacher can then suggest the need for a hands-on activity, such as an experiment, in order to test the validity of the various proposed hypotheses. Running experiments can help students to learn critical thinking skills such as the importance of gathering data to back their statements and making decisions on what information is relevant. In order for an experiment or demonstration to be successful in creating conceptual conflict, however, it must eliminate all possible explanations for the outcome, except the correct scientific explanation.[14] If this is done correctly, then students can begin reassessing their own preconceptions and altering their beliefs in order to accommodate the new information.

12 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

13 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

14 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

This process is demonstrated in a study done by Shtulman and Calabi on the effects of instruction on essentialist theories of evolution.[15] There are common misconceptions about evolution, even among people with post-secondary education. Ideas such as, individuals are born better adapted to their environment than their parents, that traits are developed over one's lifetime and then passed on to one's offspring, or that animals are more likely to survive and adapt than to die and become extinct, are quite prevalent, even among science students.[16] These types of misconceptions have been documented in the most novice individuals (i.e. children) and the most expert individuals (i.e. educational professionals) alike. The fact that these misconceptions are so generalized indicates a bias referred to as essentialism. **Essentialism** is the belief that every observable trait is due to some unobservable variable at its core, also referred to as an 'essence'.[17] This 'essence' is passed down from parent to offspring. What makes something what it is, is not a series of traits it has in common with other members of its species, but the 'essence' it inherited from its parents. This essentialist way of thinking is not only common across varying levels of knowledge, but across cultures as well.[18]

Two major paradigms that are used to test childrens' understanding of evolutionary concepts are the unknown-property paradigm and the switched-at-birth paradigm.[19] The unknown-property paradigm introduces a novel property of a familiar organism (ex: a cat [familiar organism] can see in the dark [novel property]). Then novel organisms, which may or may not possess the novel property, are introduced (ex: a cat that looks like a skunk and a skunk that looks like a cat). When tested on preschool-aged children, most tended to associate the novel property with the skunk-like cat, but not with the cat-like skunk.[20]

15 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
16 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
17 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
18 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
19 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
20 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.

Figure 43 Meyers_b13_s0595c

The switched-at-birth paradigm gives a scenario, for example, that a calf is taken from its birth parents and raised, instead, by a family of pigs. It then asks whether the calf will grow up to possess similar properties to its birth parents (i.e. straight tail, eats grass), or to its foster parents (i.e. curly tail, eats slop). Children tend to reply with the former, that it will develop like a cow, because it is a cow, not a pig.[21] This essentialist reasoning can be useful for basic details, like what an organism should look like, how it reproduces, where it prefers to live, etc., but it falls short when applied to more complex processes like evolution and natural selection. Essentialists tend to focus on differences between species, but what is most important in evolution is the differences among individuals within a species.

Shtulman and Calabi[22] took an interest in this phenomenon and conducted an test-retest study using college undergraduates in order to determine whether instruction in evolution could change students' essentialist preconceptions about evolution. Each participant was required to fill out a questionnaire before and after taking a course on evolution. The questionnaire tested six sections of the subject: variation, inheritance, adaptation, domesti-

21 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.

22 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.

cation, speciation, and extinction.[23] By comparing pre and post-test scores and calculating the difference between the two, researchers divided the students into either 'learner' or 'non-learner' categories. Those that improved significantly (learners) were shown to have significantly more preinstructional misconceptions than the non-learners. This would imply that having more misconceptions when going into a course may facilitate learning, possibly because students run into these misconceptions quite frequently throughout the course, and are thus confronted with conflicting information more often. Having to resolve these conflicts so frequently can lead to greater conceptual change, than if one rarely encountered these informational conflicts.[24]

19.2.3 Promote reassessment of preconceptions

Once students begin to question the validity of their current beliefs, it is important for the teacher to assist them in changing those beliefs by providing further information and answering questions in order to help them change their perception of the topic or event.[25] Success at this stage would result in the students changing their conceptions about a scientific event and would help promote better acquisition of scientific knowledge.

19.3 Teaching Science Effectively

In order to teach any subject effectively, one must engage with the students and support them throughout the learning process. This is especially true in science. By making them question themselves and their preconceptions, they become more deeply engaged with the materials, and develop a better understanding of the concepts and, as a result, gain a deeper sense of achievement than if they were to simply read the texts and recite the facts.

19.3.1 Inquiry-based teaching vs. Lecture style classrooms

Quite often classes are taught in a lecture style which tends to promote more of a fact-based or memorization style of learning. This can be a problem for science, in particular, because of students', often strongly developed, naive scientific preconceptions. In order to help reveal these misconceptions to both the teacher and the student, a more dynamic inquiry-based teaching approach is recommended.

Bruning, Schraw and Norby [26] describe **inquiry-based teaching** as teachers supporting active learners. In an inquiry-based classroom environment the student takes the lead by performing hands-on activities that the teacher has set up, asking questions and forming hypotheses about the tasks, collaborating with other students and comparing ideas, and

23 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.

24 Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.

25 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

26 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson

testing and reforming their hypotheses if results are contradictory to their predictions. Teachers are there to assist in their students' learning, rather than being the driving force. This allows students to voice their beliefs and to test them. If these beliefs are proven to be dysfunctional, then they may be driven to find an explanation that better supports their observations [27].

If students are simply given facts and information and tested on those facts, then none of their misconceptions are being identified or addressed, and they will continue to hold these misconceptions even if the facts they are memorizing for the exam contradict them. This may be because the facts alone aren't enough to show them why their beliefs are incorrect. If they don't fully understand why something is the way it is, though they may see an inconsistency between the information they were given and the beliefs they currently hold, this may not be enough for them to adopt a new belief. In order to change a child's beliefs, we must present them with information that is intelligible (can be understood by the student), plausible and believable (as sited in [28]). This means that the information must give a better explanation of a phenomenon than their current conception.

19.3.2 Providing strategies for deeper understanding of materials

Optimal strategies for dispelling misconceptions need to address two important functions in a student's learning process; assimilation and accommodation of information [29]. **Assimilation** is when a student uses existing **schemas** (mental representations of information or experiences) to help make sense of new information, and **accommodation** is when students replace or alter existing schemas in order to be consistent with new information.

Longfield [30] discusses discrepant teaching events as strategies to help identify students' misconceptions and cause **cognitive disequilibrium** (conflict of existing schemas and new information being presented), which would lead to the assimilation and accommodation of new information. A **discrepant teaching event** is an event that produces an unexpected outcome, and that forces students to become aware of dysfunctional beliefs that may need to be changed. These discrepant events can be used in almost any classroom, but for science, in particular, it can be a very effective strategy.

19.3.3 Reassessment and development of teaching strategies

Inquiry-based teaching and the use of discrepant teaching events can be very difficult to master, and it can take time to make a curriculum which takes full advantage of these techniques, but it is possible to improve student learning by incorporating these elements

27 Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.
28 Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.
29 Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.
30 Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.

as much as possible, and by scaffolding students in their development throughout the class [31]. It is, therefore, essential to continue to assess and reassess one's teaching strategies in order to insure that students are getting the most help possible, and that all individuals are taken into account. By being more aware of the students' needs, one can also develop an environment where students can feel safe and secure enough to ask questions and to express their own ideas and opinions.

19.3.4 Effective instruction improves science achievement

There are many factors that contribute to a student's level of science achievement, but some of the most important extrinsic factors are instructional time and quality [32]. Studies have shown that level of achievement is strongly correlated to the amount of instruction in a subject that a student has received and the amount to which they understood the information being presented. This is further reason to invest more time in building a comprehensive curriculum that helps to foster a child's curiosity and helps to scaffold them so that they may better understand the materials given.

19.4 Assessing and Monitoring Students' Level of Science Understanding

As important as it is to teach science to young people, it is just as important to assess how well they are understanding the materials. A better understanding of science can help them not only in school, but in everyday life. A large part of learning should be review of past materials in order to practice and maintain information in long-term memory. By incorporating practice and repetition of new materials, and checking students' knowledge on a regular basis, you help them to retain more information for a longer period of time, as well as hopefully encouraging them to study and practice on their own.

19.5 Essential Elements of Science Instruction

Because of the nature of science and complexity of many of the concepts, it is not something that can easily be taught simply from a text. There are several essential elements that need to be present in the curriculum in order to optimize students' learning, understanding and appreciation for science.

Design process VS Design patterns[33]

Design process is meant for developing students' ideas by adding new ideas, elaborating on current ideas, and organizing ideas into more coherent explanations. Its purpose in

31 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson
32 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson
33 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

knowledge integration is to: elicite ideas, introduce new ideas, evaluate, and synthesizing those ideas. Design patterns play an important role in students' learning of science. They include assuming predictions, conducting experiments, gathering evidence, and reflection.

Teach science as a problem-solving process[34]

The most beneficial and effective skill in problem-solving is inquiry-based approaches to science teaching, since problem-solving strategies require cognitive perspectives rather than knowledge acquisition processes in science.

Use hands-on demonstration[35]

Experiments and/or demonstrations are a good way of challenging students' preconceptions. Thus, it is important for teachers to thoughtfully choose the topic, stay focused and guide the learners through, in order to adopt correct scientific views. In order to assist students to be involved in science class, hands-on activities, which help them engage in self-questioning, should be used. These activities will advance students' maturity and improve their view of science.

Teach the nature of scientific theories[36]

As students go up in grades, they require more advanced understanding of scientific inquiry and ability to think critically. Students, therefore, have to learn how to interpret scientific theories, how they differ from hypotheses and how they are both coordinated. To secondary school students, scientific theories might be boring or difficult to deeply understand. Yet if teachers provide enough time to process the learned materials, students will be able to handle other advanced materials much more easily and proficiently.

Give enough time to restructure knowledge[37]

Not only in science, but in other subjects as well, teachers need to provide students with sufficient time to do their work in class as well as allow them to process the knowledge mentally. To change or modify one's beliefs or knowledge that one has carried for such a long time requires sufficient processing time.Conceptual change in science, especially, is not a short-term, but a long-term process. Students need to be exposed to many kind of science-based views of the world in order to have their own thoughts challenged to the point that they need to reconcile the conflict between their own beliefs and the concepts that have been presented to them. Teachers should not expect rapid change in their students' thinking since it might discourage students from deeper processing of meanings. One of the best methods for changing and developing students' knowledge is to repeatedly provide students with complex problem sets. This lets them discover new strategies on how to problem-solve, and to learn which strategies they have to apply to certain questions. Also, rather than covering many different topics, it is better to cover small sections of topics in

34 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

35 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

36 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

37 (Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).Cognitive psychology and instruction (5th ed.). Boston, MA: Pearson)

greater detail. Doing so may help students to develop a better understanding of scientific concepts and principles.

19.6 Unique Challenges In Teaching Science at Different Stages

Though there are a lot of common issues in teaching science, regardless of age and experience level, there are some unique challenges to teaching individuals at different stages in life and education. These challenges need to be taken into account when running a class in order to support students in every learning stage.

19.6.1 Elementary level

There are some difficulties in teaching young children in elementary school not only science, but most subjects. One of the causes for these challenges might have to do with the learner's motivation in relation to one's specific goals. Because elementary school students are younger, they will not be focusing on desired outcomes such as knowledge attained, grades, etc. in subjects, as older students might. Hence, teachers have to make sure to encourage them, using inquiry-based instruction, and to assist student learning by simplifying and imparting their professional knowledge. One study shows that there is evidence that elementary science achievement considerably increases when the teachers instruct using inquiry-based teaching methods. Therefore, teachers have to consider how to instruct their young children in more efficient ways.

As for the significance on inquiry teaching in science education, there are some difficulties that the teachers encounter in their classes. For instance, there is a study which examines pre-service elementary teachers, and how they manage the difficulties within their lessons. About 16 seniors (fourth-year students) in an elementary teacher education program are studied based on the teacher's inquiry lesson preparation, practice, and reflections of pre-service elementary teachers. Quantitative data such as discussion, observation of classroom teaching, and reflective writing is collected as for the data. The result has found that there are difficulties on the lesson that are missing some elements: encouraging students to have own ideas and curiosity, assisting them in valid experiments for appropriate hypothesis, scaffolding their data interpretation and discussion. These difficulties affect teachers' task such as tension between guided and open inquiry, incorrect comprehension of hypothesis and lack of self-confidence in science knowledge. Thus, this emphasizes the importance of teacher's job to understand students and their actions. [38]

People might be curious as to whether gender plays a significant role in performance on certain subjects. One study investigated whether girls would perform better than boys at an elementary school level depending on the methods of science instruction. However, the

38 Yoon, H.G., Joung, Y. J. & Kim, M. (2011) The Challenges of Science Inquiry Teaching for Pre-Service Teachers in Elementary Classrooms: Difficulties on and under the Scene. Research in Science Education, 42(3), 1-20 DOI 10.1007/s11165-011-9212-y0.

study concludes that there is no correlation between accomplishment and gender in relation to method of science instruction. [39]

19.6.2 Secondary level

These days, as school education has conformed to a new structure of teaching/learning requirements, it requires teachers and students to define new learning goals, and to take an innovative direction in instruction so that students can deal with any challenges after they graduate. Some studies demonstrated that students' poor marks for certain subjects were not actually caused by the subject's difficulty, by their study techniques, or by how they processed learned information, but by struggles students may have had in adopting teachers' teaching methods. Traditional methods of science teaching included didactic principles which related to the theoretical-action system and gave guidance to students' education for the long term. Teaching science to a new generation, however, would need to integrate technologies into a lesson plan. Of all the new orientations in educational practices, the "active-participative methods and techniques" are highlighted as new and effective methods of teaching. It provides development of students' critical thinking by stimulating one's capacity to discover, analyze, and build conceptual maps in their mind. Examples of this would be brain-writing, jigsaw, etc. Promoting an interactive learning environment, cooperational strategies when assessing learning material, and applying students' own information processing, will be an important area to think about. Considering both traditional and new teaching strategies, it is important to apply advantageous points from each side. Therefore, educators now have the significant task of formulating new pedagogical systems which harmoniously combine both traditional and new teaching strategies.

Between science teacher's instruction-based didactic methods, and active-participative and interactive didactic methods, students have shown significant difference in the efficiency of learning, especially in Physics. 148 students from two grade 6 classes and two grade 9 classes were randomly selected from the secondary school in Bucharest. Three experimental classes, which included the active-participative methods, and three controlled classes, which held didactic activities, were given written assessments such as written assignments, pretests and post-tests. From the collected data, it is noticed that pretest results showed no significant difference. However, post-test results did show a significant differences between the groups. Thus, the result reflected that the active-participative and interactive didactic teaching methods were effective when teaching science to students. [40]

Not only do the methods and strategies that the teachers use matter, but other factors matter, too. Also, the other important role for teachers is to know the students' physical, psychological and individual characteristics. This will help teachers when applying certain strategies to students, since a strategy reaches its maximum efficiency, and benefits learners most, when it's been applied to the best learning situation possible, where students are fully involved. When teachers use these methods, it is more likely for students to manage and achieve individual learning tasks and increase their motivation. Overall, secondary

39 Kensinger, S. H. (2013). Impact of instructional approaches to teaching elementary science on student achievement. Dissertation Abstracts International Section A, 73.

40 Dinescu, L., Dinica, M. & Miron, C. (2010). Active strategies - option and necessity for teaching science in secondary and high school education. Procedia - Social and Behavioral Sciences, 2(2), 3724–3730.

level years are when students' scientific thinking skills are formed and their critical analysis skills are developed. Thus, educators have to understand students' situations and their individual differences in order to come up with more meaningful ways of administering science education and applying adequate teaching strategies.

19.6.3 Post-Secondary or University level

Of all the different education levels, post-secondary students are most likely to be involved in classes which use technologies such as the Internet. The vast majority of post-secondary students frequently use the Internet to communicate and access websites. Despite the fact that students are familiar with the Internet, there are some issues raised planning and teaching a curriculum. The challenges include how well teachers are able to use the internet and how to effectively incorporate internet use into the class. [41] In order to consider how to improve one's teaching using technology, the instructors first need to carefully choose an appropriate range of websites. Then they need to introduce and explain what the procedures are, engage students in various activities which are inquiry-led, assign them into groups if necessary and ask them to investigate scientific questions. Most likely, demonstrating these processes will be a faster and more efficient way of giving guidance to students so that they can visualize in their minds and draw out what they should do. However, a more important challenge is to transfer these thoughts listed above into practical performance. Real life performance does not always proceed in the same direction as the thoughts envisioned in our minds, but in fact often conflicts and goes unexpected directions; thus, instructors must always keep in mind that their roles need to be well defined and their curricula need to be planned as well as possible.

Some key issues of where teachers need to develop their practical pedagogical skills are as follows: 1) a narrow range of criteria for selecting appropriate websites, 2) give thought on how students should be grouped in the Internet lessons, 3) students' plagiarisms, 4) more variety of ways to use Internet in science teaching, 5) limited consideration about the role of the teacher, 6) science objectives of the chapter being vanished when using Internet, 7) geographical setting of classroom. [42] As teachers, it is essential to have backup plans to secure all science lessons. Teachers have to keep in mind that they must keep students on task, give clear instructions, make the lesson student centered, check availability of resources, use plenaries to reinforce learning and implement various kinds of activities rather than just using the Internet. These innovative deployments of Internet technology in instruction demonstrate the effects of the Internet and information technology in various contexts in higher education. However, it provides some challenges for teachers when planning science lessons as well as teaching in classrooms. Such challenges and difficulties may be decreased in relation to how much effort the teachers puts in and how they try to guide their students.

41 Childs, A., Sorensen, P., & Twidle, J. (2011). Using the Internet in science teaching? Issues and challenges for initial teacher education. Technology, Pedagogy And Education, 20(2), 143-160. doi:10.1080/1475939X.2011.588413

42 Childs, A., Sorensen, P., & Twidle, J. (2011). Using the Internet in science teaching? Issues and challenges for initial teacher education. Technology, Pedagogy And Education, 20(2), 143-160. doi:10.1080/1475939X.2011.588413

19.7 Suggested readings

Childs, A., Sorensen, P., & Twidle, J. (2011). Using the Internet in science teaching? Issues and challenges for initial teacher education. Technology, Pedagogy And Education, 20(2), 143-160. doi:10.1080/1475939X.2011.588413

Dinescu, L., Dinica, M. & Miron, C. (2010). Active strategies - option and necessity for teaching science in secondary and high school education. Procedia - Social and Behavioral Sciences, 2(2), 3724–3730.

Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.

Yoon, H.G., Joung, Y. J. & Kim, M. (2011) The Challenges of Science Inquiry Teaching for Pre-Service Teachers in Elementary Classrooms: Difficulties on and under the Scene. Research in Science Education, 42(3), 1-20. DOI 10.1007/s11165-011-9212-y0.

19.8 Glossary

Accommodation: Replacing or altering existing schemas with new information.

Assimilation: The use of existing schemas to help interpret new information.

Chunking: Utilizing a letter, number, or word which may contribute to short-term memory capacity.

Cognitive disequilibrium: Conflict between existing schemas and new information being presented.

Discrepant teaching event: An event in which an unexpected outcome occurs. Used to bring to light dysfunctional student beliefs and to insight change.

Essentialism: The belief that every observable trait is due to some unobservable variable at its core, also referred to as an 'essence'.

Formal epistemology: Individuals' beliefs about professional science.

Inquiry-based teaching: Student is seen as the active learner with teacher taking a supportive role.

Naïve beliefs: Inaccurate beliefs about a phenomenon, acquired through uncontrolled observation.

Naïve theories: Incorrect conceptual frameworks for understanding a domain and important processes within that domain.

Practical epistemology: Individuals' ideas about scientific knowledge and how they construct this knowledge from personal experiences.

Schemas: Mental representations of information or experiences.

19.9 References

- Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011).*Cognitive psychology and instruction* (5th ed.). Boston, MA: Pearson
- Childs, A., Sorensen, P., & Twidle, J. (2011). Using the Internet in science teaching? Issues and challenges for initial teacher education. Technology, Pedagogy and Education, 20(2), 143-160. doi: 10.1080/1475939X.2011.588413
- Dinescu, L., Dinica, M. & Miron, C. (2010). Active strategies - option and necessity for teaching science in secondary and high school education. Procedia - Social and Behavioral Sciences, 2(2), 3724–3730. doi: 10.1016/j.sbspro.2010.03.579
- Kensinger, S. H. (2013). Impact of instructional approaches to teaching elementary science on student achievement. Dissertation Abstracts International Section A, 73.
- Longfield, J. (2009). Discrepant Teaching Events: Using an Inquiry Stance to Address Students' Misconceptions. International Journal Of Teaching And Learning In Higher Education, 21(2), 266-271.
- Shtulman, A., & Calabi, P. (2013). Tuition vs. Intuition: Effects of Instruction on Naive Theories of Evolution. Merrill-Palmer Quarterly, 59(2), 141-167.
- Wu, H., & Wu, C. (2011). Exploring the Development of Fifth Graders' Practical Epistemologies and Explanation Skills in Inquiry-Based Learning Classrooms. Research In Science Education, 41(3), 319-340.
- Yoon, H.G., Joung, Y. J. & Kim, M. (2011). The Challenges of Science Inquiry Teaching for Pre-Service Teachers in Elementary Classrooms: Difficulties on and under the Scene. Research in Science Education, 42(3), 1-20. doi: 10.1007/s11165-011-9212-y
- Science_vision image retrieved from Wikimedia commons, scientific pictures and images
- Meyers_b13_s0595c image retrieved from Wikimedia commons, zoological illustrations

20 Learning to Read

Reading is a crucial skill as it helps us learn in all academic subjects and is so important for success outside the classroom. Learning to read is a complex, multi-year process of learning to recognize the sounds and meanings of symbols and written words. Reading ability is an important achievement for children because it is their entry point into the world of literacy and learning upon which much of life depends.

Figure 44 Learning to read is a long process. Many children start reading books with simpler words and colourful pictures before progressing to more difficult books.

This chapter covers several aspects of learning to read, beginning with the cognitive factors of reading including memory and attention. Different types of reading difficulties and disabilities are reviewed, with some implications for teaching. As each child is different, there is no single method that can be used to teach all children with reading difficulties or disabilities. The chapter discusses the three stages of reading, moving from children who do not know how to read or recognize any words all the way to children who have the ability to connect letters and their sounds in order to decode unfamiliar words. Reading instruction today tends to combine and adapt methods derived from different theories to address the needs of individual learners. Finally, we discuss several ways of effectively assessing reading progress.

20.1 Cognitive Factors of Reading

Success in reading depends on using the cognitive abilities of working and long-term memory, and also focusing attention in order to make meaning of the text. In addition, the reader must have some knowledge about the world around them in order to comprehend the information.

20.1.1 Memory

Working and long-term memory are cognitive factors that have to do with children's success in learning to read. Reading is an act of memory because it depends on world and linguistic knowledge [1]. When a child is learning a word they have to keep that word in their mind long enough to build up the more complex meaning of phrases, sentences, and whole passages [2]. The temporary storage of material that a child has read depends on working memory [3]. The working memory is different from the other forms of memory due to the fact that it reflects both processing and storage [4]. Working memory is often studied when learning about children's reading development, and Baddeley's model is often used to describe the relation between working memory and reading development [5]. This model involves two basic aspects: the phonological loop and the visual sketchpad [6]. The processing of phonological information has an inner rehearsal aspect, called the articulatory loop, which allows the phonological information needed for word decoding and reading comprehension to be retained longer in memory [7]. When children are not able to, or have problems decoding words, it is then associated with difficulties in phonological awareness [8]. Children with these difficulties are unable to understand or have access to the sound structure of spoken

1 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

2 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

3 Swanson, H. L., & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition and reading comprehension in learning disabled readers: Does the executive system have a role? Intelligence, 28(1), 1-30. doi:10.1016/S0160-2896(99)00025-2

4 Swanson, H. L., & Ashbaker, M. H. (2000). Working memory, short-term memory, speech rate, word recognition and reading comprehension in learning disabled readers: Does the executive system have a role? Intelligence, 28(1), 1-30. doi:10.1016/S0160-2896(99)00025-2

5 Verhoevan, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. Reading and Writing, 24(4), 387-394. doi:10.1007/s11145-010-9232-4

6 Verhoevan, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. Reading and Writing, 24(4), 387-394. doi:10.1007/s11145-010-9232-4

7 Verhoevan, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. Reading and Writing, 24(4), 387-394. doi:10.1007/s11145-010-9232-4

8 Verhoevan, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. Reading and Writing, 24(4), 387-394. doi:10.1007/s11145-010-9232-4

language [9]. When children are young their working memory capacity is restricted due to the fact that they lack the well-developed skills needed for encoding and rehearsal [10]. In order to make reading meaningful both working and long term memory are needed [11]. Thus, when children learn new information, the information must be kept fresh in their working memory while they retrieve previously learned information from their long-term memory [12]. In order for children to become great readers, they must decode words at a reasonable speed so they don't have to hold the meaning of the words in their memory for too long when figuring out the meaning of a sentence or paragraph [13]. When poor readers are unable to decode words at a reasonable speed they are required to spend extra time trying to decode, resulting in further stress on their ability to comprehend the text. [14].

20.1.2 Attention

When it comes to attention and reading, there is no doubt that attention is crucial to the understanding and overall comprehension of the text being read. Without attention, one cannot read. Teaching young students to read can often be challenging, as some don't have the ability to sit still for prolonged periods of time, or simply are not interested in the material they are supposed to be reading.

In order for a child to read, they must have a book open in front of them, they must be oriented towards the text.[15] Even getting some children to this point can be a great accomplishment, as some children simply do not have the attention span or capacity to focus on tasks such as this for so long.

In addition to having children pay attention to the actual book in front of them, it is necessary for them to make connections while they are reading in order for them to see how smaller pieces of the reading process relate to larger ones. A great deal of attention is needed for this as well, as there are often several instances in which a student can overlook a small point that will play a bigger part in their learning later on. Though older readers do not need to focus a lot of energy on the reading process, young readers must do so, simply because they haven't learned or practiced the process as much. Things such as eye movements and moving their eyes from left to right are included in this type of attention

9 Verhoevan, L., Reitsma, P., & Siegel, L. S. (2011). Cognitive and linguistic factors in reading acquisition. Reading and Writing, 24(4), 387-394. doi:10.1007/s11145-010-9232-4

10 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

11 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

12 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

13 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

14 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

15 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson

that is needed.[16] Attention must also move systematically from word to word as they read, as well as making sure the words being read can be connected to the overall message of the text. In addition, attention needs to be shifted from images or illustrations to the text, and back again in order for all elements of the story to make sense.[17]

20.2 Reading Disabilities

As much as reading requires the child's ability to comprehend letters and words and draw on prior knowledge, the child must be taught these skills. However, some students will find difficulties in the learning process, which can in some cases be attributed to learning disabilities. There are several ways to effectively teach students the necessary means to developing literacy while working with any struggles they may be having.

20.2.1 Diagnosing Reading Difficulties

When it comes to disabilities, learning how to read can be a struggle for both teachers and students. A disability in learners can hinder the learning process, meaning teachers and instructors often have to adapt their teaching style to help the student grasp the information. Though the word "disability" can be viewed as a general term to mean a number of different things, each disability is different, and each can effect reading in a different way.

Oftentimes, the most difficult part of determining why a student is having troubles reading lies in diagnosing what the trouble is. In terms of diagnosis, there are three principles used to guide the process. First, an analysis must make a specific as possible diagnosis of the student's reading habits to discover which parts are not functioning properly. Second, the analysis has to be based upon any available and relevant facts. Last, a sense of open-mindedness must be maintained when looking over any data. [18] Though open-mindedness may not seem important in the scientific realm of things, it does make an impact on the diagnosis process, as the point of discovering a reading disability is not to prove or disprove a theory or method, but to find exactly what is troubling the student. In addition, it might be found that a student doesn't fall into the category of one specific learning disability, but perhaps show signs of struggling in more than one aspect. This is a case where open-mindedness plays a large part in the diagnosis and evaluation stages. Part of this is because though a child does have a reading disability, it doesn't necessarily need to fit a specific model or formula for what is considered a disability and what isn't.

Principles of diagnosis aside, there are six general steps in the diagnosis process:

16 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

17 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

18 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012

1. ”Measuring the reading achievement of the class or school” - Reading tests are administered to students to gauge the level of reading in each class, and deficiencies in scores can be seen.[19]

2. ”Selecting the major reading problems for each grade” - Test scores are analyzed and the greatest problem for each grade is determined, and any student below the average needs attention and support.[20]

3. ”Selecting pupils deficient in reading” - Students below the average are given attention.[21]

4. ”Obtaining additional information about the pupils selected for individual diagnosis” - Information about the student’s health, general intelligence and attitude are taken into account. Oftentimes factors such as these can have a large impact on the general leaning abilities of the student. Other factors such as perceptual span, the number and regularity of fixations, dyslexia, vocalization, and breathing habits should also be taken into account.[22]

5. ”Determining the types of reading deficiencies” and 6. ”Determining the causes of the defects in reading” can be grouped into one larger step, as the four preceding steps will help determine how and why the student is having difficulties learning.[23]

Though these steps can be used as guidelines in determining what a student may be having difficulties with, each case is unique and can be approached in other manners that may apply to that specific instance.

In diagnosing dyslexia, there are five tasks that help to determine if a child is in fact dyslexic or not: oral word and pseudoword reading, oral text reading, oral pseudoword text reading, oral word list reading, and spelling words and pseudowords.[24] In doing these tests, four types of reading speeds and four levels of reading and spelling accuracy are taken into account. If a child lands in the bottom 10th percentile of the scores

19 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012
20 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012
21 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012
22 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012
23 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012
24 Eklund, K. M., Torppa, M., & Lyytinen, H. (2013). Predicting reading disability: Early cognitive risk and protective factors. Dyslexia: An International Journal Of Research And Practice, 19(1), 1-10. doi:10.1002/dys.1447

for each tested task, it is found that they have deficient skills in that area of reading and comprehension. To be completely diagnosed with dyslexia, the child must score in the bottom 10th percentile in a minimum of three of the four accuracy tests, or in three of the four fluency tests, or in two of the accuracy tests and two of the fluency tests.[25]

In the past, learning disabilities were assessed through IQ tests and achievement scores on reading tests. If their IQ was found to be average but showed a low reading achievement score, the child was diagnosed as having a learning disability.[26] Known as the discrepancy model based procedure, this process of diagnosis was used in many schools, placing students in classrooms that could provide them with the assistance they need.

Today, the Component Model of Reading is used more often to help understand and diagnose reading and learning disabilities. There are three domains of the Component Model of Reading (CMR): cognitive, which includes the two components of word recognition and comprehension, psychological, which includes the components of motivation and interest, locus of control, learning styles and gender differences, and ecological, which includes the components of home and classroom environment and culture, parental involvement and dialect. [27] One thing to note is that the components of the cognitive domain can satisfy the condition of independence in a student, but the psychological and ecological domains do not do this as well.[28]

In a 2005 study regarding the effectiveness of the Component Model of Reading, it was found that IQ tests previously used to determine reading disabilities can only predict about 25% of variability in reading comprehension, whereas with the Component Model of Reading, 38-41% of variability can be found.[29]

Overall, the diagnosis of reading and learning disabilities is a process that has evolved over time, and is becoming more and more precise. Though there are multiple types of reading disabilities, each one should be approached with a sense of open mindedness, as well as a conscious awareness that each child and disability will be different. In terms of ways of diagnosis, the steps included in this section have proven to work, though they are subject

25 Eklund, K. M., Torppa, M., & Lyytinen, H. (2013). Predicting reading disability: Early cognitive risk and protective factors. Dyslexia: An International Journal Of Research And Practice, 19(1), 1-10. doi:10.1002/dys.1447

26 Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading: An alternative to the discrepancy model of LD. Journal Of Learning Disabilities, 41(1), 67-84. doi:10.1177/0022219407310838

27 Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading: An alternative to the discrepancy model of LD. Journal Of Learning Disabilities, 41(1), 67-84. doi:10.1177/0022219407310838

28 Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading: An alternative to the discrepancy model of LD. Journal Of Learning Disabilities, 41(1), 67-84. doi:10.1177/0022219407310838

29 Aaron, P. G., Joshi, R. M., Gooden, R., & Bentum, K. E. (2008). Diagnosis and treatment of reading disabilities based on the component model of reading: An alternative to the discrepancy model of LD. Journal Of Learning Disabilities, 41(1), 67-84. doi:10.1177/0022219407310838

to change in the future as educators learn more about intervention and how disabilities progress or change.

20.2.2 Types of Reading Difficulties and Disabilities

When discussing reading difficulties and disabilities, it is important to remember that there is a wide array of factors that can affect reading and comprehension, and not all students who experience trouble reading are diagnosed with a "reading disability". Sometimes students are not developmentally ready for leaning to read and struggle with understanding the linguistics of reading, while others come from cultural or linguistic backgrounds that don't match with the type of reading instruction taught in the school.[30] In addition, some students may have difficulty learning to read even with good instruction. This can be attributed to low general ability, meaning they struggle more with comprehension than the reading itself.[31]

Students can also have reading disabilities even if they are of average or above average intelligence, which is different than students who are poor readers. Speech problems are often paired with difficulties in writing and spelling, which in turn would hinder the student's ability to successfully read and comprehend what they're reading.[32]

One common reading difficulty lies in the phonics of a word, specifically when a student is unable to match the sounds of the letter to the visual symbol. In this case, the problem is central rather than sensory.[33] Word blindness, or dyslexia, is another common reading disability in which letters and words are mixed around in the student's brain, causing great difficulty in the comprehension of what is being read.[34]

Dyslexia is a reading deficiency that runs in families. The risk of a child developing dyslexia increases to 40% if a parent or relative also has the disability.[35]

Left handed students often have difficulty learning to read, as reading from left to right is natural for right handed students - they are used to leading away from the centre of the

30 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
31 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
32 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
33 Hoillingworth, L. S. (1923). Reading. In , Special talents and defects: Their significance for education (pp. 57-97). New York, NY, US: MacMillan Co. doi:10.1037/13549-004
34 Hoillingworth, L. S. (1923). Reading. In , Special talents and defects: Their significance for education (pp. 57-97). New York, NY, US: MacMillan Co. doi:10.1037/13549-004
35 Eklund, K. M., Torppa, M., & Lyytinen, H. (2013). Predicting reading disability: Early cognitive risk and protective factors. Dyslexia: An International Journal Of Research And Practice, 19(1), 1-10. doi:10.1002/dys.1447

body rather than to it, which is the opposite for left handed students.[36]

Slow, silent reading can be caused by visual defects as well as a narrow span of recognition and dyslexia, while poor reading comprehension of slow reading can be caused by an inability to focus, organize main ideas, or lack of attention.[37] However, though reading comprehension can be hindered by a lack of attention, too much attention or focus on single words can also cause problems. If a student focuses too much on individual words, they can be unable to bring a sentence together as a whole.

In terms of Attention Deficit Hyperactivity Disorder (ADHD), it is found that 8% to 20% of students have the disorder, but only 3% to 7% show severe enough symptoms that they are given a clinical diagnosis and are provided with special education intervention and services.[38] Though ADHD does not always mean that a student has a reading disability, it can often coincide with one, in most cases causing students to misinterpret texts, or have general comprehension issues regarding common connections in what is being read.

20.2.3 Implications for Teaching

As with any student who is struggling with any subject matter, teachers and learning aids need to make changes in teaching styles and material to help make the material learnable. One approach is the Reading Recovery method, which was developed in New Zealand. This method consists of four steps:

1. "Children are assessed on a variety of literacy tasks, such as their ability to identify letters, read words, write, and do oral reading, as well as on their literacy knowledge and strategies"

2. "A series of 30-minute daily tutorials in which a Reading Recovery teacher works one-on-one with an individual student."

3. "Standardized sessions that provide a systematic set of activities, including having the child practice letters and words, read from short books, and produce short compositions that are cut up and re-read."

36 Dearborn, W. F. (1932). Difficulties in learning. In W. V. Bingham, W. V. Bingham (Eds.) , Psychology today: Lectures and study manual (pp. 186-194). Chicago, IL, US: University of Chicago Press. doi:10.1037/13342-021

37 Brooks, F. D. (1926). How to diagnose reading deficiencies. In , The applied psychology of reading: With exercises and directions for improving silent and oral reading (pp. 168-185). New York, NY, US: D Appleton & Company. doi:10.1037/14870-012

38 Zentall, S. S., & Lee, J. (2012). A reading motivation intervention with differential outcomes for students at risk for reading disabilities, ADHD, and typical comparisons: 'Clever is and clever does'. Learning Disability Quarterly, 35(4), 248-259. doi:10.1177/0731948712438556

4. "A systematic process of staff development in which teachers are trained by Reading Recovery trainers."[39]

This level of scaffolding is both practical and efficient in propelling the learning of students, and provides a high level of support for both students and teachers.

In a 2005 study conducted by Robert Schwartz, the Reading Recovery program was examined in terms of the effectiveness in aiding first grade students. In this study, 47 Reading Recovery teachers in 14 states sent information of 107 students, 53% of which were male and 47% of which were female. The students were paired with a Reading Recovery teacher who led them through the program, which includes daily tutorials that span the length of 30 minutes that are targeted toward structured activities that include practicing letters and words, reading short books, producing small pieces of writing that are later divided up and re-read. At the end of the study, 65% of students "graduated" the program, 16% were recommended for further help, and 16% did not complete the program. This can be compared to the national Reading Recovery data: 56% of students graduated, 15% were recommended for further help, 19% were labelled as incomplete, 5% "moved" and 4% were labelled as "none of the above".[40]Reading Recovery has proven to be a very successful program in regards to rehabilitation and intervention. One interesting aspect of the Reading Recovery program is that though it's been around since the 80's, the system and process is still effective, and hasn't needed to undergo any major changes. A testament to the success of the program is that is it used internationally in English speaking countries, and has a high success rate.

As with any situation in which a student is struggling, teaching methods and procedures must be adjusted to adapt to the struggle of the child. Intervention of reading disabilities is very important in the stages of learning to read, as a problem developed with learning to read can plague a student throughout their entire lives if not caught soon enough. This is exactly why programs such as Reading Recovery and the help of teachers are so important in the process of learning to read. Though the help of SEA's and other support workers can greatly benefit the students and help take some of the load off of teachers, it is still important to remember that each child does need to have a unique learning plan catered to what they need and don't need assistance with.

Though not all students are diagnosed with a reading disability, it is not uncommon for students to struggle with material taught in class. Sometimes this can be attributed to an undiagnosed disability. In the case of an undiagnosed student, or a student who is not disabled but still faces challenges with learning, intervention and understanding can play a large part in the future development for the child.

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39 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

40 Schwartz, R. M. (2005). Literacy Learning of At-Risk First-Grade Students in the Reading Recovery Early Intervention. Journal Of Educational Psychology, 97(2), 257-267. doi:10.1037/0022-0663.97.2.257

20.3 Stages of Reading

Like learning any other thing in life, learning to read requires steps or stages. When children start to learn to read there are three main stages that they will all go through. Children start off learning to read by not being able to decode any words (pre-alphabetic stage), they then start to use phonic cues and other reading strategies (partial alphabetic stage), and finally get to the point where they are able to distinguish between similar spelt words and are able to learn new words while making connections (full alphabetic stage) [41]. Reading develops in multiple dimensions before individuals reach conventional literacy. Each of these stages is described as young children move from displaying very little literacy-related behaviours to eventually being able to systematically decode language.

20.3.1 Pre-Alphabetic Stage

The **pre-alphabetic stage** consists of children who know quite a bit about literacy but don't know how to read any words. Children at this stage have no alphabetic knowledge which is why the stage is called pre-alphabetic stage. Children however do know a lot of words, can speak in full sentences, and have conversations with others, but are just not able to read any actual words. However, they may say a word by looking at the symbol associated with it. For example, reading the word 'McDonald's' by looking at the big 'M' or saying the word 'dog' by looking at a picture of one. Children have no recognition of the word 'McDonald's' or the word 'dog' nor will they be able to read the word once the picture is taken away. Children are simply responding to their environment and not to the print [42]. Despite children knowing quite a bit of words and being able to say full sentences they are just not able to read the words or any print on their own. Another type of group in this stage try "linking a word's look with its pronunciation and meaning" [43]. However, the memory demands of reading in this way become very overwhelming and exhausting for children and they soon try relying more on phonetic information while reading [44].

20.3.2 Partial Alphabetic Stage

Children enter the **partial alphabetic stage** when they learn the names or sounds of the alphabet and then use this knowledge to read words [45]. This is the stage where the actual reading starts to occur. Children are no longer just looking at the images and reading the word, they are actually trying to read the print. They now have knowledge of the letters in the alphabet and are using this knowledge to help them read words. Children in this stage

41 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
42 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
43 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
44 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
45 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4

generally focus more on the first and last letters of words, for example, the letter *s* and *n* to read *spoon* [46]. When children are asked to write down words they tend to write down the letters whose sound they can hear when pronouncing the word. For example, children might write the word *giraffe* as *jrf* [47]. Children's reading at this stage is only partial because they are simply just looking at some of the letters in words and usually only some sound for pronunciation [48].

To better understand the difference of pre-alphabetic stage readers and partial alphabetic stage readers, a study was conducted by Ehri and Wilce in 1985. This study tested kindergartners by separating them into the two different stages mentioned above. Each stage was given several practice trials to learn to read two kinds of spellings. One kind involved visual spellings with varied shapes but no relationship to sounds, so for example, *mask* spelled uHo. The other kind involved phonetic spelling that had letters represent some sounds in the words, so for example, *mask* spelled MSK.

The results were that the pre-alphabetic stage readers learned to read visual spellings a lot easier than the phonetic spellings [49]. Ehri explained that this confirmed their idea that pre-alphabetic stage readers depend on visual cues because they lack knowledge of letters. The partial alphabetic stage readers displayed the opposite pattern and were able to use letter-sound cues to remember the words.

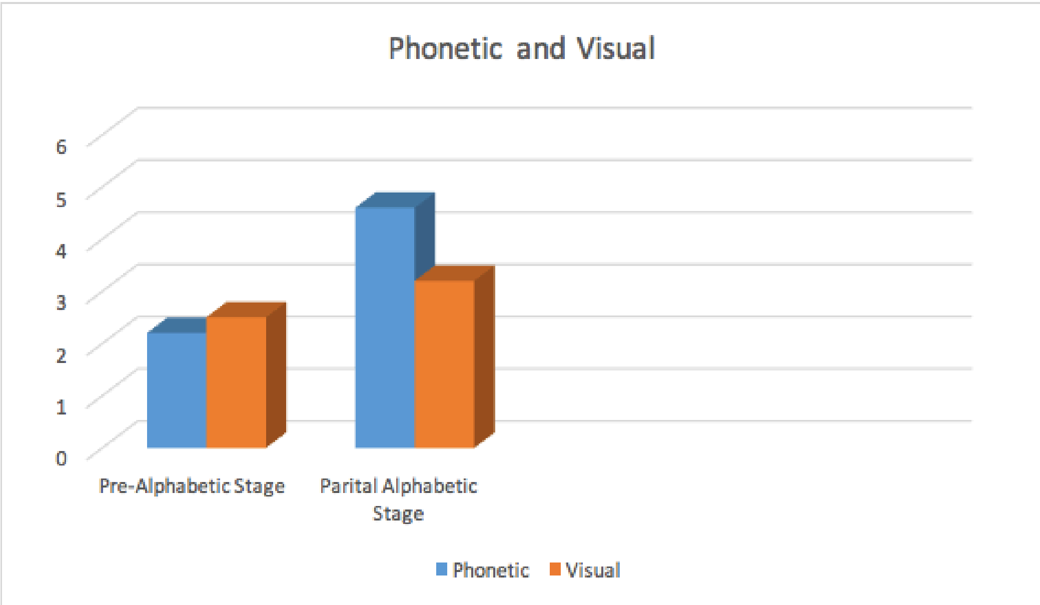

Figure 45 Results for Wilce and Ehri's 1985 Experiment of Stages of Reading (graph is showing number of words read in each stage)-Graph is Recreated

46 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4

47 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

48 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

49 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4

20.3.3 Full Alphabetic Stage

When children are able to learn sight words by forming complete connection between letters in spelling and phonemes in pronunciations, they have moved onto the **full alphabetic stage** [50]. In the partial alphabetic stage children will write down words with only the letters they can clearly hear when pronouncing the word. However, in the full alphabetic stage children are now able to decode unfamiliar words when reading, they can invent spellings that represent all the phonemes, and are able to remember the spelling of words a lot better [51].

To show the difference in the phases of reading a study was conducted by Ehri and Wilce in 1987. This study was done to show the differences in sight word learning between full and partial stage readers [52]. For this study, kindergartners who were already in the partial alphabetic stage were randomly selected. They then were randomly assigned to a treatment or a control group. The treatment group then received training to become full alphabetic stage readers by having them practice reading similarly spelled words. This required processing all the grapheme-phoneme relations in the words to read them correctly. The control grouped received no training what so ever and remained as partial stage readers. Following this, both groups of kindergartners got practice learning to read a set of fifteen words over several trials. All the words in the list had similar spellings which made it harder for children to learn by remembering partial cues. The list of words included words such as spin, stab, stamp, or stand. Before the study none of the children could read more than two of these words prior to training.

The results of the study showed huge differences between the two groups of kindergartners. Full-alphabetic stage readers learned to read most of the words in the list in three trials but the partial alphabetic stage readers never even reached this level of learning [53]. The study did say that the reason for difficulty for the partial alphabetic stage readers is due to them confusing similarly spelled words. Which goes to show the advantage readers get when they can form full connections to retain sight words in memory [54].

50 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
51 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
52 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
53 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
54 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4

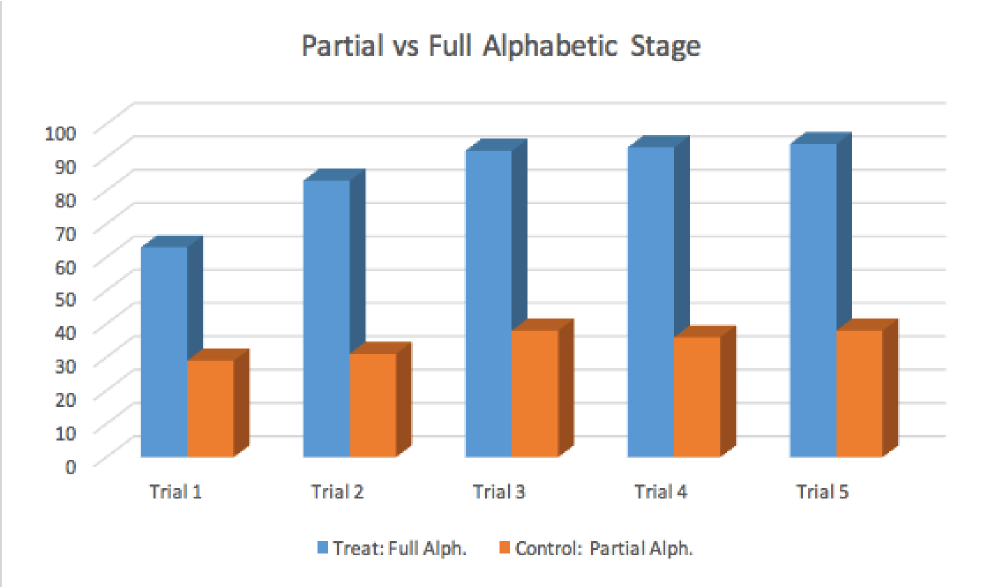

Figure 46 Results of Ehri and Wilce's 1987 Experiment for Phases of Reading (graph is showing the number of trials and percent of words gotten right)-Graph is Recreated

It is important to note how just being one stage behind in reading can cause such a huge difference in the results. Just by being at the full alphabetic stage the kindergartners were able to read the similarly spelled words in three trials whereas the partial alphabetic stage kindergartners had so much trouble doing so. It goes to show the importance of each reading stage and how important it is for teachers to make sure students are ready to go onto the next stage. Teachers need to be sure that students have learnt everything they need in the previous stage to help them pass the next one.

20.3.4 Consolidated Stage

Children get to this final stage of reading when they have retained more sight words in their memory and are familiar with letter patterns [55]. Children are now familiar with letter patterns that appear repeatedly in different words and the grapheme-phoneme connections begin to get consolidated into larger units [56]. For example, words such as printing is learned more easily now because fewer connections are required to secure the word in memory and the word is no longer being processed as many separate letter-sound connections but as two syllable sized chunks [57].

55 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
56 Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188, doi: 10.1207/s1532799xssr0902_4
57 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

20.3.5 Implications for Teaching

The English language is not perfect and therefore it can have one letter represent one sound, two or more letters represent that one sound, a silent final vowel can change the sound of the medial vowel, and many words contain letters that have no sound [58]. When teachers are starting to teach their students how to read they should be aware of the interconnection between letters and sounds and know the different stages children go through when they are developing their literacy skills. Throughout the three alphabetic stages, teachers should focus on decoding and vocabulary as the mastery as these dimensions are vital to successful reading [59]. Children need to be able to decode words or in other words be able to think about letter and sound relationships and correctly pronounce written words. Games can be used to teach children the correct pronunciation of letters and their sounds. Having children hear the different sounds of letters with the letter in front of them will help them understand better. Since beginner readers are visual learners, pictures might help them understand the relationship between letters and the sound. For example, a teacher may put up a picture of bat and write on the board the word bat but skipping the first letter. Now the teacher can ask the students what the first letter might be by repeatedly saying the word bat and helping the students sound it out. It is important for children to decode and fluently read words, but it is also vital that children understand the meaning of specific contextual words [60]. When children can read and understand the meaning of the words they are able to truly comprehend a text [61]. Teachers should help children in discovering the meaning of words found in a text by having them place words connected to each other in specific categories, create connected categories of words, pointing out relationships between words, using dictionaries or thesauruses to extend word meaning, and having students self-select words for vocabulary study and stating specific reasons for choosing these words [62].

20.4 Teaching to Read

There is often great importance placed on literacy and the skill of reading, and so teachers may feel pressured to find the best approaches or methods for teaching their students how to read. Deciding which areas to focus on can be challenging when teaching beginning readers. Ideally, reading instruction should touch on each of the foundations of language, as well as the benefits of learning to read. Over the course of the history of reading instruction, there have been numerous controversies about which methods are the best to teach children to read[63]. In 1967, Jeanne Chall grouped reading methods into two categories that are

58 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463
59 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
60 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463
61 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463
62 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463
63 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

still useful in understanding the divide on reading instruction: code-emphasis methods and meaning-emphasis methods. **Code-emphasis methods** focus on decoding and learning letters and sounds, while **meaning-emphasis methods** focus on making meanings and using one's general knowledge store[64]. The following approaches to teaching reading are separated by their methodology, but today, models of reading strive for a balance between the two types of reading methods because they are both recognized as essential for learning to read. Reading and literacy development have many different dimensions, but we also must not forget the importance of teaching children that reading can be enjoyable.

20.4.1 Phonics-Based Approach

A phonics-based approach to teaching reading is a type of code-emphasis method. Primary goals include making sure children can: understand letter-sound correspondences, automatically recognize familiar words, and decode unfamiliar words[65]. Researchers advocating for a more phonics-based approach believe that phonemic awareness is a requirement for learning to connect alphabetic symbols to their sounds, and that these letter-sound connections are required for learning to identify individual words and learning to read in general[66]. From a logical standpoint, learning letter-sound correspondences may seem the most salient for beginning readers, especially since words are made up of combinations of letter-sound correspondences. Within a phonics-based approach, there are two types of instruction: an explicit phonics approach and an implicit phonics approach. In an **explicit phonics approach**, sounds are associated with the letters by themselves, and then are blended together to form words[67]. In the classroom, a teacher might directly tell students the sound represented by an individual letter. Once students have learned a few letter-sound correspondences, they begin to learn to read by blending the sounds together[68]. The main strategy used for identifying words in an explicit phonics approach is based on the student's knowledge of letter-sound correspondences[69]. When a student encounters an unfamiliar word, they are encouraged to sound it out and they are not directed to the context of the word until after the word has been identified[70]. In this case, context is only a metacognitive strategy

64 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

65 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

66 Vellutino, F.R. (1991). Introduction to three studies on reading acquisition: Convergent findings on theoretical foundations of code-oriented versus whole-language approaches to reading instruction. Journal of Educational Psychology, 83(4). 437-443. doi:10.1037/0022-0663.83.4.437

67 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

68 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

69 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

70 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

used to understand the text as a whole[71]. In an **implicit phonics approach**, sounds of letters are identified in the context of whole words rather than letters in isolation[72]. During instruction, the teacher might write the word hand on the board, and underline the letter h. Then, the teacher would have the students say "hand" to elicit from them that h makes the sound /h/[73]. In addition, the context of the word and picture clues may be used to sound out unfamiliar words. A common problem that has been identified in using context to teach letter-sound correspondences is that some students fail to learn these correspondences because they are unable to split words into their individual sounds, since they lack the skills needed to infer sounds from a whole word[74]. Evidence from research indicates that a large majority of poor readers are deficient in alphabetic coding and phonemic awareness [75]. As stated earlier, ideal reading instruction should involve both code-emphasis methods and meaning-emphasis methods. As such, more people are against over-emphasis of phonics and prescriptive teaching methods than there are people against phonics instruction itself[76].

A study by Maddox and Feng (2013) compared the efficacy of whole language reading instruction versus phonics instruction for improving students' reading fluency and spelling accuracy. The researchers hypothesized that explicit phonics instruction would have a more positive effect on students' reading fluency and spelling accuracy than whole language instruction, and that the students receiving explicit phonics instruction would show greater gains in reading fluency and spelling accuracy than students receiving whole language instruction. Twenty-two first graders from one classroom were randomly assigned to either the experimental group or the control group. The experimental group became the phonics group and received explicit phonics instruction, while the control group became the whole language group and did not receive explicit phonics instruction. With the experimental group, the teacher taught phonics patterns and the group practiced segmenting, coding, blending and working with these patterns, but did not read any stories. With the control group, the teacher read the students fourteen stories from the Raz-kids reading program; the words in the stories contained the same phonics patterns as those taught in the phonics group and the students focused on picture walks, story predictions, and meaning of vocabulary. Both groups met with their teacher (who was also one of the experimenters) for twenty minutes, five days a week, over a span of four weeks. Before the training sessions began, students' pretest scores were gathered using the Aimsweb Reading Curriculum Based Measure (RCBM) and the Aimsweb Spelling Curriculum Based Measure (SCBM). After the

71 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

72 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

73 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

74 Stein, M., Johnson, B., & Gutlohn, L., (1999). Analyzing Beginning Reading Programs: The Relationship Between Decoding Instruction and Text. Remedial and Special Education, 20(5), 275-287. doi:10.1177/074193259902000503

75 Vellutino, F.R. (1991). Introduction to three studies on reading acquisition: Convergent findings on theoretical foundations of code-oriented versus whole-language approaches to reading instruction. Journal of Educational Psychology, 83(4). 437-443. doi:10.1037/0022-0663.83.4.437

76 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

four weeks of training, the same tests were administered to the students again to calculate posttest scores to measure changes in reading fluency and spelling accuracy. The results indicated no statistically significant differences in reading fluency or spelling accuracy of either group. The phonics group had higher reading scores on average and increased their reading fluency by 8.00 points compared to the whole language group, who increased their reading fluency by 4.09 points. Data for spelling accuracy showed the phonics group had positive results with an increase in 1.00 point while the whole language group regressed with a decrease of -0.27 points. A direct comparison indicates the phonics group made greater gains in both reading fluency and spelling accuracy.[77]

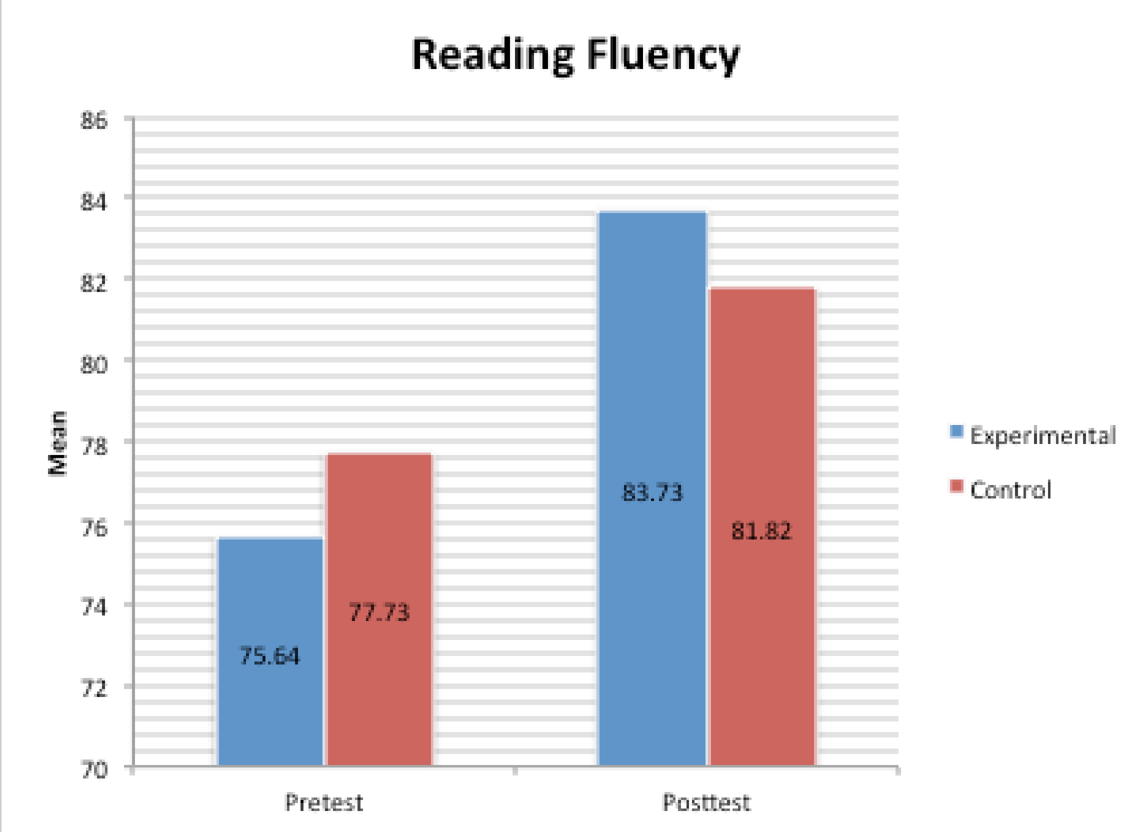

Figure 47 Mean pretest and posttest scores for experimental and control groups for Reading Fluency.

77 Maddox, K., & Feng, J. (2013). Whole Language Instruction vs. Phonics Instruction: Effects on Reading Fluency and Spelling Accuracy of First Grade Students. Retrieved from ERIC database. (ED545621)

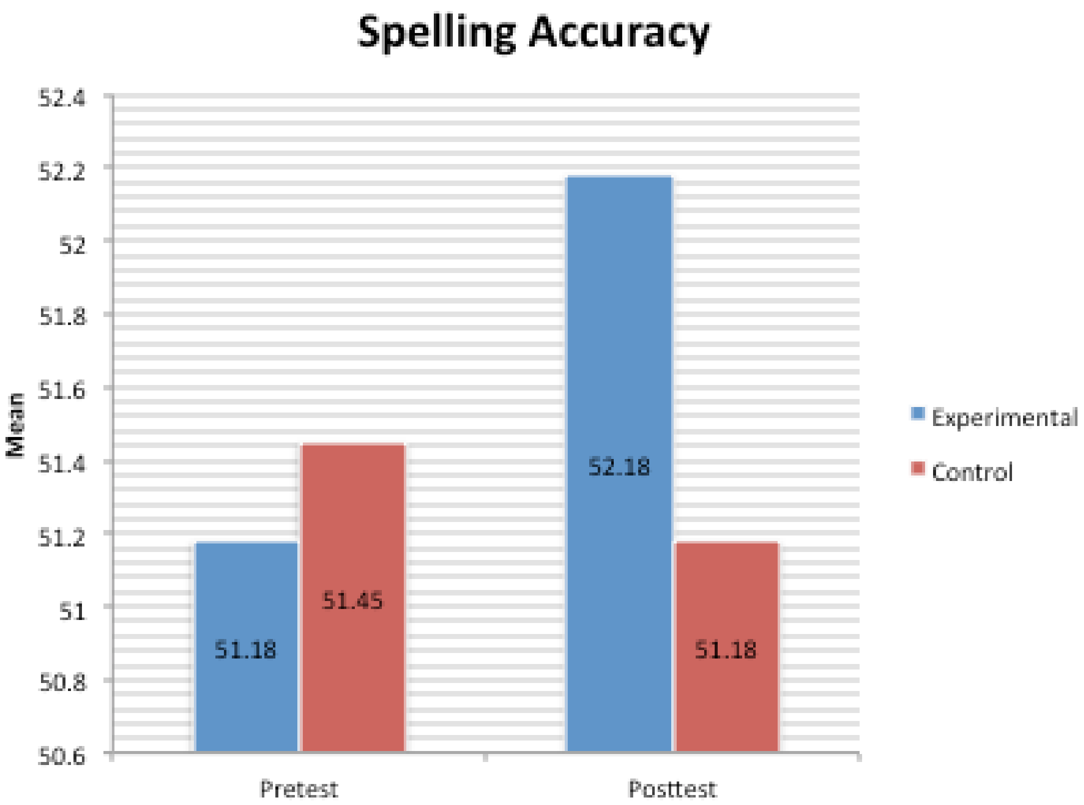

Figure 48 Mean pretest and posttest scores for experimental and control groups for Spelling Accuracy.

20.4.2 Phonemic Awareness

How does phonemic awareness affect learning to read? **Phonemic awareness** is described as the ability to focus on and manipulate phonemes in spoken words. **Phonemes** are the smallest units that make up spoken language, and are combined to form syllables and words,[78] thus, phonemic awareness is a code-emphasis method. Research has posited that sight-reading words from memory requires phoneme segmentation skills, and that phonemic awareness is thought to help children write words by enabling them to invent letter-sound spellings or retrieve spellings from memory[79].

A study by Castle, Riach and Nicholson (1994) was done with the aim of determining whether training in phonemic awareness would get children off to a better start in reading

78 Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T.. (2001). Phonemic Awareness Instruction Helps Children Learn to Read: Evidence from the National Reading Panel's Meta-Analysis. Reading Research Quarterly, 36(3), 250–287. Retrieved from `http://www.jstor.org/stable/748111`

79 Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T.. (2001). Phonemic Awareness Instruction Helps Children Learn to Read: Evidence from the National Reading Panel's Meta-Analysis. Reading Research Quarterly, 36(3), 250–287. Retrieved from `http://www.jstor.org/stable/748111`

and spelling, even if they were already being instructed within a whole language program. The experiment was done with children in New Zealand during their first few months of school, during the time they were just learning to read and write. Thirty 5-year-olds from three different schools were divided and matched into one experimental group and one control group. The experimental group had 20-minute training sessions twice a week for 10 weeks, totalling 6.7 hours in overall training time. The topics covered during these sessions were chosen with the purpose of increasing phonemic awareness, including phoneme segmentation, phoneme substitution, phoneme deletion, and rhyme. The control group had the same amount of instructional time, but the children were involved in process writing activities as part of the whole language approach in New Zealand schools, in which children wrote their own stories and invented their own spellings of words. A series of pretests were administered before the training sessions began, including: Roper's measure of phonemic awareness, a Wide Range Achievement of Spelling test, an experimental spelling test, and a diction test. These same tests were also administered as posttests after the training sessions were completed. The results from the study showed significant gains for both groups in phonemic awareness, but there was a considerable difference between the experimental and control groups that indicates that the training program used in the study was effective in improving phonemic awareness skills. There was also a significant difference between the groups on two of the spelling tests (Wide Range Achievement of Spelling test and experimental spelling test), showing that improvement in phonemic awareness skills leads to better spelling skills. In conclusion, the findings of the study suggest that the ability to link letters and their sounds is associated with spelling progress, and that phonemic awareness promotes spelling acquisition[80].

80 Castle, J.M., Riach, J., & Nicholson, T. (1994). Getting Off to a Better Start in Reading and Spelling: The Effects of Phonemic Awareness Instruction Within a Whole Language Program. Journal of Educational Psychology, 86(3), 350-359. doi:10.1037/0022-0663.86.3.350

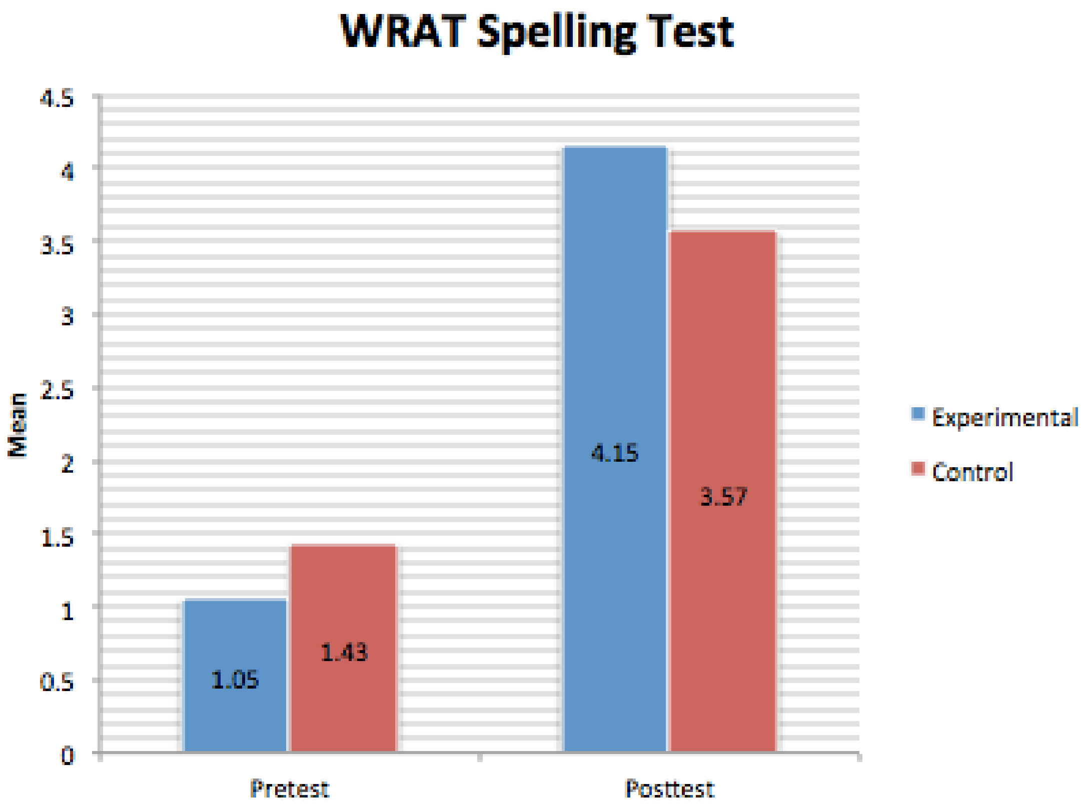

Figure 49 Mean pretest and posttest scores of experimental and control groups for WRAT Spelling Test.

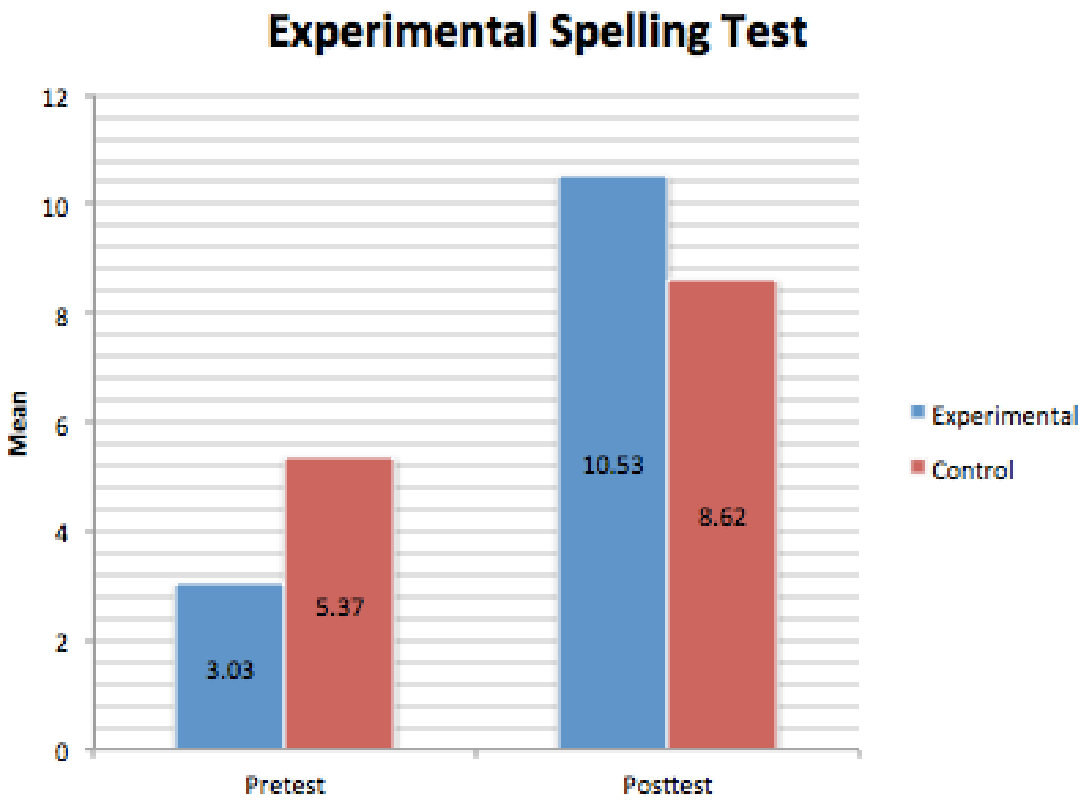

Figure 50 Mean pretest and posttest scores of experimental and control groups for Experimental Spelling Test.

It is important to note that the impact of phonemic awareness instruction is greatest in the preschool and kindergarten years, and may become smaller beyond first grade[81]. As students move beyond first grade, phonemic awareness skills becomes less important than the need to learn spelling patterns[82]. Explicit instruction in phonemic awareness may not be as effective for older students, however; it may be effective for children who have not made normal reading progress and students with reading disabilities, thus, phonemic awareness skill instruction can help with these students' reading and spelling difficulties[83].

81 Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T.. (2001). Phonemic Awareness Instruction Helps Children Learn to Read: Evidence from the National Reading Panel's Meta-Analysis. Reading Research Quarterly, 36(3), 250–287. Retrieved from `http://www.jstor.org/stable/748111`

82 Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T.. (2001). Phonemic Awareness Instruction Helps Children Learn to Read: Evidence from the National Reading Panel's Meta-Analysis. Reading Research Quarterly, 36(3), 250–287. Retrieved from `http://www.jstor.org/stable/748111`

83 Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T.. (2001). Phonemic Awareness Instruction Helps Children Learn to Read: Evidence from the National Reading Panel's Meta-Analysis. Reading Research Quarterly, 36(3), 250–287. Retrieved from `http://www.jstor.org/stable/748111`

20.4.3 Whole Language Approach

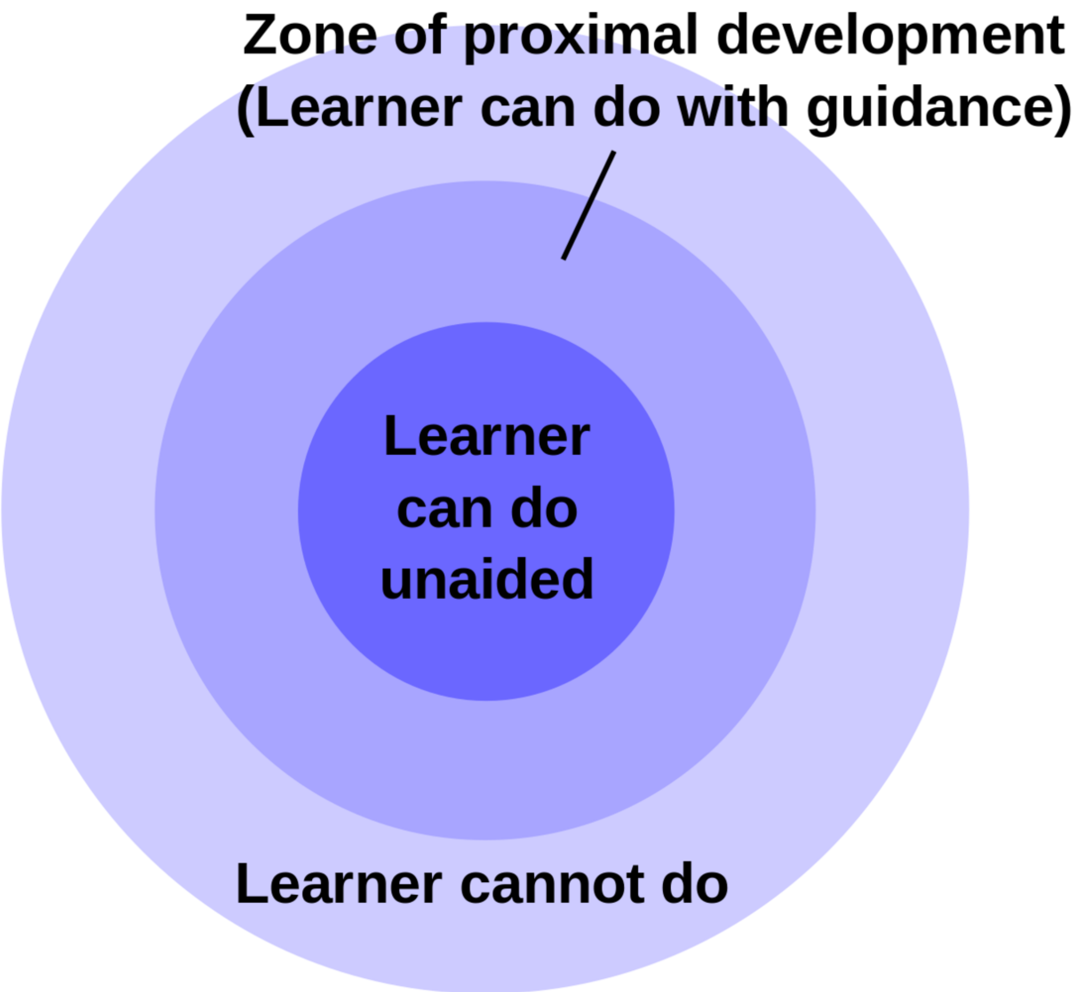

Figure 51 Zone of proximal development

In a whole language approach, literacy is viewed as a top-down process[84]. The whole language approach is a philosophy that emphasizes reading words and sentences are of greater importance than learning the sounds and phonemes that make up words. Letter sound-correspondences are not taught independently of reading, and so it is a type of meaning-emphasis method. Students are engaged with language as a whole, rather than separating out the parts and practicing each one on its own[85]. Reading is meant to occur naturally, as when children first learned to speak: with very little direct instruction and lots

84 McCaslin, M. M.. (1989). Whole Language: Theory, Instruction, and Future Implementation. The Elementary School Journal, 90(2), 223–229. Retrieved from http://www.jstor.org.proxy.lib.sfu.ca/stable/1002031

85 Stone, T. J. (1993). Whole language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

of encouragement[86]. By experiencing the wholeness of reading, only then do students learn the subparts of words[87]. A whole language approach is very much a context-driven process, and words are not presented out of context[88]. In order to make sense of the text at hand, students are meant to use their store of accumulated knowledge, illustrations, phonetic strategies and prior experiences to make sense of the text and any unfamiliar words[89]. Teachers who support a whole language approach often use "real books" rather than basal readers (often seen in code-emphasis methods) because they promote reading fluency and making meanings[90]. Furthermore, it is stressed in a whole language approach that the process of learning is not always smooth and certain, and that students must take ownership and responsibility for their learning goals[91]. The whole language approach is often looked at from a Vygotskian perspective: teachers are mediators who make learners' transactions with the world possible[92]. According to Vygotsky, learning is a social interaction, and children need to converse with others in order to exchange and form meanings [93]. As such, the whole language approach to reading instruction flourishes through all kinds of social interaction because learners can more effectively solve problems when they are collaborating on the same problems and developing the same skills[94]. When students work together, their discussion can often lead to not only solving the problem at hand, but also forming new meanings and accumulating new knowledge from information derived from collaboration. Vygotsky also stated that literacy experiences should be structured so that they are necessary for something, that is, there is a purpose for learning how to read and write[95]. Using examples in class that are relatable or have a parallel comparison to students' experiences outside the classroom can increase reading motivation[96]. One other Vygotskian model for reading instruction using a whole language approach is to work within a student's **zone of proximal development**, which is a person's area of learning between what they can do alone and what they can do with help. During reading, asking students questions about the language

86 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

87 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

88 Vellutino, F.R. (1991). Introduction to three studies on reading acquisition: Convergent findings on theoretical foundations of code-oriented versus whole-language approaches to reading instruction. Journal of Educational Psychology, 83(4). 437-443. doi:10.1037/0022-0663.83.4.437

89 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

90 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

91 McCaslin, M. M.. (1989). Whole Language: Theory, Instruction, and Future Implementation. The Elementary School Journal, 90(2), 223–229. Retrieved from `http://www.jstor.org.proxy.lib.sfu.ca/stable/1002031`

92 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

93 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

94 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

95 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

96 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

or for clarification can build on skills they already posses[97]. Asking students questions about the material and fostering meaning making can have a positive effect on reading comprehension. Research suggests that when real reading is considered the main element of whole-language reading instruction, the approach is beneficial to reading comprehension tests[98]. After all, reading comprehension is a main goal of reading instruction.

Manning and Kamii's study (2000) on reading and writing tasks in kindergarten students compared the effectiveness of whole language versus isolated phonics instruction. Thirty-eight children from two kindergarten classes at one school in the United States were examined. The teacher of one class identified as a whole language teacher, and the other as a phonics teacher. In the phonics classroom, the students had daily phonics worksheets and oral-sound training, and often used flashcards to practice sight words and letter-sound correspondences. There were posters that displayed various phonics rules, marked with symbols to indicate long or short vowel sounds. In the whole language classroom, children did a lot of shared reading and writing, such as independent journal writing and also group writing activities. Books were read aloud by the teacher for over an hour each day, spread out over the day. All the children were interviewed individually five times throughout the year, where they were asked to write eight words and then read two to four sentences. The researchers then scored the students according to their level of writing and ability to identify a word in a given sentence. Results showed that although the whole language group started out the year at a lower level, many more children ended the year at a higher level than the phonics group. In the phonics group, there were more instances of regression, and overall advanced less and became more confused during their kindergarten year[99].

20.4.4 Schema Theory

Schema theory is an explanation of how readers use their prior knowledge to comprehend text[100]. The term **schema** (plural: *schemata*) was first introduced in psychology to describe a mental framework that organizes a person's knowledge, and was then later used in reading instruction to describe the role that students' prior knowledge plays in reading comprehension[101]. According to schema theory, people organize everything they know into schemata[102]. Everyone's schemata are individualized, and the more elaborated a person's schema is for any specific topic, the more easily they will be able to learn new information in that topic area[103]. A person's existing knowledge structures are malleable and constantly

97 Stone, T. J. (1993). Whole-language reading processes from a Vygotskian perspective. Child & Youth Care Forum, 22(5), 361-373. doi:10.1007/BF00760945

98 Krashen, S.D. (2002). Defending whole language: the limits of phonics instruction and the efficacy of whole language instruction. Reading Improvement, 39(1), 32-42.

99 Manning, M., & Kamii, C. (2000). Whole Language vs. Isolated Phonics Instruction: A Longitudinal Study in Kindergarten With Reading and Writing Tasks, Journal of Research in Childhood Education, 15(1), 53-65. doi: 10.1080/02568540009594775

100 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

101 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

102 Tracey, D.H., & Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

103 Tracey, D.H., & Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

changing[104]; when a person learns new information, their pre-existing schema may need to adjust to accommodate this new information. In regards to reading, the main idea of schema theory is that written text does not carry meaning alone; rather, the text provides guidance for how readers should retrieve or construct meaning from previously existing knowledge structures[105]. In addition to having schemata for content, learners also have schemata for reading processes and different kinds of text structures[106]. Understanding the text is a reciprocal and interactive process between the reader's prior knowledge and the actual text because effective comprehension requires the ability to relate prior knowledge to the text[107]. Schema theory has two kinds of processing during reading comprehension: **bottom-up processing** is schema activation (when textual stimuli signal recall of relevant schemata) through specific information in the text, while **top-down processing** starts with general knowledge and moves down towards more specific details, and as more stimuli are presented, the reader's specific schemata pertaining to the text can be activated[108]. These two types of processing occur simultaneously and interactively in order to comprehend text[109].

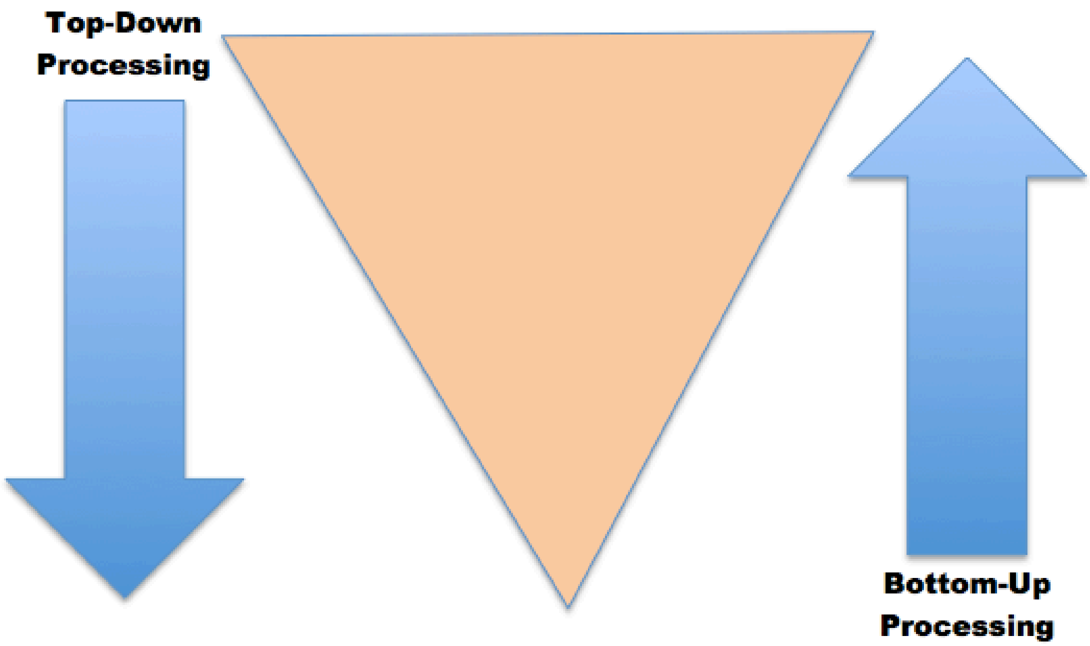

Figure 52 Top-Down and Bottom-Up Processing

104 Tracey, D.H., & Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

105 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

106 Tracey, D.H., & Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

107 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

108 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

109 Shuying, A. (2013). Schema Theory in Reading. Theory & Practice in Language Studies, 3(1), 130-134. doi:10.4304/tpls.3.1.130-134

Research suggests that when readers activate prior knowledge by previewing the text, they use schemata immediately when they start reading and focus instead on new information, with the aim of building connections between old and new information[110]. Without existing schema regarding the structure or content of the text, reading comprehension will not occur[111]. Due to the importance of pre-existing knowledge, teachers can build on and activate students' schema prior to reading[112]. Previewing the text can include brainstorming or group discussions, or even reviewing strategies and skills for reading the text. It is also important to note that differences and students' schemata relate in differences in reading comprehension, but previewing text also allows a reader to realize in advance that they have knowledge of the subject, increasing the student's self-efficacy for that reading task[113].

A study of Iranian students examined whether schema activation through pre-reading activities has an effect on reading comprehension of culturally based texts. The subjects consisted of seventy-six English as a Foreign Language (EFL) students either majoring in English Literature, or majoring in Teaching English as a Foreign Language (TEFL). All the participants were sophomore students in their fourth semester at the Islamic Azad University of Kerman in Iran. To make sure all students were of the same English proficiency, they were categorized from a basic to upper-intermediate level of English based on their results on the Oxford Placement Test. Participants were then separated into two groups: one experimental group and one control group. The researchers tested two null hypotheses: the first, that there would be no significant difference between the mean pretest and mean posttest scores of the experimental group after schema activation; and the second, that there is no relationship between the pretest and posttest scores of the experimental group when the students' schemas are activated through pre-reading activities. During the procedure, both the experimental and control groups were administered a reading comprehension test about the origins and customs of Halloween as a pretest. The topic was chosen because the holiday is culturally loaded, and so students from another country may have difficulties understanding it. Then, the experimental group had two training sessions of schema activation with a researcher– these sessions included pre-reading activities, previewing, pre-teaching vocabulary, and looking at pictures to make the students more familiar with Halloween customs. The group was then asked to talk about what they knew about Halloween, and this served as a basis for group discussion. During the training sessions, the researcher asked the group questions about new vocabulary word, and provided synonyms and definitions when necessary. The experimental group was then given the same reading comprehension test as a posttest two weeks later. The control group was only administered the initial pretest, and did not have any training sessions or a posttest. The results showed that both null hypotheses were rejected, and that both groups scored about the same on the pretest – the experimental group with a mean score of 16.42 and the control group with a mean score of 16.57 – but after the experimental group's training sessions, their posttest mean

110 Al-Faki, I., & Siddiek, A. G. (2013). The role of background knowledge in enhancing reading comprehension. World Journal of English Language, 3(4), 42-n/a. Retrieved from http://search.proquest.com/docview/1525981385?accountid=13800

111 Tracey, D.H., & ;Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

112 Tracey, D.H., & ;Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

113 Al-Faki, I., & Siddiek, A. G. (2013). The role of background knowledge in enhancing reading comprehension. World Journal of English Language, 3(4), 42-n/a. Retrieved from http://search.proquest.com/docview/1525981385?accountid=13800

score increased to 18.70. The researchers also found a significant relationship between the pretest and posttest scores of the experimental group. In conclusion, as the experimental group received more background knowledge, reading comprehension was enhanced, and the researchers strongly believe that the results and implications of the study are applicable to other less culturally bound materials. Teacher guidance is crucial for helping students connect new information to existing schemas, and spending time on schema activation activities leads to better student performance[114].

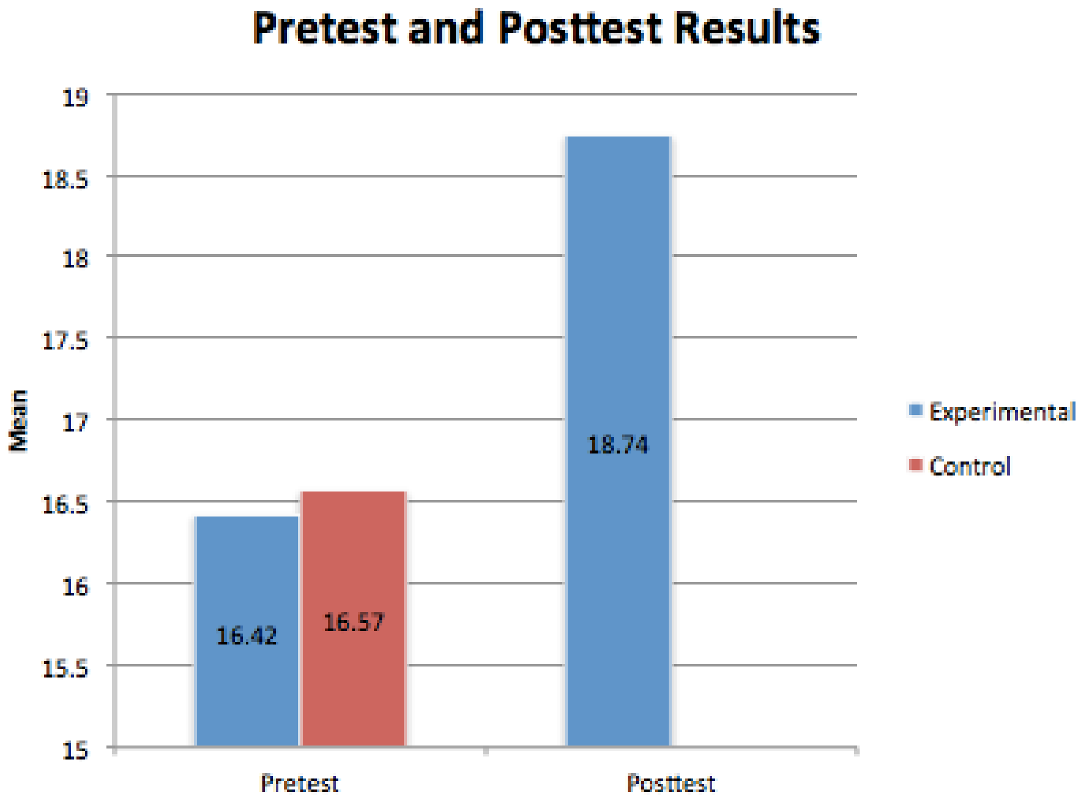

Figure 53 Comparison of mean pretest and posttest results of experimental and control groups on reading comprehension test.

20.5 Assessing Reading Progress

When children start school, one of the very first things they start to learn is reading. Formally learning to read starts in kindergarten and continues throughout our lifetime. When children are learning to read it is important to give them feedback and assess them along the way to see how they are doing. In order to gauge the success and improvement of a student's reading skills, there are some frequently assessed markers to determine one's

114 Maghsoudi, Najmeh. (2012). The impact of schema activation on reading comprehension of cultural texts among Iranian EFL learners. Canadian Social Science, 8(5), 196-201. doi:10.3968/j.css.1923669720120805.3131

reading progress: phonemic awareness, letter knowledge, and oral reading fluency [115]. Before children learn to print, they need to be aware of how the sounds of the letters in words work. Phonemic awareness is basically assessing just that, children need to have the ability to notice, think about, and manipulate the phonemic segments of spoken words [116]. If children are not aware of the sound structure of language they will be not be able to attend to the separate sounds in spoken words and thus will not be able to establish letter-sound correspondences [117]. It is believed that this letter-sound link is a foundational skill in decoding, and are important early skills in literacy [118]. Letter knowledge is measured by children's ability to name upper and lower case letters and know the sounds of each of the letters in the alphabet [119]. This is key for children to know because it is only when they understand the letters and their sounds that they can start to read. While reading, children have to know how to sound out words, decode them, and pronounce them and this is only possible if they have mastered the letters and their sounds. The third type of assessment used to measure early reading progress is known as reading fluency. This is basically trying to measure children's ability to read quickly, accurately, and with expression [120]. This type of assessment is controversial for some people because they don't believe that by reading quickly children have progressed. Reading quickly and accurately isn't the real purpose of reading, it's understanding and recalling what you have read that is important [121].

Effective assessment should be an ongoing process and shouldn't just stop after children can quickly read a text and understand it. Which is why there are some authentic assessment measures that teachers are able to use to determine students' skills and learning and to inform present and future instruction [122]. Teachers are able to use assessments such as oral and written story retellings which will informally measure students' reading comprehension, literacy portfolios can be used to showcase student's oral and written processes, products, and skills, and checklists can be used to help the teacher's observations of students and to determine students' literacy needs and growth [123].

115 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

116 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

117 Walsh, R. (2009). Word games: The importance of defining phonemic awareness for professional discourse. Australian Journal of Language & Literacy, 32(3), 211-225. Retrieved from `http://web.a.ebscohost.com.proxy.lib.sfu.ca/ehost/pdfviewer/pdfviewer?sid=e203b503-b43d-4f66-b2e9-2534fa1b2905%40sessionmgr4002&vid=13&hid=4104`

118 Walsh, R. (2009). Word games: The importance of defining phonemic awareness for professional discourse. Australian Journal of Language & Literacy, 32(3), 211-225. Retrieved from `http://web.a.ebscohost.com.proxy.lib.sfu.ca/ehost/pdfviewer/pdfviewer?sid=e203b503-b43d-4f66-b2e9-2534fa1b2905%40sessionmgr4002&vid=13&hid=4104`

119 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

120 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

121 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

122 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463

123 Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463

Assessing the reading progress of students' is important and makes teachers aware of what stage their students' are at. This will help teachers to better assist their students' needs. Assessing students has a lot of benefits to it but teachers should always be aware that assessing isn't everything and not all students can be assessed at the same time or in the same way.

20.6 Glossary

Bottom-up processing: An approach to information processing that involves piecing together smaller pieces of information and building up to bigger concepts.

Code-emphasis methods: Approaches to reading that stress the importance of decoding letters and words, and letter-sound correspondences.

Discourse: Structured, coherent sequences of language in which sentences are combined into higher order units, such as paragraphs, narratives, and expository texts, i.e., conversations [124].

Explicit phonics approach: Reading instruction in which the sounds associated with letters (letter-sound correspondences) are identified first independently, then are later blended together to form words.

Full Alphabetic Stage: Readers who, as they conclude the early stages of reading, can identify the separate sounds in words and understand that spellings correspond to pronunciation [125].

Implicit phonics approach: Reading instruction in which the sounds of letters are identified within the whole word rather than independently.

Meaning-emphasis methods: Approaches to reading that focus more on making meanings from the words and using one's general knowledge store.

Partial Alphabetic Stage: Readers who, in the early stages of reading, read by associating some but not all of words' letters with sounds [126].

Phoneme: The smallest unit of sound that makes up a word.

Phonemic Awareness: The ability to identify and manipulate the individual phonemes in a word.

Pragmatics: The meanings, messages, and uses of language [127].

Pre-Alphabetic Stage: It is the stage when children know quite a bit of literacy but do not know how to read any words.

124 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
125 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
126 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.
127 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

Schema: The idea of a mental framework that helps us organize knowledge and the relationships between these pieces of information.

Schema activation: The process by which textual stimuli signal the recall of relevant schemata from memory for the present reading task.

Semantics: The study of words and their meanings [128].

Syntax: Ways words in a language are grouped into larger units, such as in phrases, clauses, and sentences [129].

Top-down processing: An approach to information processing that involves using general knowledge to fill in what is known and working down towards smaller details.

Zone of proximal development: A concept created by Vygotsky that describes the area of learning between what a student is capable of doing by themselves, and what they can do with help, i.e., from a teacher, parents, or caregiver.

20.7 Recommended Readings

Bukowiecki, E. M. (2007). Teaching children how to read. Kappa Delta Pi Record, 43(2), 58-65. doi: 10.1080/00228958.2007.10516463

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188. doi: 10.1207/s1532799xssr0902_4

Hempestall, K. (2005). The whole language-phonics controversy: A historical perspective. Australian Journal of Learning Disabilities, 10(3-4), 19-33. doi: 10.1080/19404150509546797

Tracey, D.H., & Morrow, L.M. (2012). Lenses on Reading, Second Edition : An Introduction to Theories and Models. Guilford Press.

20.8 References

128 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

129 Bruning, R.H., Schraw, G.J., & Norby, M.M. (2011). Cognitive Psychology and Instruction (5th ed). Pearson.

21 Learning Mathematics

Mathematics contains many areas of study such as geometry, algebra, calculus, and probability; each requiring the mastery of specialized concepts and procedures. The challenges of teaching and learning mathematics can be understood and overcome through analysis of cognitive processes. In this chapter we examine cognitive theories and research that inform the practice of mathematics education. We discuss the relevant aspects of Piaget's theory of cognitive development and the criticism that it has received. We explain the factors that influence individual students' abilities to learn mathematics and how teachers can account for these factors when designing lessons.

21.1 What is Mathematics?

Mathematics is the study of numbers, quantities, geometry and space, as well as their relationships and functions. It utilizes a combination of **conceptual, procedural, and declarative knowledge**.[1] In order to successfully solve mathematical problems, students need to acquire this set of knowledge. To fully engage in their learning of mathematics, students must first gain a conceptual understanding, which requires utilizing background knowledge of learned concepts. Conceptual understanding of mathematics leads to the acquisition of more mathematical knowledge, helping to construct the other strands of mathematical proficiency: productive disposition, procedural fluency, strategic competence and adaptive reasoning. Growth in each proficiency leads to growth in the other proficiencies and leads to more knowledge. That is, conceptual knowledge enhances procedural knowledge and so on.[2] For example, there are many different algorithms in mathematics that students need to be familiar with. When students have a clear understanding of mathematical principles and concepts, they will be able to select and re-create the appropriate algorithm for any mathematical problem. This demonstrates the connection between conceptual knowledge and procedural knowledge because students can have many learned strategies but they have to select the correct one and build upon it.[3] In addition, when there are successes or failures while using certain procedures to solve complex mathematical problems, students can often learn more. Students can learn from their failure by self-questioning their mistakes and can reconstruct their existing knowledge. As a result, this increases their conceptual knowledge. Declarative knowledge is definitely related to both conceptual and procedural knowledge because it requires students to retrieve mathematical

1 Wong, B., Graham, L., Hoskyn, M., & Berman, J. (Eds.). (2008). *The ABCs of learning disabilities* (2nd ed.). Boston: Elsevier Academic Press.

2 Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction* (5th ed.). Boston: Pearson Education.

3 Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction* (5th ed.). Boston: Pearson Education.

concepts (i.e., conceptual knowledge) and specific mathematical algorithms (i.e., procedural knowledge) from the long-term memory. Deficiency in any one, or all, of these knowledge areas may cause learning difficulties in mathematics.[4] Thus, this combination of conceptual, procedural, and declarative knowledge influences learning since they are all associated with one another.

21.2 Cognitive Theory and Mathematics

21.2.1 Piaget's theory of Cognitive Development

Jean Piaget has indicated four primary stages of cognitive development from birth to young adulthood, these includes sensorimotor (from birth to age 2), preoperational (about age 2 to age 7), concrete operational (about age 7 to age 11), and formal operational (about age 11 to age 15). Although everyone progresses through these stages differently, Piaget believed that every child would eventually experience every stage of thinking in the sequence and no one would miss a stage because one would not be able to develop to the next stage until they understand the previous one; it's just a matter of time.

Piaget also pointed out that children's learning is usually developed through movement and the five senses from birth to age 2. During the infants' first few weeks, they start learning how to track objects and to get a hold of them by constantly practicing, which can help the parts of the brain that process and connect visual and motor behaviour to start developing. Once the infants recognize that learning follows by repetition, then they will start learning how to plan in advance and reach for the objects that they want by using a more efficient approach. Piaget claimed that infants are able to link numbers to objects at this stage[5] and there is also evidence that children have already acquired some knowledge of the concepts of the numbers and counting[6]. In order to develop the mathematical skills of infants at this stage, educators can offer activities that will integrate with numbers and counting. For example, educators can read books that have pictograms in them. This not only helps children to relate the pictures of objects to their corresponding numbers, but also helps build their reading and comprehension capabilities. During this period, Piaget has demonstrated that infants can already build their own ways of dealing with objects and knowledge about them, which can support gains reflective intelligence.[7] Since Piaget believed that an individual needs to build upon knowledge that is acquired from the prior stage and therefore cannot move to the next stage until the current stage is mastered. Thus, in order to enhance infants' understanding of numbers, educators can provide a general foundation of mathematics by engaging activities that incorporate counting.

4 Wong, B., Graham, L., Hoskyn, M., & Berman, J. (Eds.). (2008). *The ABCs of learning disabilities* (2nd ed.). Boston: Elsevier Academic Press.

5 Piaget, J. (1977). Epistemology and psychology of functions. Dordrecht, Netherlands: D. Reidel Publishing Company.

6 Fuson, K. C. (1988). Children's counting and concepts of numbers. New York: Springer.

7 Piaget, J. (1963). The origins of intelligence in children. New York, NY: W.W. Norton & Company, Inc.

Children start acquiring language ability, symbolic thought, egocentric perspective and some degree of logic at around age 2 to age 7. During this period, children learn how to employ problem-solving skills that integrate with objects, such as numbers, blocks, etc. Although children have already gained some knowledge of concepts of numbers, they only have limited logic association, and cannot process operations in a reverse order. For example, children who understand that 5+3=8 may not have the mindset that 3+5=8 also. According to Piaget, this is because children can only identify one aspect or dimension of an object with the loss of other aspects. In order to enhance the children's mathematical capabilities in this period, educators can ask them to build a specific object by using building blocks. While they are building it, they can learn how to group them based on their identical features, and also help them understanding that there are always multiple methods of combining them together.[8]

According to Piaget, children's cognitive development accelerates between ages 7 and 11. They can start using their five senses to distinguish objects, which can help them to identify two or three aspects of dimensions at once. For instance, Piaget used an experiment of pouring the same amount of liquid into different size containers. Children at this stage are able to notice the levels of liquid will be different based on the dimension of the container. Another major cognitive growth that occurs during this period is the ability of **classification** and **seriation** to separate objects.[9]Children learn classification by grouping objects based on similar features, and acquire the ability of seriation by categorizing objects based on their increased or decreased value, such as length, width, volume, etc. Even though they may have already acquired some basic arithmetical operations at this stage, they do not know how to apply these concepts into solving math problems. For example, when they are being asked to count the pieces that are made of 3 rows of 5 building blocks, they do not know how to apply multiplication while counting. In other words, the abstract concepts of arithmetic must be directly related to physically available elements and operations. This also implies that they are still not capable of setting up a consistent system based on measurement at this stage.

The final stage of cognitive development often occurs at around age 11 to age 15. At this stage, children are able to form their own theories and construct their own mathematics concepts. They can also relate abstract concepts to concrete situations now. For example, when they encounter an algebra problem, they are now able to solve it by themselves instead of having a teacher to refer to a concrete condition. The reason that they can now develop abstract thought patterns into concrete situations is that that they start building their reasoning skills, which includes **clarification**, **inference**, **evaluation**, and **application**. In order to make students comfortable with these concepts, teachers can teach students on how to separate the word problems and understand the differences between related and unrelated information in the problem.

8 Thompson, C. S. (1990). Place value and larger numbers. In J. N. Payne (Ed.), Mathematics for young children (pp. 89–108). Reston, VA: National Council of Teachers of Mathematics.

9 Piaget, J. (1977). Epistemology and psychology of functions. Dordrecht, Netherlands: D. Reidel Publishing Company.

Piaget believed that if a child has a difficulty understanding a concept, it is because of the too-rapid progress from the qualitative structure of the problem to the mathematical formulation. According to Piaget, in order to help the children to understand the concept, teachers should find an active approach that allows children to explore spontaneously, so they can learn and reconstruct their own concept, instead of having the teachers to give them the answers directly. [10]

21.2.2 Critiques of Piaget's Theory

Piaget's belief of cognitive development	**Criticism**
1) Children start developing an understanding of the object permanence	• Piaget overlooked children's need for motivation • Children's memory capacity has increased
2) Children's sensory abilities and cognitive development occur in their first 6 months of birth	• Not all learners are the same, they might be placed in a higher or lower category based on their unique abilities
3) Every child will experience the four stages in a specific order	• Piaget neglected the external factors, such as heredity culture, and education
4) Piaget separated the cognitive development into definite stages	• The stages of cognitive development should be viewed as a gradual and continuous progress

Even though Piaget's theory is widely used by teachers to monitor their students' cognitive development in the classroom nowadays, his theory is controversial. Lots of educators rely on Piaget's theory to measure students' readiness for learning math. On the other hand, Hiebert and carpenter advised that Piaget's theory is not a useful guide, as lots of researches have proved that children who fail to follow Piaget's theory are still able to learn the math concepts and skills.[11] While Piaget focused on children's internal exploration for knowledge, and believed that children start developing an understanding of object permanence (such as how to track for a hidden object) from birth to age 2, other researchers argue that Piaget neglected the children's need for motivation. Berger believes that external motivations and teachings play an important impact also.[12] Kagan believes that the reason why an infant is able to reach for objects even with displacement is because their memory capacity has increased, not, as Piaget pointed out, in terms of the new cognitive structure.[13] Piaget has also been criticized for broadly speaking of children's abilities. He deduced that children's sensory abilities and cognitive development occur in their first six months of birth. While Piaget believed that each child must go through those stages in a particular order, Heuvel-Panhuize argued that Piaget's theory underestimates young children's abilities. For example, he found that since early childhood teachers' belief of stages of cognitive development deeply relied on Piaget's theory, they may have lower expectations for children's

10 Piaget, J. (1968). Genetic epistemology. New York, NY: Columbia University Press Retrieved June 13, 2003 from the World Wide Web: `http://www.marxists.org/reference/subject/philosophy/works/fr/piaget.htm`

11 Hiebert, J., and T. P. Carpenter. "Piagetian Tasks as Readiness Measures in Mathematics Instruction: A CriticalReview." EDUCATIONAL STUDIES IN MATHEMATICS 13: 329-345, 1982

12 Berger, K.S. (1988). The developing person through the life span (2nd ed.). New York: Worth Publishers Ltd.

13 Berger, K.S. (1988). The developing person through the life span (2nd ed.). New York: Worth Publishers Ltd.

knowledge of symbols, the counting sequence, and arithmetic operations than what the children are actually capable of.[14] Beger also argued that their perceptual learning might actually develope before birth.[15] Even though a child is supposed to be in a certain stage based on his or her age, not all learners are the same. They might be placed in a higher or lower stage based on their unique abilities. For instance, Gelman and Gallistel have pointed out that children in their preoperational stage are capable of thinking abstractly in terms of counting objects. In addition, Piaget fails to demonstrate the aspects of emotional and personality development of children. Even though Piaget's theory explains an effective approach that can measure children's intelligence and memory development, he neglects the remarkable aspects of creativity and social interaction of individuals.[16] Christina Erneling argues that the pattern of development can be established only if the children are put in the right conditions. She believes that any concepts of learning require an expansive theory of education, and the fundamental part of cognitive development is to acknowledge the differences of an individual's social and cultural backgrounds. In other words, Piaget seemed to be overlooking cultural effects. Since his research was done in a Western country, his theory of cognitive development may only represent Western society and culture. According to Piaget, scientific thinking and formal operations can only be reached at a certain stage. On the other hand, Edwards et. al argued that Piaget's research was unreliable due to the lack of controls and small samples. He believed that there could a higher regard for the basic level of concrete operations in other cultures.[17] Beger also argues against Piaget's definite stages, he judges that Piaget had explicitly explained the children's internal search for knowledge, but he tended to overlook the external factors, such as heredity, culture, and education. He suggested that Piaget's stages of cognitive development should rather be seen as a gradual and continuous progress instead of separating into definite stages.[18] Piaget's theory has also been criticized for not offering a sufficient description of cognitive development in his last stage. He supposed that everyone will be able to develop abstract reasoning between age 11 to age 15. On the other hand, Paplia et.al believes that not everyone can acquire the skills of formal operations at this stage. And even though they may not attain this ability, it does not mean they are immature. We can only conclude that they have different phases of mature thought.[19] Hence, a more persuasive belief of cognitive development should be perceived as an irregular process as children attain new skills and different behaviors individually at each stage.[20]

14 Cross, C. (2009). The Early Childhood Workforce and Its Professional Development. In Mathematics learning in early childhood paths toward excellence and equity. Washington, DC: National Academies Press.

15 Berger, K.S. (1988). The developing person through the life span (2nd ed.). New York: Worth Publishers Ltd.

16 Papalia, D. E., Olds, S. W., and Feldman, R. D. (1998). Human development(7th ed.). Boston: McGraw-Hill.

17 Edwards, L., Hopgood, J., Rosenberg, K., & Rush, K. (2000). Mental Development and Education. Retrieved April 25, 2009, from Flinders University

18 Berger, K.S. (1988). The developing person through the life span (2nd ed.). New York: Worth Publishers Ltd.

19 Papalia, D.E., Olds, S.W., & Feldman, R.D. (1998). Human development (7th ed.). Boston: McGraw-Hill.

20 Berger, K.S. (1988). The developing person through the life span (2nd ed.). New York: Worth Publishers Ltd.

21.2.3 Cognitive Domains

Cognitive theory and its relevance to learning mathematics has come a long way since Piaget. Numerous studies have been done which demonstrate the relationships between different cognitive abilities and mathematical abilities. As early as 1978, researchers were studying the relationship between academic abilities and patterns of brain related behaviour. In 1978, Rourke and Finlayson studied 9-14 year old children with learning disabilities and found that children lacking abilities in arithmetic performed as would be expected if their right cerebral hemisphere was not functioning correctly.[21] More recent studies have been able to identify repeating patterns of even more specific relationships for cognitive abilities and functional deficiencies in math.

In 2001, Hanich, Jordan, Kaplan and Dick studied the mathematical performance of grade 2 students.[22]. Children were divided into four groups, consisting of normal achieving students, children with math deficiencies, children with reading deficiencies, and children with both math and reading deficiencies. Children in each of the four groups were given seven mathematics tests in the same order, to assess performance in: a.) exact calculation in arithmetic combinations, b.) story problems, c.) approximate arithmetic, d.) place value, e.) calculation principles, f.) forced retrieval of number facts, and g.) written computation. They found that children with math and reading deficiencies struggled with both word problems and with standard computation (such as number facts, number combination and procedural computations); whereas children deficient in just math struggled only with standard computational skills. This, and subsequent studies, have led researchers to conclude that there is more than one cognitive domain for math, with each domain using different processes of the brain.

Fuchs, Fuchs, Stuebing, Fletcher, Hamlett, and Lambert noted that a number of studies have consistently found that predictors for computational success include: a.) working memory, b.) visual-spatial working memory, c.) attention ratings, d.) phonological processing (detecting and discriminating differences in speech sounds), and e.) vocabulary knowledge (2008)[23]. During a long-term, large scale study of students who were randomly sampled, the authors undertook to determine whether or not problem solving and computation were distinct aspects of mathematics. The authors assessed students for computational and word-problem solving abilities, phonological skills, non-verbal problem solving, working memory, attentive behaviour, processing speed, and reading skills. They found that attentive behaviour and processing speed played dominant roles for computational difficulty.

Further, Fuchs et al also noted that working memory, short term memory, non-verbal problem solving (ability to complete patterns presented visually), concept formation, and language ability (including reading) were all predictors of problem solving ability. They also noted that deficiencies in language skills was a discerning factor for students who exhibited problem solving difficulties.

21 Rourke, B. P., & Finlayson, M. A. J. (1978). Neuropsychological significance of variations in patterns of academic skills: Verbal and visual-spatial abilities. Journal of Abnormal Child Psychology, 6, 121–133.

22 Hanich, L. B., Jordan, N. C., Kaplan, D., & Dick, J. (2001) Performance across different areas of mathematical cognition in children with learning disabilities. Journal of Educational Psychology, 93, 615–626.

23 Fuchs, L. S., Fuchs, D., Stuebing, K., Fletcher, J.M., Hamlett, C. L. , & Lambert, W. (2008). Problem solving and computational skill: Are they shared or distinct aspects of mathematical cognition? Journal of Educational Psychology 100 (1), 30

Processes of the brain for each cognitive math domain

Computation Cognitive abilities	**Problem Solving Cognitive abilities**
Predictors for computational success:	Predictors for problem solving success:
• Working memory 1. Auditory working memory 2. Visual-spatial working memory • Attention ratings• Processing speed• Language ability 1. 2. Phonological processing (detecting and discriminating differences in speech sounds) 3. Vocabulary knowledge	• Working memory 1. Auditory working memory • Short term memory• Non-verbal problem solving (ability to complete patterns presented visually)• Concept formation• Language ability 1. 2. First language, cultural differences 3. Phonemes, vocabulary

21.2.4 The Importance of Working Memory in Learning Mathematics

Working memory is the system responsible for temporarily holding new or previously-stored information which is being used for the completion of a current task. Its capacity is limited. There are two types of working memory: auditory memory and visual-spatial memory. Visual-spatial memory has been found to be important for solving computational problems. Auditory memory has been found to be important for all mathematical domains. The variation of an individual's capacity for working memory may be due to how fast information is processed, one's knowledge, or one's ability to ignore irrelevant knowledge.[24] Executive processing activities, such as planning, organization and flexible thinking, may also affect working memory. [25]

On the other hand, **short term memory** is responsible for temporarily storing information which must be used, but not necessarily manipulated. Again, the capacity for short term memory is limited, maybe only a few seconds. This is where we store information such as a telephone number we need to remember for only a few seconds while we dial it.

In their study, The Relationship Between Working Memory and Mathematical Problem Solving in Children at Risk and Not at Risk for Serious Math Difficulties (2004), Swanson and Beebe-Frankenberger concluded that working memory plays a critical role in integrating information during problem solving. They argue that working memory is highly important to integrating information during problem solving because "(a) it holds recently processed information to make connections to the latest input and (b) it maintains the gist of information for the construction of an overall representation of the problem."[26]

A new study by H. Lee Swanson suggests that the capacity of working memory moderates the influence of cognitive strategies on problem solving accuracy.[27] The author conducted an intervention study to ascertain what role working memory capacity played in strategy intervention outcomes and the role of strategy instruction on word problem solving accuracy.

24 Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem-solving in children at risk and not at risk for serious math difficulties. Journal of Educational Psychology, 96, 471–491

25 Swanson, H. L. (2003). Age-related differences in learning disabled and skilled readers' working memory. Journal of Experimental Child Psychology, 85, 1–31.

26 Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem-solving in children at risk and not at risk for serious math difficulties. Journal of Educational Psychology, 96, 471–491.

27 Swanson, H. L. (August 4,2015). Cognitive strategy interventions improve word problem solving and working memory in children with math disabilities. Front Psychol., 2015; 6: 1099. Retrieved from doi: 10.3389/fpsyg.2015.01099

Both verbal and visual-spatial working memory were measured for all children in the study group. Children, both with and without math disabilities, were were then divided into three treatment groups for a randomized control trial. Group 1 was given verbal strategies for problem solving; Group 2 was given visual-spatial strategies for problem solving; and Group 3 was given a combination of both verbal and visual-spatial strategies. Each of the groups was also provided with lesson plans that regularly increased irrelevant information within the word problems. The author's strategy of adding irrelevant information was meant to teach the children to attend to relevant information only. This strategy was prompted by a number of other studies which showed that learning to differentiate between relevant and irrelevant information is significantly correlated with problem solving accuracy for students at risk for math disabilities.

The results of the study support the view that strategy instruction facilitates solution accuracy. However, it must be noted that the effects of strategy instruction were moderated by individual differences in working memory capacity. Those children with low working memory capacity did not benefit as much as expected. It was the children with higher working memory capacity, both with and without math disabilities, who were most likely to benefit from the learning strategies. All children with math disabilities, whether possessing high or low working memory capacity, did benefit from strategies that used visual information, however children with low working memory capacity needed the combination of both verbal and visual strategies. Lastly, the results suggest, academic tasks that train processes related to working memory for controlled attention may, in fact, influence later working memory performance.

Implications of this study would suggest that students with math disabilities be evaluated for working memory capacity and then strategies for addressing their individual concerns be determined based on their working memory capacity.

21.3 Factors that Affect Learning and Teaching Mathematics

21.3.1 Individual Differences

Every learner has their own distinct skills, background knowledge, culture, and interests. These aspects can affect learning and teaching mathematics because instructional strategies should be modified accordingly.

Differences in Skills

All learners have their own strengths and weaknesses. They may be skilled in some aspects in mathematics but may be incompetent in another area. It is important for teachers to know what skills the students have because they can utilize these skills to help improve the students' weaknesses. If teachers do not recognize the students' strengths and weaknesses, they might give students challenges. Students will face difficulty in the the given task because they do not have the required skills. As a consequence, it may even influence the students' self-efficacy and create learned helplessness when students cannot accomplish the task. Hence, if teachers know what students are proficient in, then students will not have problems in learning new knowledge of mathematics. Mathematical problems require a set of pre-skills such as simple arithmetic, algebra and logic reasoning. For instance, solving word problems require mental representation of the problem and simple arithmetic to transform the word problem into a mathematical equation. As a result, students who are not skilled at formulating a mathematical equation will not be able to solve the word problem.[28] Teachers should adjust their instructional practices according to the different pre-skills that the students have because these pre-skills play a big part in solving mathematical problems. When students gain more conceptual and procedural skills in mathematics, they become more competent and efficient in learning mathematics.[29] In modern high schools, there are different levels in the course of mathematics such as beginner, principle, and advance level. Students are placed accordingly to their set of mathematical skills level. Otherwise, they can choose which level they want to be in. In this case, it is important that teachers support and evaluate the students' performance to see whether or not if they are suitable in the chosen level. Students do not want to be in a math class that is too difficult or else it would be too overwhelming, neither should it be too easy or else it would be too boring. Hence, by knowing what skills the students have, students can achieve new mathematical knowledge.

Differences in Background Knowledge

Students' knowledge of mathematics can be affected from their background knowledge. Indeed, all students have different background knowledge because they all have different experiences in the social world. These real-life experiences are crucial because they learn about the functionality of mathematics symbols from these observations. For example, students can learn simple arithmetic from grocery shopping which involves dealing with money. Students can learn how to estimate the total cost of goods and how much change they should received back. Therefore, when mathematical concepts are taught in a way that is related to their background knowledge, students will be able to interpret these concepts more easily.[30] In addition, students are more motivated and engaged when their learnings of mathematics are related to their real-world situations. This is because they find the acquired learnings very meaningful and important as they are applicable in their daily living.[31] For instance, many students might find learning mathematics from a textbook boring or difficult. However, if mathematics are taught to solve real-life problems such as calculating the interest gained in the bank, the total cost of living expenses, or the probability of winning in a poker game. As a result, students will have a better understanding of mathematical symbols and concepts when these learnings are related to their prior experiences. In addition, challenging mathematical problems not only require background knowledge of mathematics, but also some knowledge of other subject areas such as physics terms or

28 Wong, B., Graham, L., Hoskyn, M., & Berman, J. (Eds.). (2008). *The ABCs of learning disabilities* (2nd ed.). Boston: Elsevier Academic Press.

29 Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction* (5th ed.). Boston: Pearson Education.

30 Wong, B., Graham, L., Hoskyn, M., & Berman, J. (Eds.). (2008). *The ABCs of learning disabilities* (2nd ed.). Boston: Elsevier Academic Press.

31 Wong, B., Graham, L., Hoskyn, M., & Berman, J. (Eds.). (2008). *The ABCs of learning disabilities* (2nd ed.). Boston: Elsevier Academic Press.

chemistry terms.[32] Mathematical word problems require a good understanding of the text meaning before it can be solved which means that students need to be able to utilize their language knowledge to comprehend the text. As a result, students' background knowledge can impact their learning in mathematics. For instance, many math courses in University require prerequisite courses because the advance level math courses require understanding of some basic mathematical knowledge. Without these background knowledge, students will have difficulty comprehending the new math materials.

Differences in Interests

Everyone has different interests. Some students might enjoy mathematics because they were born or taught at a young age with strong mathematical skills, while other students might hate mathematics because they always face failure with mathematics which discourages them to continue to learn. Having interests in mathematics can increase students' motivation to learn mathematics. This concept is an **intrinsic motivation** because students want to study mathematics out of their own interests.[33] As a result, they are more engaged in the tasks and would try their best to solve the challenge. Students' interests are related with their beliefs on their self-perceptions, their ability, and their academic achievement.[34] Thus, it is important to develop interests in mathematics for students in order to increase their academic performance. Indeed, there are many ways to increase interest in mathematics such as family, classmates, and teachers.[35] Family can show support and encouragement to students in mathematics at home which can increases students' value on mathematics. Students usually have social comparisons and like to follow what other classmates are doing. Hence, classmate influences play a big role in students. When students see their classmates enjoying a mathematics problem or game such as sudoku or a puzzle, students will also be interested in solving. Most importantly, teachers can organize fun and interactive games in a classroom setting while showing enthusiasm in their teaching.[36] This will enhance students' interests in learning a subject they do not enjoy. As a result, it is important that teachers create an enjoyable setting for students to learn in order to promote interests in mathematics. It would be very difficult to teach students mathematics if the learners hate mathematics. They will not want to learn the materials and only study because they have to.

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32 Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction* (5th ed.). Boston: Pearson Education.

33 Bruning, R., Schraw, G., & Norby, M. (2011). *Cognitive Psychology and Instruction* (5th ed.). Boston: Pearson Education.

34 Upadyaya, K., & Jacquelynne, S. E. (2014). How do Teachers' Beliefs predict Children's Interests in Math from Kindergarten to Sixth Grade? *Merrill-Palmer Quarterly, 60*(4). Retrieved from `http://web.b.ebscohost.com.proxy.lib.sfu.ca/ehost/pdfviewer/pdfviewer?sid=aaa92fa2-22f8-4cd7-9d94-49896f602e89%40sessionmgr120&vid=0&hid=109`

35 Frenzel, A.C., Goets T., Pekrun R., & Watt, H.M.G. (2010). Development of Mathematics Interest in Adolescence: Influences of Gender, Family and School Context. *Journal of Research on Adolescence, 20*(2), 507-537. doi:10.1111/j.1532-7795.2010.00645.x

36 Frenzel, A.C., Goets T., Pekrun R., & Watt, H.M.G. (2010). Development of Mathematics Interest in Adolescence: Influences of Gender, Family and School Context. *Journal of Research on Adolescence, 20*(2), 507-537. doi:10.1111/j.1532-7795.2010.00645.x

Cultural Differences

Students with different cultural background have different academic achievement levels and different goals.[37] Also, their values on mathematics might be different depending on their culture. When a culture values a particular subject such as mathematics, these children tend to be trained at a young age at school and at home. Hence, these students will have a higher efficiency of mathematics performance. Students who study mathematics regularly are likely to have a high level of automaticity because they have sufficient practices of the mathematical problems. They will be able to select the appropriate strategy and solve the mathematical problem more efficiently.[38] Vice versa, when a culture does not believe that mathematics is important, these children might not be taught vigorously and will performed at lower competence levels. In order to excel in a subject area, it is important to have practices both at school and at home. Students who only practice their mathematics skills at school by the teachers' support do not have enough training because they are not encouraged to study actively and intensively at home. In addition, cultures that hold positive beliefs on performance such as high standards, effort, and positive attitudes can lead to high academic proficiency levels.[39] Different cultures have different languages. By all means, their way of wording a mathematical problem may also differ. Research shows that the structure of Chinese number languages (e.g., 15 is ten five) is easier to learn than Indo-European number languages which is English (e.g., 12 is twelve and -teens words are often inconsistent).[40] It is often to faster to pronounce Chinese number languages than in English which affects students' mathematics efficiency. Hence, Chinese has the ability to retain these numbers in short-term memory longer especially in complex mathematical problems with multi-digit numbers.[41] Cultural differences should be taken into consideration when designing instructional practices since different students have different cultures that can affect how they approach mathematical problems.

21.3.2 Self-Efficacy in Mathematics

Students' self-efficacy in math is their belief in their ability to solve math questions. Students with a higher level of self-efficacy believe that they are capable in solving math questions, which they are more likely to engage in math-related tasks and have higher academic performance in math. On the other hand, students with low self-efficacy believe that they are

37 Tsao, Y-L. (2004). A Comparison of American and Taiwanese Students: Their Math Perception. *Journal of Instructional Psychology, 31*(3). Retrieved from `http://web.b.ebscohost.com.proxy.lib.sfu.ca/ehost/pdfviewer/pdfviewer?sid=97c91599-4222-4cc8-8717-703e6b774b06%40sessionmgr110&vid=19&hid=109`

38 Imbo, I., & LeFevre, Jo-Anne. (2009). Cultural differences in Complex Addition: Efficient Chinese versus Adaptive Belgians and Canadians. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(6),1465-1476. doi:10.1037/a0017022

39 Imbo, I., & LeFevre, Jo-Anne. (2009). Cultural differences in Complex Addition: Efficient Chinese versus Adaptive Belgians and Canadians. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(6),1465-1476. doi:10.1037/a0017022

40 Imbo, I., & LeFevre, Jo-Anne. (2009). Cultural differences in Complex Addition: Efficient Chinese versus Adaptive Belgians and Canadians. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(6),1465-1476. doi:10.1037/a0017022

41 Imbo, I., & LeFevre, Jo-Anne. (2009). Cultural differences in Complex Addition: Efficient Chinese versus Adaptive Belgians and Canadians. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 35*(6),1465-1476. doi:10.1037/a0017022

not capable in solving math questions, which they will feel more anxious in solving math questions and have lower academic performance in math. Therefore, students' self-efficacy in math has strong connections with their engagement and academic performance in math.

Self-Efficacy's Impact in Math

Self-efficacy can influence the way students think, understand, and feel about their learning in math. Students with high self-efficacy believe that they have the ability and skill to perform well in math.[42] Having the thought that they are capable in solving math, students will be more motivated to learn and study math. By doing so, students will encounter self-fulfilling prophecy which fits their belief of their ability in math when their math improved after they studied. On the other hands, students with low self-efficacy in math will believe that they do not have the ability to perform well in math. [43]With this belief, students might have the thought that they cannot achieve math even if they tried very hard. Therefore, they are less motivated in doing math questions. Also, students with low self-efficacy in math might give up easily after a few trials of questions by thinking that they do not have the ability to get the right answer. When they do so, it reinforces their belief of their disability in math. The student will encounter self-fulfilling prophecy which they act in a way that fulfill their belief in their low ability in math.

Assessing Students' Self-Efficacy

It is important to assess students' self-efficacy and know whether or not if they are confident in learning a particular topic in math because it may affect their performance. One of the ways to assess students' self-efficacy is to construct a list of first-person statement and have students to rate their self-efficacy for each statement. [44] First, teachers have to identify the topic that they would like to assess their students' self-efficacy on. For instance, if the topic is on finding surface area, teachers then construct a list of first-person statements on that topic. Then teachers can have students to rate the statement using a scale range from 0-100 (0 which the statement is false and 100 which the statement is true).[45] The following chart is an example of a student's rating his self-efficacy on the topic of surface area.

Rate (0-100)	**Statement**
80	I know what information do I need in order to find the surface area for a parallelogram.
100	I can find the surface area of a rectangle when given the length and width.

42 Schunk, D. H., & Zimmerman, B.J. (2006). Competence and control beliefs: Distinguishing the means and ends. In P.A. Alexander & P.H. Winne (Eds.), Handbook of educational psychology (2nd ed., pp.349-367). Yahweh, NJ: Erlbaum.

43 Schunk, D. H., & Zimmerman, B.J. (2006). Competence and control beliefs: Distinguishing the means and ends. In P.A. Alexander & P.H. Winne (Eds.), Handbook of educational psychology (2nd ed., pp.349-367). Yahweh, NJ: Erlbaum.

44 Bandura, A. (1997). Self-efficacy: The exercise of control.New York, NY:Freeman.

45 Bandura, A. (1997). Self-efficacy: The exercise of control.New York, NY:Freeman.

Rate (0-100)	Statement
60	I can write the equation for the surface area of a trapezoid.
50	I can explain to my classmate why the equation for the surface area of a triangle is bxh $\div 2$.
90	I can calculate the area for a square which have the length of 4cm.

After the student rated the statement, the teacher can estimate how confident the student is on that topic by adding up the scores. For the above example would be 80+100+60+50+90. From the scores, the teacher will have an idea on student's self-efficacy on that topic. Furthermore, the teacher can compare student's self-efficacy for a particular topic to their general efficacy in math. Also, when assessing students' self-efficacy, teachers should keep in mind that students' self-efficacy may impact their learning motivation and learning behavior. Therefore, teachers should adjust their teaching instructions to increase students' self-efficacy and match their level respectively.

Development of Students' Self-Efficacy

Bandura has proposed four major influences on the development of self-efficacy.[46] The first influence is students' mastery experiences.[47] For instance, when students succeed in a math test, their level of confidence in that area of math will go up. This will have a positive effect on students future performance, which students will be more confident that they have to ability to solve it when facing similar questions. The second influence is students' various experience.[48] By observing others, especially peers with similar ability, students self-efficacy in doing a particular task will increase. When the teacher introduced a new topic in math, which students are uncertain about the level of difficult for that topic, by observing their peers completing the questions, their level of confident in understanding and completing the questions in the new topic will go up. Moreover, even watching a documentary on mathematicians doing math improves students' math self-efficacy.[49] The third influence is social persuasion.[50] This could be a positive phrase from the people which the students interact with, such as their parents, peers or teachers. Positive feedback from the teacher, such as "you are getting better in solving algebra questions" will increase students confident in solving algebra questions. The fourth influence is students psychological state.[51] This refers to students emotional reaction toward a situation. For example, a student might feel that her failure of a math test is due to her inability of math, which in reality is a result of

46 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

47 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

48 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

49 Hekimoglu, S., & Kittrell, E. (2010). Challenging students' beliefs about mathematics: The use of documentary to alter perceptions of efficacy. PRIMUS: Problems, Resources, And Issues In Mathematics Undergraduate Studies, 20(4), 299-331. doi:10.1080/10511970802293956

50 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

51 Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ, US: Prentice-Hall, Inc.

her anxiety. In this case, student misjudged her ability and lowered her confident in math. Another case might be student seeing her successful performance in a math test as luck, instead of her ability in performing well. In this case, the student lost a chance of building her confident in math. Therefore, students perception toward both positive and negative situations have an effect on building their self-efficacy. The way to increase students self-efficacy in this route is to have them to recognize their true ability in math and increase their positive feelings of their ability.

Usher has conducted a research on measuring the four different sources of middle school students self-efficacy's development in math, by interviewing the students, parents, and teachers. [52]The result of the research is consistent with Bandura's proposed idea on the development of self-efficacy, which mastery performance, vicarious experiences, social persuasion and physiological states all have a connection with students confidence in math. For mastery performance, it showed a strong relationship with students development of self-efficacy. A strategy that usher suggested which math teacher can use to increase students confident through mastery performance is to "deliver instruction in a way that maximize the opportunity for mastery experiences, however small."[53] For instance, a teacher could teach the students the correction strategy on math topic like algorithm and algebra. An example question is $18 \div 6 = ?$. The teacher could teacher the students to self-check the answer by multiplying the quotient by the divisor (3 x 6= 18) and if the answer is the same as the dividend, then is correct. Students who have been taught and used the correction strategy had increased their mastery performance in math.[54] Assign challenging assignments for students which are within their ability to complete it will also increase students' mastery experience.

In addition, some evidence in the usher's research has shown that the four sources have a connection with each others too. For vicarious experiences, the finding has shown that both of the parents and the teachers' experience with math have a connection with students math confident. One of the compelling finding in the research is which a student interpreted his parents' failure in math as evidence that he could be different.[55] This shows that not only successful experiences, unsuccessful experiences with math could have a connection with have students math confident. The finding also shows students' physiological states would have an affect on how they interpret others' experience. For social persuasion, the finding has shown that the messages both parents and teachers have sent to the children could largely impact student's belief in their ability.[56] For instance, a message that belief math is a fixed ability would result in students lack of motivation. So, if parents tell their children that with math ability is either they have it or not, their children might end up believing

52 Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. American Educational Research Journal, 46(1), 275-314. doi:10.3102/0002831208324517

53 Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. American Educational Research Journal, 46(1), 275-314. doi:10.3102/0002831208324517

54 Ramdass, D., & Zimmerman, B. J. (2008). Effects of self-correction strategy training on middle school students' self-efficacy, self-evaluation, and mathematics division learning. Journal Of Advanced Academics, 20(1), 18-41.

55 Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. American Educational Research Journal, 46(1), 275-314. doi:10.3102/0002831208324517

56 Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. American Educational Research Journal, 46(1), 275-314. doi:10.3102/0002831208324517

that they do not have the ability to perform well and lower their confident in math. In this case, social persuasion could have an affect on students' physiological sates.

Teachers Efficacy

Teachers' teaching efficacy refers to the belief that they can make a significant change in their students,[57]such as students' academic performance, self-efficacy, motivation, attitude and interest in learning. In order for teachers to establish a high level of teaching efficacy, they need to have a positive attitude, rich pedagogical knowledge and content knowledge toward their teaching subject. Teachers' attitude towards math may have a strong influence on students' attitudes and academic performance. A study has examined teachers' attitudes toward math in four different groups through interviewing the teachers and having them to complete a teacher attitude scale.[58] The four different groups are K-4 teachers, middle school teachers, other educators (Principals, other administrators) and special education teachers. The result indicated that among the four groups, middle school teachers have the strongest positive attitude toward math (60% strongly positive, 30% neutral, 10% strongly negative), whereas K-4 teachers have the strongest negative attitude toward math (43% strongly positive, 23% neutral, 34% strongly negative). [59] The result shows that math is less emphasize and valued in elementary level then in middle school level. By having a negative attitude towards math, teachers are less likely belief that they can make a change in their students' learning, which is correlated to their teaching efficacy. Teachers' pedagogical knowledge and content knowledge in math are also factors that affect their teaching efficacy. A current research has studied teachers' math pedagogical knowledge and math content knowledge in relation to teachers' teaching efficacy and students' achievement in the topic of algebra i.[60] The result have found that they are strong correlation between teacher's teaching efficacy with their pedagogical knowledge and content knowledge, which indicating that teachers with a rich pedagogical knowledge and content knowledge are more confidence with their teaching and more likely to believe that they can make a significant change in their students' learning.[61]

Teachers' teaching efficacy can affect students' learning in many different ways. One of the more observable factors is students' academic achievement. A study had conducted K-12 school teachers' self-efficacy beliefs and found that their self-efficacy beliefs are positively associated with students' achievement. [62] Besides students' achievement, teachers' teaching efficacy could also affect student motivation, interest and strategies use in learning. This is because teachers with higher teaching efficacy are more likely to use praise instead criticism,

57 Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teachers' sense of efficacy and beliefs about control. Journal of Educational Psychology, 82(1), 81-91. doi:10.1037/0022-0663.82.1.81

58 Kolstad, R. K., Hughes, S., & Briggs, L. D. (1994). Teacher attitudes toward mathematics. Journal Of Instructional Psychology, 21(1), 44-48.

59 Kolstad, R. K., Hughes, S., & Briggs, L. D. (1994). Teacher attitudes toward mathematics. Journal Of Instructional Psychology, 21(1), 44-48.

60 Fox, A. M. (2015). Teacher self-efficacy, content and pedagogical knowledge, and their relationship to student achievement in algebra i. Dissertation Abstracts International Section A, 75,

61 Fox, A. M. (2015). Teacher self-efficacy, content and pedagogical knowledge, and their relationship to student achievement in algebra i. Dissertation Abstracts International Section A, 75,

62 Chears-Young, J. B. (2015). The association between math teachers' moral judgment development and self-efficacy beliefs, and their relationship with student achievement. Dissertation Abstracts International Section A, 76,

to be more accepting and more task oriented. [63] Another research has found that teachers with higher efficacy will teach their students more learning strategies and have more focused academic learning time, which will increase students' performance.[64]

21.3.3 Self-Regulated Learning

People might think that students' low mathematics achievement is due to their low ability in math or the consequences of not studying. But that may not be the case in all situations. Sometimes, students' low mathematics achievement might be a result of not using the most appropriate strategies to study due to their lack of **self-regulated learning** skills. Self-Regulated Learning is students' ability to control all aspect of their learning, from advance planning to how they evaluate their own performance afterward [65]. There are three core components for self-Regulated Learning. The first one is metacognitive awareness, which refer to how students' set their goal and their plan of reaching that goal. [66]The second one is strategies use, which refer to a list of self-regulated strategies that students could apply to their studying. Skilled learners use more effective strategies when they are learning.[67] The last one is motivation control, which is students' ability to set goals and their positive belief on their academic skills and performance.[68] The ability of self-regulated learning has a big impact on students' mathematic achievement. Students will use better strategies and have a better understanding on how to study mathematics, when their self-regulated learning skills improved, which will increase this mathematic achievement.

Mathematics Self-Regulated Learning Program Study

A research in Southeast Asia had established a mathematics self-regulation learning program and the result had shown that when students are being taught with self-regulated learning skills, their mathematic achievement increases. The research involved with 60 lower mathematic achieving students in elementary level. 30 students are being placed in the experimental group, which they have to attend a mathematics self-regulated learning program.

This program contains 30 sessions, which serve a purpose of increasing students' self-regulated learning skill by increasing their motivational control and teaching them the self-regulation strategies. (Sessions 1-5) The program started with developing students' self-regulation belief system. They introduced students' to the value of personal responsibility, self-efficacy, learning goal and attribution to effort by lecturing students with storytelling

63 Kagan, D.M. (1992). Implications of research on teacher belief. Educational psychologists, 27, 65-90.

64 Ghaith, G., & Yaghi, H. (1997). Relationships among experience, teacher efficacy, and attitudes toward the implementation of instructional innovation. Teaching and Teacher Education, 13, 451-458.

65 Zimmerman, B. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp.13-39). San Diego, CA: Academic Press.

66 Zimmerman, B. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp.13-39). San Diego, CA: Academic Press.

67 Zimmerman, B. J., & Martinez-Pons, M. (1990). Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. Journal of Educational Psychology, 82, 51-59.

68 Zimmerman, B. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp.13-39). San Diego, CA: Academic Press.

and having them to share their ideas in a group.[69] (Sessions 6-11) Then, they introduced students the 14 self-regulated learning strategies that were proposed by Zimmerman.[70] Each strategy was explained by emphasizing its usage and important in learning mathematics. Afterward, students are given the opportunity to practice each strategy on their own. (Sessions 12-30) Lastly, students are guided to apply self-regulated learning strategies in their regular mathematic lessons. Also, they have to evaluate their own progress by completing the goal setting, self-evaluation and self-consequating forms. After the students completed the 30 sessions in mathematics self-regulated learning program, they will take a mathematic achievement test and a self-regulated learning test. The results have shown that students who attended the program scored higher in both tests compared to those who did not attend the program.

Applying Self-Regulated Learning strategies in Mathematic

Strategies	**Application in Mathematic**
Self-evaluation	Students do so by making sure that they have the right answers for the questions with the appropriate steps.
Organizing and transforming	Students' ability to organize math questions. Some of the ways are using graphs, equations, and diagrams.
Goal-setting and planning	Students setting goals and their plan of achieving those goals.
Keeping records and monitoring	Taking notes in class. Organizing the equations.
Environment structuring	Studying in an environment which benefits their study.
Self-consequences	Students' own punishment or reward on its own success or failure in mathematic.
Rehearsing and memorizing	Student learned by doing a lot of different forms of math questions.
Seeking information	Student seek information from the nonsocial source.
Seeking social assistance	Students seek help from their peers, teacher or other adults.
Reviewing records	Students re-read textbook, notes or their homework questions.

After attending 30 sessions of a mathematics self-regulated learning program, students showed significant improvement in their mathematical achievement and self-regulated learning test. [71] This shows that it is possible to teach lower-achieving math students with self-regulated learning skills. When they were equipped with these skills and taught to focus on the processes and strategies, their math solving skills improved. With improvement, students will gradually recognize their ability to do better in math. Praising and rewarding

69 Camahalan, F. G. (2006). Effects of Self-Regulated Learning on Mathematics Achievement of Selected Southeast Asian Children. Journal Of Instructional Psychology, 33(3), 194-205.

70 Zimmerman, B. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp.13-39). San Diego, CA: Academic Press.

71 Camahalan, F. G. (2006). Effects of Self-Regulated Learning on Mathematics Achievement of Selected Southeast Asian Children. Journal Of Instructional Psychology, 33(3), 194-205.

themselves for their improvement will provide students will have even greater improvement in math. As a result, their self-efficacy and their interest in math will rise. This creates a positive cycle: when students believe that they have the ability to achieve math, they will work even harder in math with the appropriate self-regulated learning skills.

In the traditional classroom, math is viewed as an answer-centred subject rather than a process-centred subject. By emphasizing speed and accuracy, students will develop skills in copying and memorizing mathematical facts instead of understanding math. Also, the learning only flows one way, from teacher to students. In this kind of classroom setting it would be hard for students to apply self-regulated learning strategies because when the students are not allowed to have choice and control over their study, they are not likely to learn strategies for self-regulation, nor willingly self-initiate and control the use of various strategies. [72]Therefore, in order for students to apply self-regulation skills, the classroom environment is very important. One of the best ways to develop self-regulated learning skills is to give a certain degree of control to students for their own learning. Math teachers should promote the sharing of knowledge and decision making. When students have a voice in setting goals, planning activities and evaluating their own performance, they have a chance to practice their self-regulated learning skills, which will have a positive impact on their math achievement.

Upper-grade students can apply self-regulated learning skills better than lower grade students. [73]This is because older students are more capable of understanding concepts and ideas that are presented in self-regulated learning theory. Also, some of the self-regulated learning strategies require prior knowledge and skills, such as writing a plan or organizing learning materials. Therefore, it is easier for upper-grade students to learn some of the self-regulated strategies. As a result, upper-grade students show more improvement in mathematical achievement than lower grade students when they are taught self-regulated learning skills.

21.4 Implications for Teaching

21.4.1 Mathematics-Learning Disabilities

Recent studies into cognition, working memory and mathematics learning disabilities all point to a need to distinguish between computation and problem solving learning disabilities in math. To this point, mathematics assessments have been generic and have not given appropriate consideration to the different features of each domain. Professionals must consider these two skills separately when diagnosing students. Teachers should also take into account the different domains when instructing children with mathematical learning disabilities. Some suggestions and tools that may help students with their mathematical learning are:

72 Camahalan, F. G. (2006). Effects of Self-Regulated Learning on Mathematics Achievement of Selected Southeast Asian Children. Journal Of Instructional Psychology, 33(3), 194-205.

73 Camahalan, F. G. (2006). Effects of Self-Regulated Learning on Mathematics Achievement of Selected Southeast Asian Children. Journal Of Instructional Psychology, 33(3), 194-205.

21.4.2 External Representation

External representation is a helpful tool in mathematics because mathematical problems can be complicated to solve mentally at times. By using external representation, it provides a clear understanding on the concept of mathematics by which students can develop knowledge acquisition. Some external representations are worked-out examples, animations, and diagrams.

Worked-out Examples

Worked-out examples are a useful instructional method that teachers use to facilitate students in learning mathematics. Research shows that using worked-out examples can increase the students who have low mathematics performance level. One reason is when students are given a problem to solve, their optimal goal is to solve the problem rather than to learn mathematics. In contrast, when students are given worked-out examples, they actually learn and try to interpret the materials on their own. [74] Thus, worked-out examples focus more on intentional learning for students. Students usually do not understand the mathematical theory or proof because they are complicated to comprehend. However, worked-out examples are easier for students to acquire learning and understand the concept of mathematics. Without giving explicit instruction, teachers simply show the steps of how to solve the mathematical problem as an example for the students to refer to. There are detailed explanations on the steps required to solve the mathematical problem. Then, students have the autonomy to self-explain similar types of mathematical problem on their own. Thus, they can use the worked-out examples as references to solve many mathematical problems. [75] They can explicitly reflect their thinking on how to solve the problem by referring to the worked-out examples that the teachers provide. Hence, this can also enhance the students in self-regulated learning as they are practicing their critical thinking in solving the problem. This **metacognitive** strategy can help students improve their problem-solving skills especially on mathematical word problems. Metacognitive strategies include self-questioning, self-evaluating, summarizing, and illustrating the problem. [76] These strategies are believed to acquire knowledge for students while constructing a deeper understanding from the worked-out examples. Research shows that students who can self-explain the problem and solve them have higher mathematics achievement. When students explain the steps of how to solve the mathematical problem on their own, they are exercising their reflective thinking which can construct a greater understanding beyond what the information was given. Indeed, students can develop new and sophisticated knowledge of mathematics because they consolidate the newly learned materials with their prior knowledge. [77] In ad-

74 Renkl, A. (1999). Learning Mathematics from worked-out examples: Analyzing and Fostering self-explanations. *European Journal of Psychology of Education, 14*(4), 477-488. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/BF03172974%C2%A0`

75 Tu, C-T. (2011). An Instructional experiment: Using worked-out examples in mathematics problem-solving of elementary school students. *Bulletin of Educational Psychology, 43*(1), 25-50.

76 Tajika, H., Nakatsu, N., Nozaki H., Neumann, E., & Maruno S. (2007). Effects of Self-Explanation as a Metacognitive Strategy for Solving Mathematical Word Problems. *Japanese Psychological Research, 49*(3), 222-233. doi: 10.1111./j.1468-5884.2007.00349.x

77 Tajika, H., Nakatsu, N., Nozaki H., Neumann, E., & Maruno S. (2007). Effects of Self-Explanation as a Metacognitive Strategy for Solving Mathematical Word Problems. *Japanese Psychological Research, 49*(3), 222-233. doi: 10.1111./j.1468-5884.2007.00349.x

dition, worked-out examples can also be used in group settings where students can discuss with their classmates in solving mathematical problems. Research found two ways that students can use worked-out examples in classrooms. [78] One way is students who understand the worked-out examples can explain to those who do not understand. The other way is students interpret the worked-out examples altogether by using their logic and reasoning skills. Both ways engage students in learning in a social interactive setting by discussing the details of the worked-out examples. Learning in a social setting can strengthen the understanding of the materials because students are elaborating the examples more in depth. They can also ask any questions that they have with the worked-out examples in order to get a clear comprehension. [79] Therefore, it is important that students should discuss further on the worked-out examples in small groups to reflect on the problem procedure and to generate knowledge acquisition beyond their existing knowledge.

Animations

To increase the students' interest in learning mathematics, animation is a great instructional tool to use to teach students. Since mathematics can be quite boring and uninteresting at times, animations can attract students' interest in learning mathematics. Most importantly, animations claim to facilitate students' problem-solving skills in mathematics. [80] Before students solve any mathematical problem, it is important that students identify the problem and know what to solve. Henceforth, when students find the problem hard to translate, animation becomes most effective because it consists of visual representation that makes it easier for students to interpret the question. In contrast, when students just take notes on the problem, they do not have a clear understanding of what the problem means because they are just simply copying the text. By having a pictorial representation along with the verbal explanation of the problem, students can visualize what is happening in the problem fully. For instance, the concept of addition and subtraction is hard to explain through text to an elementary school student. However, when using animations to display a before and after frame of what happened in the problem can construct a clear comprehension. In the case of addition or subtraction mathematical problems, animations can demonstrate an increase or decrease of objects to represent the solution. In addition, animations can illustrate abstract math theories by showing visible objects, concrete results, and specific instances. Thus, animations can be used to convey the abstract concepts of mathematics with reference to distinct examples. [81] Animations can facilitate the acquisition of abstract principles and

78 Mevarech, Z. R., & Kramarski, B. (2003). The Effects of Metacognitive Training versus Worked-out Examples on Students' mathematical reasoning. *British Journal of Educational Psychology, 73*(4), 449-471. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1348/000709903322591181%C2%A0`

79 Mevarech, Z. R., & Kramarski, B. (2003). The Effects of Metacognitive Training versus Worked-out Examples on Students' mathematical reasoning. *British Journal of Educational Psychology, 73*(4), 449-471. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1348/000709903322591181`

80 Scheiter, K., Gerjets, P., & Schuh, J. (2010). The Acquisition of Problem-Solving Skills in Mathematics: How Animations Can Aid Understanding of Structural Problem Features and Solutions Procedures. *Instructional Science, 38*(5), 487-502. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11251-009-9114-9%C2%A0`

81 Scheiter, K., Gerjets, P., & Schuh, J. (2010). The Acquisition of Problem-Solving Skills in Mathematics: How Animations Can Aid Understanding of Structural Problem Features and Solutions Procedures. *Instructional Science, 38*(5), 487-502. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11251-009-9114-9%C2%A0`

the comprehension of worked-out examples due to the visual representation of the problems. Although worked-out examples are known as a effective instructional practice, animations can be used to effectively improve these examples. [82] Worked-out examples may not always have a pictorial representation but only have written texts. Therefore, when each of the steps of the solution procedure of the worked-out examples have a visual representation, students can imagine what is going on in the problem. Students can also interpret the worked-out examples better with the explanations and the pictures given. As a result, it is recommended that teachers should use animations as an instructional tool in their practices to fully consolidate the students' learning in mathematics.

Diagrams

To produce an informational diagram can be a very difficult procedure, because students do not only required to interpret the verbal information into the visual information, but also needed to identify and integrate the related information together before associating to their prior knowledge.[83] Larkin and Simon believed that diagrammatic representation is easier and more efficient than sentential representation because of three aspects in regards to searching, matching, and inference. First, it clearly retains all the information about the topographical and geometric relations between the elements of the word problems. Therefore, students can search for particular information easily. Second, since all the related elements are grouped together, it shows the connections between the concrete representations and the pictograms. Hence, it can simplify the process of identifying the related information. Besides that, the memory load is lower if the problem is produced by drawing a diagram, as the students can clearly see the essential inference between the related information.[84] Many studies have suggested that the use of diagrams can improve the efficiency in problem solving.

Banerjee has conducted a research on the effects of using diagramming as a representational technique on high school students' achievements in solving math word problems. The result has proved that the diagramming method (such as focusing on the creation and labels of diagrams to represent the mathematics) can significantly improve their achievements in solving math word problems.[85]

82 Scheiter, K., Gerjets, P., & Schuh, J. (2010). The Acquisition of Problem-Solving Skills in Mathematics: How Animations Can Aid Understanding of Structural Problem Features and Solutions Procedures. *Instructional Science, 38*(5), 487-502. doi: `http://dx.doi.org.proxy.lib.sfu.ca/10.1007/s11251-009-9114-9%C2%A0`

83 van Garderen, D., Scheuermann, A., & Poch, A. (2014). Challenges students identified with a learning disability and as high-achieving experience when using diagrams as a visualization tool to solve mathematics word problems. ZDM Mathematics Education, 46, 135–149.

84 Larkin, J., & Simon, H. (n.d.). Why a Diagram is (Sometimes) Worth Ten Thousand Words. Cognitive Science, 65-100.

85 Banerjee, B. (2011). The effects of using diagramming as a representational technique on high school students' achievement in solving math word problems. Dissertation Abstracts International Section A, 71, 394

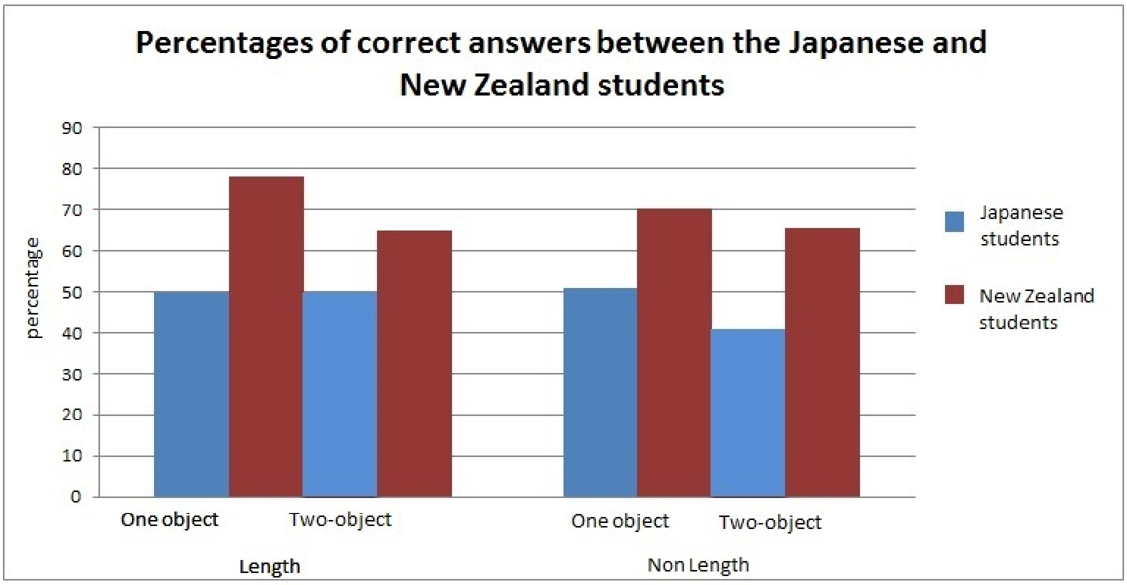

Figure 54 Describes the result of the percentage of correct answers by using the diagram to solve math word problems between the Japanese and New Zealand students

In a study with the use of diagrams in solving the math word problems, Uesaka, Manalo, and Ichikawa made a comparison of students in Japan and New Zealand. [86] The diagram that was drawn by a Japanese student was using a one-object problem, and the one that was produced by a New Zealand student was using a two dimensional object to solve the math word problems. Results indicated that the percentages of correct answers by the New Zealand students were significantly higher than the Japanese students. The reason is that producing a diagrammatic representation can index the sentences by location, so students can observe the details at a specific location explicitly, which ease them on understanding the problem.[87]

In order to promote students on using diagrams to solve math problems, teachers should first teach them on 1) what diagrams are, 2) the importance of using diagrams to solve problems, 3) when to apply the diagrams in solving problems, 4) which type of diagram should be using for the math problems, 5) how to generate a diagram, and 6) how to use a diagram effectively. The reason that students should know the fundamental concepts of diagrams is that diagrams may not apply on all the math problems. Uesaka and Manalo pointed out that students tend to use diagrams when solving math word problems in regards of length and distance instead of spatial problems, because it usually involves a concrete relationships

86 Uesaka, Y., Manalo, E., & Ichikawa, S. (2007). What kinds of perceptions and daily learning behaviors promote students' use of diagrams in mathematics problem solving?. Learning And Instruction, 17(3), 322-335.

87 Uesaka, Y., Manalo, E., & Ichikawa, S. (2007). What kinds of perceptions and daily learning behaviors promote students' use of diagrams in mathematics problem solving?. Learning And Instruction, 17(3), 322-335.

and known quantities.[88] After teaching them the important concepts of diagrams, teachers can then instruct them the 3 step procedure – Ask, Do, and Check.[89] Van Garderen and Scheuermann suggested that students should first concentrate on what needs to be solved; then they should produce a diagram. Finally, they can solve the problem by using the diagrams. For example, in order to focus on what needs to be solved, students can use the key word method to search for the information, and place the information that is given from the problem.[90] In conclusion, diagrams can be an effective strategy when solving math problems; it does not only help students to think critically, but also aid them in solving problems by using a different approach.

21.4.3 Algorithms

An algorithm is a series of steps to help students solving math problems. If they follow these procedures, they will always be able to compute a correct answer every time. Algorithm involves with repeating sequences, it applies to addition, subtraction, multiplication, and division. By using algorithms, students can learn how to explain what is happening in each step, and able to track their mistakes if they yield an incorrect answer in the end. It requires them be attention to details when they are problem solving, that is, when they are working through a multiple step solutions, they are required to recall the algorithms from their long term memory and have a set of steps in their mind already. Also, teachers should instruct students that algorithms must be solved in a sequential order, none of the steps can be jumped over. For example, when students are learning basic arithmetic operations, they have to learn that there is a specific order to solve a problem like $5+8\times6$. Students need to understand that they have to do the multiplication first, then the addition part. If they can follow the correct order, they can always yield to a correct answer. However, Paul Cobb has conducted a study in regards of Grade 1 and 2 students solving double-digit addition problems. He noticed that all of the students were managed to give a correct answer for $16+9$ by using various methods. Conversely, if they were asked to use the traditional school algorithm with carrying to solve the same problem but with a vertical context, many of them tend to yield an incorrect answer. He concluded that the reason of causing the students to have a higher possibility of making errors with a traditional school algorithm is that they were only forcing themselves to follow the rules instead of fully understanding how the algorithms work.[91] J.S. Brown and Burton found out that there is a significant amount of students are using one or more wrong versions of algorithm consistently to solve their math problems. Even though lots of incorrect algorithms yield to a correct answer, yet it may not apply to all cases.[92] For example, some children had a preconception that the subtraction algorithm means taking the smaller number from the larger in every single

88 Uesaka, Y., & Manalo, E. (2012). Task-related factors that influence the spontaneous use of diagrams in math word problems. Applied Cognitive Psychology, 26, 251–260.

89 van Garderen, D., & Scheuermann, A. (2015). Diagramming word problems: A strategic approach for instruction. Intervention in School and Clinic

90 Walker, D. W., & Poteet, J. A. (1989-90). A comparison of two methods of teaching mathematics story problem-solving with learning disabled students. National Forum of Special Education Journal, 1, 44-51.

91 Cobb, P. (1991). Reconstructing Elementary School Mathematics. Focus on Learning Problems in Mathematics, 13(2), 3–32.

92 Brown, J.S., Burton, R.B. (1978). Diagnostic models for procedural bugs in basic mathematical skills. Cognitive Science, 2, 155-192

column, regardless of which number was on the top. The diagram on the left can explain why incorrect algorithms may not produce a correct solution all the time.

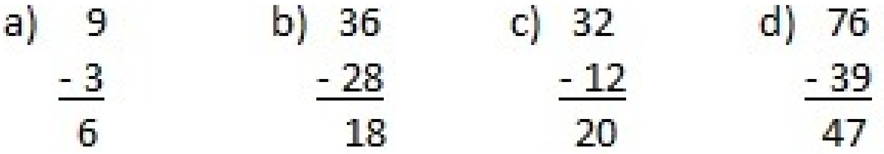

Figure 55 A diagram that explains why a faulty algorithm does not work

Brown and Burton pointed out that even though the children who have the wrong perception of the subtraction algorithm may seem to understand the arithmetic operations of subtraction, as this can guide them to yield the correct solution on part a) and part c). However, they will yield an incorrect answer on part b) and part d), as the numbers on top in the second columns are smaller than the numbers in the bottom. Nagel and Swingen believed that the traditional algorithms with carrying or borrowing can only increase their efficiency and accuracy, yet neglect the sense-making for the students.[93]

Therefore, in order to deal with the serial aspects of algorithms effectively, educators should teach students to use their spatial abilities when applying multiple steps to solve a problem. For example, they need to learn how to keep numbers aligned and spaced correctly to solve the problems successfully; especially when they are computing column subtraction, multiple digit multiplication, etc. Teachers should encourage students to develop and use their own algorithms to solve problems. They can encourage their students to incorporate mnemonics with algorithms; this approach can help them to remember things such as the procedures in solving problems.[94] For example, PEDMAS can tell them the order when carrying out operations. Instead of simply solving an arithmetic operation from left to right, they now understand that they have to solve the brackets first.[95] Moreover, teachers should ask the students to look over the entire problems first before trying to solve for an answer, then they should teach them how to break the problem into small parts and to determine which parts will require using the algorithms. They should also know which algorithms they should apply on for each parts; and finally, they should reflect on their answers for every steps.

93 Nagel, N., & Swingen, C. C. (1998). Students' explanations of place value in addition and subtraction. Teaching Children Mathematics, 5(3), 164–170.

94 Nelson, P. M., Burns, M. K., Kanive, R., & Ysseldyke, J. E. (2013). Comparison of a math fact rehearsal and a mnemonic strategy approach for improving math fact fluency. Journal Of School Psychology, 51(6), 659-667. doi:10.1016/j.jsp.2013.08.003

95 Jeon, K. (2012). Reflecting on PEMDAS. Teaching Children Mathematics, 18(6), 370-377.

By showing steps, students can always track their mistakes and come to a correct solution ultimately.

21.4.4 Word Problem Strategies

Word problems present a special case for all children, but especially those with problem solving learning disabilities. The most significant difference between computational problems and word problems is the addition of linguistic information. In other words, children must first read written words and filter out the information in order to translate the written problem into a computational number sentence. Children must then identify the missing information, as well as the relevant information, before completing the actual math portion of the problem.

Word problems are challenging for many students to comprehend but the problem is compounded when the learner's first language is not English. According to Jan, S. and Rodrigues, S. (2012)[96], children with English as a second language cannot comprehend problem statements due to language barriers. They tend to rely on key words or misinterpret the problem statement and so their resulting solution may be incorrect. Relying on key words can distract students from trying to understand the problem. "Key words can cause confusion in differentiating between everyday language and mathematical language." [97]

Findings from this study suggest that class or small group discussions will provide students with an opportunity to clarify the nature of a problem so that they can understand what is being given and what is being asked. Providing students with opportunities to read, understand, share each other's ideas, and to consider the problem and solution from a number of different tactics will provide the students with a greater understanding of the problem.

In taking a cognitive approach to teaching word problems, it is important for the teacher to provide ample opportunity for students to think about and discuss the meaning of the word problems, and then consider multiple solutions with their classmates. This approach is valuable for both those students who have language barriers and those students with math learning disabilities.

The Council for Learning Disabilities [98] recommends some of the following strategies for instructing students in problem solving:

FAST DRAW (Mercer & Miller, 1992) Find what you're solving for. Ask yourself, "What are the parts of the problem?" Set up the numbers. Tie down the sign.

Discover the sign. Read the problem. Answer, or draw and check. Write the answer.

96 Jan, S. and Rodrigues, S., (2012). Students' difficulties in comprehending mathematical word problems in English language learning contexts. International Researcher, Vol. 1, Issue 3, Accessed Dec 4, 2015 from`http://www.academia.edu/2078056/STUDENTS_DIFFICULTIES_IN_COMPREHENDING_MATHEMATICAL_WORD_PROBLEMS_IN_ENGLISH_LANGUAGE_LEARNING_CONTEXTS`

97 Jan, S. and Rodrigues, S., (2012). Students' difficulties in comprehending mathematical word problems in English language learning contexts. International Researcher, Vol. 1, Issue 3, P. 156, Accessed Dec 4, 2015 from`http://www.academia.edu/2078056/STUDENTS_DIFFICULTIES_IN_COMPREHENDING_MATHEMATICAL_WORD_PROBLEMS_IN_ENGLISH_LANGUAGE_LEARNING_CONTEXTS`

98 `http://www.council-for-learning-disabilities.org/mathematics-disabilities`

Questions and Actions (Rivera, 1994) Step a. Read the problem. Questions Are there words I don't know? Do I know what each word means? Do I need to reread the problem? Are there number words? Actions Underline words. Find out definitions. Reread. Underline. b. Restate the problem. What information is important? What information isn't needed? What is the question asking? Underline. Cross out. Put in own words. c. Develop a plan. What are the facts? How can they be organized? How many steps are there? What operations will I use? Make a list. Develop chart. Use manipulatives. Use smaller numbers. Select an operation. d. Compute the problem. Did I get the correct answer? Estimate. Check with partner. Verify with calculator. e. Examine the results. Have I answered the question? Does my answer seem reasonable? Can I restate question/answer? Reread question. Check question/answer. Write a number sentence.

3. *TINS Strategy* (Owen, 2003) Different steps used to analyze and solve word problems are represented with this acronym. Thought: Think about what you need to do to solve this problem and circle the key words. Information: Circle and write the information needed to solve this problem; draw a picture; cross out unneeded information. Number Sentence: Write a number sentence to represent the problem. Solution Sentence: Write a solution sentence that explains your answer. Example: Kyle bought 6 baseball cards. The next day, he added 11 more cards to his collection. How many cards does he have in all? Thought: + Information: 6 baseball cards, 11 baseball cards Number Sentence: 6 + 11 = Solution Sentence: Kyle has 17 baseball cards in his collection.

4. *Problem Solving* (Birsh, Lyon, Denckla, Adams, Moats, & Steeves, 1997) Read the problem first. Highlight the question. Circle the important information. Develop a plan. Use manipulatives to represent the numbers. Implement the plan. Check your work.

21.5 Glossary

Algorithm is a procedure with a series of steps in mathematics that when used appropriately to solve a mathematical problem, it will yield a correct solution.

Application occurs when students are able to make associations between mathematical concepts and daily life situations.

Clarification occurs when students identify and analyze aspects of a problem, it allows them to interpret the information that they need in order to solve the problem.

Classification is the ability of grouping objects based on similar characteristics.

Conceptual knowledge is the mental structures that promote students' reasoning and understanding of mathematics.

Declarative knowledge is when mathematical concepts, that are factual knowledge, are being retrieved from the long-term memory; hence, using these concepts to solve other complex mathematical problems.

Evaluation occurs when students can use a particular rubric to determine the correctness of a problem solution.

Inference occurs when students are able to use general concepts to specific situations and distinguish the similarities and differences among objects.

Intrinsic motivation is when students want to perform mainly for their own personal interests.

Metacognitive is the knowledge used to control one's thinking and learning.

Procedural knowledge is the knowledge about how to solve mathematical problems using the sequence of strategy steps.

Seriation is the ability of ordering objects from small to large based on the sizes, such as length, weight, or volume.

Self-regulated learning is the ability to control one's learning, from planning to how one evaluate performance afterward.

Short term memory is responsible for temporarily storing information which must be used, but not necessarily manipulated.

Working memory is the system responsible for temporarily holding new or previously-stored information which is being used for the completion of a current task.

21.6 Suggested Reading

1. A case study of novice teachers' mathematics problem solving beliefs and perceptions. *Baker, C. K. (2015). A case study of novice teachers' mathematics problem solving beliefs and perceptions. Dissertation Abstracts International Section A, 75*

2. Piaget and Vygotsky: Many resemblances, and a crucial difference. *Lourenço, O. (2012). Piaget and Vygotsky: Many resemblances, and a crucial difference. New Ideas In Psychology, 30(3), 281-295. doi:10.1016/j.newideapsych.2011.12.006*

21.7 References

Fuchs, L. S., Fuchs, D., Stuebing, K., Fletcher, J.M., Hamlett, C. L. , & Lambert, W. (2008). Problem solving and computational skill: Are they shared or distinct aspects of mathematical cognition? Journal of Educational Psychology 100 (1), 30

Hanich, L. B., Jordan, N. C., Kaplan, D., & Dick, J. (2001). Performance across different areas of mathematical cognition in children with learning disabilities. Journal of Educational Psychology, 93, 615–626.

Rourke, B. P., & Finlayson, M. A. J. (1978). Neuropsychological significance of variations in patterns of academic skills: Verbal and visual-spatial abilities. Journal of Abnormal Child Psychology, 6, 121–133.

Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem-solving in children at risk and not at risk for serious math difficulties. Journal of Educational Psychology, 96, 471–491.

Swanson, H. L. (2003). Age-related differences in learning disabled and skilled readers' working memory. Journal of Experimental Child Psychology, 85, 1–31.

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Version 3, 29 June 2007

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Version 3, 29 June 2007

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