Using GIFT to Support an Empirical Study on the Impact of the Self-Reference Effect on Learning

Anne M. Sinatra, Ph.D.

Army Research Laboratory/Oak Ridge Associated Universities
anne.m.sinatra.ctr@us.army.mil

Abstract. A study is reported in which participants gained experience with deductive reasoning and learned how to complete logic grid puzzles through a computerized tutorial. The names included in the clues and content of the puzzle varied by condition. The names present throughout the learning experience were either the participant's own name, and the names of two friends; the names of characters from a popular movie/book series (*Harry Potter*); or names that were expected to have no relationship to the individual participant (which served as a baseline). The experiment was administered using the Generalized Intelligent Framework for Tutoring (GIFT). GIFT was used to provide surveys, open the experimental programs in PowerPoint, open external web-sites, synchronize a Q-sensor, and extract experimental data. The current paper details the study that was conducted, discusses the benefits of using GIFT, and offers recommendations for future improvements to GIFT.

1 Introduction

The Generalized Intelligent Framework for Tutoring (GIFT) provides an efficient and cost effective way to run a study (Sottilare, Brawner, Goldberg, & Holden, 2012). In Psychology research, in-person experiments usually require the effort of research assistants who engage in opening and closing computer windows and guiding participants through the experimental session. GIFT provides an opportunity to automate this process, and requires a minimal knowledge of programming, which makes it an ideal tool for students and researchers in the field of Psychology. GIFT was utilized in the current pilot study, which is investigating the impact of the self-reference effect on learning to use deductive reasoning to solve logic grid puzzles.

1.1 The Self-Reference Effect and Tutoring

Thinking of the self in relation to a topic can have a positive impact on learning and retention. This finding has been consistently found in Cognitive Psychology research, and is known as the self-reference effect (Symons & Johnson, 1997). In addition, research has suggested that linking information to a popular fictional character (e.g.,

Harry Potter) can also draw an individual's attention when they are engaged in a difficult task, and can result in similar benefits to the self-reference effect (Lombardo, Barnes, Wheelwright, & Baron-Cohen, 2007; Sinatra, Sims, Najle, & Chin, 2011). The self-reference effect could potentially be utilized to provide benefits in tutoring and learning. Moreno and Mayer (2000) examined the impact of a participant being taught science lessons in a manner consistent with first person speech (self-reference), or in the third person. No difference was found in regard to knowledge gained from the lessons, however, when asked to apply the knowledge in a new and creative way, those that received the first person instruction demonstrated better performance. This suggests that relating information to the self may result in a "deeper" learning or understanding, which allows the individual to easily apply the information in new situations.

It has been suggested that deep learning should be a goal in current instruction (Chow, 2010). This is consistent with findings that including topics of interest (e.g., familiar foods, names of friends) when teaching math can have a positive impact on learning outcomes (Anand & Ross, 1987; Ku & Sullivan, 2002). Many of the domains (e.g., math, science) that have been examined in the literature are "well-defined" and do not transfer skills to additional tasks. There has not been a focus on deductive reasoning or teaching logic, which is a highly transferable skill. Logic grid puzzles are useful learning tools because they allow an individual to practice deductive reasoning by solving the puzzle. In these puzzles, individuals are provided with clues, a grid, and a story. The story sets up the puzzle, the clues provide information that assists the individual in narrowing down or deducing the correct answers and the grid provides a work space to figure out the puzzle. It has been suggested that these puzzles can be helpful in instruction, as they require the individual to think deeply about the clues and have a full understanding of them in order to solve the puzzle (McDonald, 2007). After practicing deductive reasoning with these puzzles, the skill can then potentially be transferred and applied in many other domains and subject areas.

1.2 The Current Study

The current study sets out to examine the self-reference effect in the domain of deductive reasoning, by teaching individuals how to complete logic grid puzzles. It is a pilot study, which will later be developed into a large scale study. During the learning phase of the study, there were three different conditions: Self-Reference, Popular Culture, and Generic. The study was administered on a computer using GIFT 2.5. The interactive logic puzzle tutorial was developed using Microsoft PowerPoint 2007 and Visual Basic for Applications (VBA). In the Self-Reference condition, participants entered their own name and the names of two of their close friends into the program, in the Popular Culture condition, the participant was instructed to enter names from the *Harry Potter* series ("Harry", "Ron", and "Hermione") into the program, in the Generic condition, participants were instructed to enter names which were not expected to be their own ("Colby", "Russell", and "Denise") into the program. The program then used the entered names throughout the tutorial as part of the clues and the puzzle with which the participants were being taught. Therefore, the

participants were actively working with the names throughout their time learning the skill.

After completing the tutorial, participants were asked to recall anything that they could about the content of the puzzle, answer multiple-choice questions about what they learned, answer applied clue questions in which they were asked to draw conclusions based on a story and an individual clue, and complete two additional logic puzzles (one at the same difficulty level as the one in the tutorial, and one more difficult). These different assessments allowed for measures of retention of the learned content, ability to apply the knowledge, and ability to transfer/apply the knowledge in a new situation.

It was hypothesized that there would be a pattern of results such that individuals in the Self-Reference condition would perform better on all assessments than that in the Popular Culture and Generic conditions, and that the Popular Culture condition would perform better on all assessments than the Generic condition. It was also expected that ratings of self-efficacy and logic grid puzzle experience would increase after the tutorial.

1.3 GIFT and the Current Study

The current study required participants to use a computer, and answer survey questions before and after PowerPoint Tutorials and PowerPoint logic grid puzzles. Due to the capabilities of GIFT 2.5 to provide survey authoring and administering, it was an ideal choice for the development of the study. As GIFT has the capability of opening and closing programs (such as PowerPoint), and presenting surveys and instructions in specific orders, it is a highly efficient way to guide participants through a learning environment and a study, without much effort from research assistants.

In Psychology research there are often many different surveys that are administered to participants. An advantage of GIFT is that the Survey Authoring System provides a free and easy to use tool in which to create surveys. A further advantage is that it does not require the individual to be online when answering the survey.

2 Method

2.1 Participants

In the current pilot study, there were 18 participants recruited from a research organization, and a University. Participants did not receive any compensation for their participation. The sample was 55.6% male (10 participants) and 44.4% female (8 participants). Reported participant ages ranged between 18 years and 51 years (M = 28.8 years, SD = 9.2 years). As there were 3 conditions, there were 6 participants in each condition.

2.2 Design

The current study employed a between subjects design. The independent variable was the types of names included in the tutorial during the learning phase of the study. There were three conditions: Self-Reference, Popular Culture, and Generic. The dependent variables were ratings of self-efficacy before and after the tutorial, ratings of logic grid puzzle experience after the tutorial, performance on a multiple-choice quiz about the content of the tutorial, performance on applied logic puzzle questions (which asked the participants to apply the skill they learned in a new situation), performance on a logic puzzle of the same difficulty as the tutorial, and on one that was more difficult.

2.3 Apparatus

Laptop and GIFT. The study was conducted on a laptop that was on a docking station, and connected to a monitor. GIFT 2.5 and PowerPoint 2007 were installed on the laptop, and a GIFT course was created for each condition of the experiment.

Q-sensor. Participants wore a Q-sensor on their left wrists. It is a small band approximately the size of a watch, which measures electrodermal activity (EDA).

2.4 Procedure

Upon arriving, participants were given an informed consent form, and the opportunity to ask questions. For this pilot study, participation occurred individually. After signing the form, participants were randomly assigned to a condition. The experimenter launched ActiveMQ and the GIFT Monitor on the computer. Participants were then fitted with the Q-sensor on their left wrists. The experimenter clicked "Launch all Modules" and then proceeded to synchronize the Q-sensor with the computer. If synchronization was unsuccessful after three tries, the experimenter edited the GIFT sensor configuration file and changed the sensor to the Self Assessment Monitor as a placeholder (the data from it was not used). Next, the "Launch Tutor Window" button was clicked, and the experiment was launched in Google Chrome. The experimenter created a new UserID for the participant, and then logged in. The correct condition was then selected from the available courses. The participants were then instructed that they should interact with the computer and let the experimenter know if they had any questions.

Participants were first asked to answer a few brief demographics questions (e.g., age/gender) and filled out Compeau and Higgins' (1995) Self Efficacy Questionnaire (SEQ) with regard to their beliefs in their ability to solve a logic grid puzzle in a computer program and rated their logic grid puzzle experience. They then began the Tutorial. Depending on the condition they were in, they received different instructions in regard to the names to enter (their own name and the name of friends, *Harry Potter* related names, or General names). They then worked through the tutorial that walked them through completing a logic grid puzzle and explained the different types of clues.

After completing the tutorial, they filled in the SEQ again, rated their experience again, and were asked to report any information they remembered from the content of the puzzle. Next, they answered 20 multiple choice questions about the material they learned about in the tutorial. Then, they answered 12 applied clue questions, which provided a story and an individual clue, then asked the participants to select all of the conclusions that could be drawn from that clue. Next, participants had 5 minutes in which to complete an interactive PowerPoint logic grid puzzle at the same level of difficulty as the one that they worked through in the tutorial, and 10 minutes to complete a more difficult puzzle. Finally, they were directed to an external web-site to complete a personality test. They wrote their scores on a piece of paper, and entered them back into GIFT. Afterward, they were given a debriefing form and the study was explained to them.

2.5 GIFT and the Procedure

The Survey Authoring System in GIFT was used to collect survey answers from the participants. While it was a fairly easy to use tool to enter the questions initially, there was some difficulty in the export function. Instead of exporting all the entered questions, there appeared to also be previously deleted questions within the files that were exported. This made it impossible to simply import the questions into an instance of GIFT on an additional computer (in order to have an identical experiment on more than one computer). As a work around, the questions had to be manually typed in and added to each additional computer that was used for the study.

A course file was generated using the Course Authoring Tool. The tool was also fairly easy to use. It provided the ability to author messages that the participant would see between surveys and training applications, determine the specific surveys and PowerPoint applications that would be run, and the order in which they would run. Further, it could send participants to an external web-site; however, while the participants were on the site there was no ability to keep instructions on the screen. Participants only saw a "Continue" button at the bottom of the screen – which may have led to some participants in the current study clicking "Continue" before filling out the surveys they needed to on the web-site. A solution to this was employed by creating a PowerPoint to explain what the participants would be doing on the web-site. However, having the ability to author comments that are seen by the participant while they are on the external web-site would be beneficial.

3 Results

3.1 Pilot Study Results

Performance Results. A series of One Way ANOVAs were run for the percentages correct on the multiple choice questions [$F(2,15) = .389$, $p = .684$], applied clue questions [$F(2,15) = 2.061$, $p = .162$], the easier assessment logic puzzle [$F(2,15) = 3.424$, $p = .060$] and the more difficult logic puzzle [$F(2,15) = 1.080$, $p = .365$]. However,

there were no significant differences found between conditions for any of the assessments. See Table 1 for the means and standard deviations for each condition and DV.

	Self-Reference	Popular Culture	Generic
Multiple Choice	*M* = 96.67%, *SD* = 2.58%	*M* = 95.83%, *SD* = 6.65%	*M* = 94.17%, *SD* = 4.92%
Applied Clue	*M* = 80.55%, *SD* = 16.38%	*M* = 87.50%, *SD* = 11.48%	*M* = 69.44%, *SD* = 18.00%
Easy Logic Puzzle	*M* = 51.95%, *SD* = 37.47%	*M* = 93.21%, *SD* = 16.63%	*M* = 74.07%, *SD* = 23.89%
Difficult Logic Puzzle	*M* = 69.78%, *SD* = 24.61%	*M* = 76.89%, *SD* = 16.49%	*M* = 86.89%, *SD* = 19.31%

Table 5. Means and Standard Deviations for Performance Variables for each condition

Logic Grid Puzzle Experience. A 3 (Condition) x 2 (Time of Logic Puzzle Experience) Mixed ANOVA was run comparing the conditions and participant's self rating of their logic grid puzzle experience. Overall, participants indicated that they had significantly higher logic grid puzzle experience after the tutorial (M = 3.78, SD = 1.215) than before (M = 2.00, SD = 1.085), $F(1,15) = 28.764$, $p<.001$. However, there was no significant interaction between condition and logic grid puzzle experience ratings, $F(2, 15) = .365$, $p = .700$.

Self Efficacy Questionnaire. A 3 (Condition) x 2 (Time of SEQ score) Mixed ANOVA was run comparing the conditions and the scores on the logic grid puzzle self-efficacy questionnaire. There were significantly higher scores of self-efficacy after tutoring regardless of condition (M = 5.583, SD = .6564) than before tutoring (M = 5.117, SD = .7618), $F(1,15) = 9.037$, $p = .009$. However, the condition did not seem to matter, as there was not a significant interaction between condition and time of SEQ score, $F(2,15) = .661$, $p = .531$.

3.2 Using GIFT to extract the information and results

The Event Reporting Tool was used to export survey data from GIFT. However, in the initial GIFT 2.5 version, data from only one participant would export at a time. These files were manually copied and pasted together into one Excel file for analysis. An updated version of GIFT 2.5 offered the ability to export multiple participant files at once. However, if using multiple instances of GIFT on separate computers, it is important to name the questions identically. Combining the outputs of questions that have different names in the survey system may result in the data for those columns not being reported for certain participants.

4 Discussion

4.1 Pilot Results Discussion

The results indicate that the tutorial was successful in teaching participants the skill of completing logic grid puzzles, and made them feel more confident in their abilities than before tutoring. However, the manipulation of the names present in the puzzle during tutoring did not impact performance. As this is a small pilot study, it likely did not have enough power to find results. Currently there are only 6 participants in each condition. The full study is expected to have at least 40 participants in each condition. Individual differences in the ability of individuals to solve the puzzles and the wide variety of ages may also have played a role in the results. Based on the experience with this pilot study, some changes have been made to the full-scale study. First, a pre-test of applied clue questions will be given. Secondly, as not all the participants were able to finish the easier logic puzzle in 5 minutes, the amount of time given for this task will be increased. It is also possible that the current "tests" are not sensitive enough to differences. Further, the sample population for the pilot is different than the intended population for the full-scale study (college students), therefore, those with less research and logic training may show different results.

4.2 GIFT Discussion and Recommendations

GIFT was extremely useful in the current study. During this pilot, participants were able to easily understand and interact with the courses developed with GIFT. All of the survey data was recorded and able to be cleaned up for analysis. One improvement that could be made would be to change the UserID system. Currently, it is set up such that UserIDs are created one by one and in order. It would be beneficial to be able to assign a specific participant number as the User ID in order to reduce confusion when exporting the results (e.g. "P10" rather than "1"). Further, improvements could be made to the ability to launch an external web-site. Currently, there is no ability to provide on-screen directions to individuals while they are on the page. While the Survey Authoring System is useful, it could be greatly improved by having a more reliable import/export option for questions and entire surveys. By doing so, it would be easier to set up identical instances of GIFT on multiple computers.

Overall, GIFT is a useful, cost effective tool which is an asset in running a study. It has a wide variety of helpful functions, and with each release the improvements will likely make it even more valuable to researchers who adopt it.

5 References

1. Anand, P.G., & Ross, S.M. (1987). Using computer-assisted instruction to personalize arithmetic for elementary school children. *Journal of Educational Psychology, 79* (1), 72 – 78.
2. Compeau, D.R., & Higgins, C.A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly, 19* (2), 189 – 211.

3. Chow B. (October 6th, 2010). The quest for deeper learning. *Education Week*, Retrieved from http://www.hewlett.org/newsroom/quest-deeper-learning
4. Ku, H-Y, & Sullivan, H.J. (2002). Student performance and attitudes using personalized mathematics instruction. *ETR&D, 50* (1)*,* 21 – 34.
5. Lombardo, M.V., Barnes, J.L., Wheelwright, S.J., & Baron-Cohen, S. (2007). Self-referential cognition and empathy in autism. *PLOS one, 2* (9), e883.
6. McDonald, K. (2007). Teaching L2 vocabulary through logic puzzles. *Estudios de Linguistica Inglesa Aplicada, 7*, 149 – 163.
7. Moreno, R., & Mayer, R.E. (2000). Engaging students in active learning: The case for personalized multimedia messages: *Journal of Educational Psychology, 92* (4), 724 – 733.
8. Sinatra, A.M., Sims, V.K., Najle, M.B., & Chin, M.G. (2011, September). An examination of the impact of synthetic speech on unattended recall in a dichotic listening task. *Proceedings of the Human Factors and Ergonomics Society, 55*, 1245 – 1249.
9. Sottilare, R.A., Brawner, K.W., Goldberg, B.S., & Holden, H.K. (2012). The Generalized Intelligent Framework for Tutoring (GIFT). Orlando, FL: U.S Army Research Laboratory – Human Research & Engineering Directorate (ARL-HRED).
10. Symons, C.S., & Johnson, B.T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin, 121* (3), 371 – 394.

6 Acknowledgment

Research was sponsored by the Army Research Laboratory and was accomplished under Cooperative Agreement Number W911NF-12-2-0019. The views and conclusions contained in this document are those of the author and should not be interpreted as representing the official policies, either expressed or implied, of the Army Research Laboratory or the U.S. Government. The U.S. Government is authorized to reproduce and distribute reprints for Government purposes notwithstanding any copyright notation herein.

Authors

Anne M. Sinatra: Anne M. Sinatra, Ph.D. is an Oak Ridge Associated Universities Post Doctoral Fellow in the Learning in Intelligent Tutoring Environments (LITE) Lab at the U.S. Army Research Laboratory's (ARL) Simulation and Training Technology Center (STTC) in Orlando, FL. The focus of her research is in cognitive and human factors psychology. She has specific interest in how information relating to the self and about those that one is familiar with can aid in memory, recall, and tutoring. Her dissertation research evaluated the impact of using degraded speech and a familiar story on attention/recall in a dichotic listening task. Prior to becoming a Post Doc, Dr. Sinatra was a Graduate Research Associate with the University of Central Florida's Applied Cognition and Technology (ACAT) Lab, and taught a variety of undergraduate Psychology courses. Dr. Sinatra received her Ph.D. and M.A. in Applied Experimental and Human Factors Psychology, as well as her B.S. in Psychology from the University of Central Florida.