An Emerging Computational Model of Flow Spaces to Support Social Creativity

Shiona Webster, Konstantinos Zachos & Neil Maiden
Centre for Creativity in Professional Practice
City University London
Northampton Square, London, EC1V0HB, UK
{shiona.webster.2, k.zachos, N.A.M.Maiden}@city.ac.uk

Abstract

This position paper reports an emerging computational model of flow spaces in social creativity and learning that can be applied to guide human-centered creative cognition in social groups. In particular we are planning for the model to be applied to inform creative goal setting, creativity technique selection and adaptation, and guided social interaction during creative problem solving and learning.

Social Creativity and Learning

Social creativity and learning are increasingly important and related phenomena. Indeed, fostering creativity in learning is seen as a key direction with which to transform promising ideas into new processes, products or services (Retalis and Sloep, 2010). The explosion of information made available through the advancement of Web 2.0 has resulted in publicly available content that is continuously (re)created over the social media universe at an ever-increasing speed (Kaplan and Haenlein, 2010). Such rich content resources can provide a wealth of useful information that can support creativity and learning in both informal and formal social groups. Technologies are available to support such social creativity and learning and which support many different techniques that can be applied to solve problems creatively.

However, one outstanding challenge is which techniques to use to support different forms of social creativity and learning. The techniques can be categorized by the creative outcome that each can deliver when applied effectively, for example, the distinction between transformational, exploratory and combinatorial creativity (Boden, 1990), yet these categories offer few insights into effective processes that lead to social creativity and learning.

We argue that the success of social creative processes can depend on the extent to which people in the process are able to collect and relate information as well as create ideas collaboratively (Shneiderman, 2002), and whether these people experience flow and can create and learn, as opposed to becoming bored or anxious during it (Csikszentmihalyi, 1974).

For example, consider the following three different creativity techniques that could be deployed in a social creative process: (i) creativity triggers for business services, an exploratory creativity technique which directs the problem solver to solutions associated with creative ideas with qualities such as *convenience* and *trust*; (ii) constraint removal, a transformational creativity technique that removes or reduces perceived constraints to increase the possible search space e.g. (Onarheim, 2012), and; (iii) analogical problem solving, an exploratory creativity technique that transfers a network of interrelated facts from a mapped source domain to the target domain e.g. (Gick and Holyoak, 1983). Each of the techniques has different strengths and weaknesses. Analogical reasoning from a source domain necessitates information about the domain to be collected and related before ideas can be generated. Analogical knowledge transfer can then trigger the problem solver to generate multiple and more radical new ideas and concepts, but is cognitively difficult to do (Gick and Holyoak, 1983), and can lead to anxiety rather than flow and learning through the formation of new problem schemata. Constraint removal also necessitates information to be collected beforehand, and can lead to the generating of more ideas than with analogical problem solving (Jones et al., 2008).

We argue that criteria and mechanisms for selecting the most effective creativity technique at the right time in a social creative process are currently lacking. Whilst some experienced human consultants demonstrate an ability to select and adapt techniques to changing situations in social processes, such work is best categorized as craft, with little externalization of the knowledge and mechanisms applied. Moreover, if we are to embed such knowledge and mechanisms in computational environments that will guide and support people in the use of Web 2.0 creativity support tools during such processes, then new research is needed to discover and describe this knowledge and mechanisms – new research that we are undertaking in the COLLAGE consortium.

COLLAGE is a EU-funded Integrated Project, to inform and enable the design of effective Web 2.0 social creativity and learning technologies and services. The focus is to design, develop and validate an innovative cloud-enabled social creativity service-set that will support the interlinking of learning processes and systems with (i) social computational services for inspiring learners, (ii) social affinity spaces for leveraging expression and exploration, and (iii) social game mechanics for supporting social evaluation and appreciation of creative behaviour. The new computational environment that we are developing to invoke different services in this set will need new capabilities to select between and recommend services, then adapt guidance to the social group during the social process. To deliver these capabilities, the approach adopted in COLLAGE is to develop a descriptive model of the desirable creative processes that is derived from existing theories and models of creativity and learning.

In this paper we report a first version of the model that describes how creativity and learning might be associated within a social process. The focus of the model is on descriptions of conceptual spaces in which flow, creativity and learning can be achieved. This model will, we anticipate, enable the design of effective social creativity and learning technologies and computational services with which to inform the selection and use of different creativity techniques and support tools.

Initial version of the COLLAGE Social Creativity and Learning Model

The COLLAGE Social Creativity and Learning (SCL) model is being developed to inform the principled selection and use of different techniques and computational services that support creative idea generation based on inspiration and recommendation engines, game mechanics and affinity spaces. To develop the model, we have drawn on Shneiderman's GENEX framework and Boden's concept of conceptual space to support social creativity and collaborative learning in workplaces. The use of each is reported in turn.

GENEX Framework

The SCL Model is based on the GENEX framework (Shneiderman, 2002) – an established situationalist model of social creative processes. The GENEX framework identifies four key processes during social creativity: (i) collecting information from public domain and available digital sources; (ii) relating, interacting, consulting and collaborating with colleagues and teams; (iii) creating, exploring, composing, and evaluating solutions; and (iv) disseminating and communicating solutions in a team and storing them in digital sources. These phases may occur in any order and may repeat and cycle iteratively.

Boden's Theory of Search Spaces

In COLLAGE we use Boden's model of creativity (Boden, 1990) to support the creative work by exposing novel information spaces to problem solvers and in turn, recommend creativity techniques that can be used to discover novel ideas for problem solving. Creativity is seen as a search of solution possibilities in a space based on measures of dissimilarity between possibilities as proxies for solution novelty (Ritchie, 2007). The search task is to find a complete solution among a set of partial and complete solutions that make up the search space. Hence, we assert that the problem at hand can be mapped to a problem of searching a space of solution possibilities.

The SCL model extends both the GENEX framework and Boden's concept of conceptual space to incorporate three capabilities that are critical to support social creativity and learning: (i) to reason about a new solution in order to discover the spaces in which novel and useful ideas are most possible; (ii) to guide the use of creativity techniques to search these spaces in order to discover novel and useful ideas; (iii) to engage the problem solver in such a way that he is fully immersed, feeling involved and successful in exploring the space of possible ideas.

To deliver these capabilities the SCL model includes: (a) a theory of goal-driven creative search spaces that computes novel search spaces and recommends creativity techniques to discover novel ideas; (b) a collaborative learning model for creativity that exploits a problem solver's real learning capacity in a collaborative and creative setting. The next section describes our use of the theory of goal driven creative search and new collaborative learning model that combines Csíkszentmihályi's notion of 'flow' with Vygotsky's Zone of Proximal Development.

Theory of Goal-driven Creative Search Spaces

Since search spaces have an implicit modularity in their structure (Johnson, 2005) and are often too large to search in a single search activity, the SCL model supports the discovery and exploitation of modular building blocks in the space. In COLLAGE we see the SCL model as a search-based creative process, i.e. a process of breaking down an initial, bigger problem into sub-problems, working out how those sub-problems fit together, and then tackling those sub-problems.

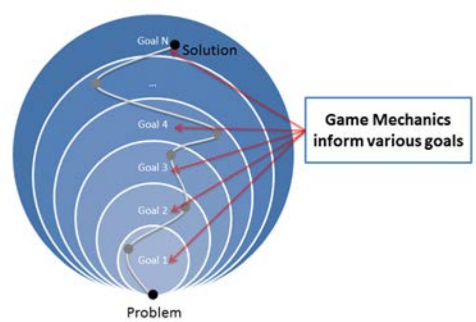

Figure 1. The overall search space divided into sub-spaces

Figure 1 shows a representation of two types of search space that we are seeking to describe and enable the search of, and discovery of ideas within. The first one is the larger overall search space that includes all of the ideas in the space. Since the space is too large to search in a single creative search activity, the space is searched through a series of creative search activities, each of which searches the local part of the space expressed by the current goal, related to the ideas already discovered in the space. We can express a creative search activity in terms of a current subspace in a wider design space, and apply search-based techniques and theories to it.

One characteristic of creative search processes is that the criteria for evaluation of where to make the moves in the search space are not easy to capture in rule-bound form. Therefore, in COLLAGE we will employ game mechanics as a means to set intermediate goals in the overall search space that will both guide and engage problem solvers in further creative activities. Just as a game has levels that one tries to achieve, so should each creative search activity be informed by specific goals; game mechanics are used to provide these goals, which can be in the form of awards, credits and acknowledgements, in order to motivate and engage learners further in the creative problem solving process. Each subspace reveals a new goal that compels the problem solver to continue their creative search activity.

Collaborative Learning Model

The fundamental idea of how a subspace is traversed can be illustrated through an approach that combines Csíkszentmihályi's notion of 'flow' (Csíkszentmihályi, 1996) with Vygotsky's notion of the Zone of Proximal Development (Vygotsky, 1978). By combining both ideas, we introduce the concept of the collaborative learning model.

Csíkszentmihályi suggests that a person (or group) can experience 'flow' when fully immersed in an activity, feeling full involvement, an energized focus and success. Creativity is more likely to result from flow states (Csikszentmihalyi, 1996). Csíkszentmihályi identified three things that must be present to enter a state of flow:

- **Goals** – Goals add motivation and structure to the task; therefore, the person must be working towards a goal to experience flow.
- **Balance** – There must be a good balance between a person's perceived skill and the perceived challenge of the task. If one weighs more heavily than the other, flow probably won't occur.
- **Feedback** – A person must have clear, immediate feedback, so that he can make changes and improve his performance. This can be feedback from other people, or the awareness that progress is being made.

Vygotsky's conceptualisation of the zone of proximal development (ZPD) is designed to capture that continuum between the things that a learner can do without help, and the things that a learner can do when given guidance, or in collaboration with more knowledgeable others. According to Vygotsky, learning occurs in this zone.

Therefore, for learning to occur, people in a creative social process must be presented with tasks that are just out of reach of our present abilities. Tasks that are in the ZPD are tasks we can almost do ourselves, but need help from others to accomplish. After receiving help from others we will eventually be able to do the tasks on our own, thus shifting them out of our ZPD, in other words we have learned something.

In COLLAGE we combine flow and the zone of proximal development in the collaborative learning model depicted graphically in figure 2. The concentric circles represent the subspaces and goals that make up the larger overall search space. The horizontal axis represents a problem solver's domain-specific knowledge of the task at hand and the vertical axis represents the level of the task challenge.

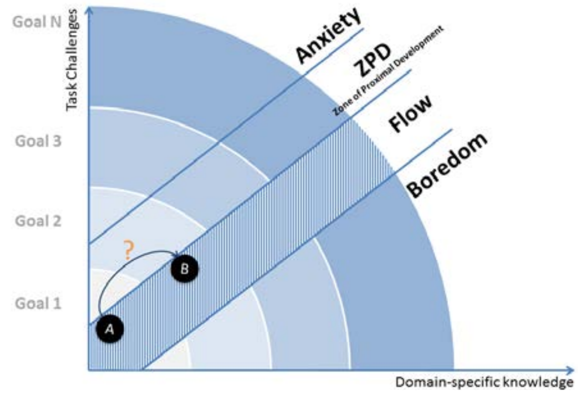

Figure 2. The collaborative learning model

As the problem solver's acquisition of knowledge advances in response to the challenges, an ideal path in the flow region would progress from the origin towards the upper right. The transition from starting point (A) to destination point (B) indicates the increase of knowledge and challenge that naturally traverses the ZPD, but under control and with the expectation that the problem solver will return to the flow zone again. We can see how a problem solver can move from bored (when their domain-specific knowledge exceeds their challenges) into the flow zone (where everything is in balance), but can easily move into a space where he needs some help. Most importantly, if we move upwards and out of the ZPD by increasing the challenge too soon, we reach the point where a problem solver starts to realize that he is well beyond his comfort zone. In COLLAGE, we seek to characterize each path connecting a knowledge/challenge space by the goal, balance and feedback needed to encourage flow:

- Game mechanics can provide achievable goals;
- Balance between a problem solver's domain-specific knowledge and skills and the perceived challenge of the task will be sought;
- Specific COLLAGE creativity-supported feedback services will provide clear and immediate feedback.

The next section describes how we are developing computational guidance for social creative processes.

Providing Guidance for Creative Processes

Our vision in COLLAGE is to utilize the emerging model with its concepts of information search for idea discovery, individual and social flow, and zones of proximal development to recommend and adapt the use of different computational services and affinity spaces during a social creative process. The ambition is deliberately ambitious, with the aim to develop a computational environment to propose and adapt different services and spaces to maximize search, and achieve flow and learning. Indeed, according to Amabile, one of the single most important factors that induces creativity is a sense of making progress on a meaningful task (Amabile and Kramer, 2011), therefore the guidance will provide catalysts that induce progress, for example by setting achievable goals, providing resources, offering help and enabling users to learn from knowledge gained during previous creative activities.

The guidance is being developed to direct users along paths that connect a knowledge/challenge starting point (A) with destination point (B) in the collaborative learning model depicted in figure 2. We see the role of the creative process guidance to direct the problem solvers to effectively use the different creativity techniques, dependent on the situation, to bring balance to the knowledge/challenge. The creativity-supported feedback component incorporates all four processes from the GENEX framework.

The first version of the model identifies at least the following characteristics of social creativity and learning:

1. Defining and searching conceptual spaces of possible ideas
2. The setting of goals that render effective periods of individual and group flow achievable, within risking boredom and/or anxiety;
3. The maintenance of group flow in groups of distributed individuals who are often collaborating asynchronously;
4. Guiding individual learners into zones proximal development to encourage then support learning about creativity techniques and/or the problem domain as part of the flow process.

COLLAGE creativity services and affinity spaces need to support people to undertake creativity and learning activities with these characteristics. Moreover, we argue that each of these characteristics indicates one or more affordances of creativity services and affinity spaces for these characteristics of social creativity and learning. Consider each of the characteristics in turn.

Defining and Searching Conceptual Spaces of Possible Ideas

Any creativity service and affinity space should afford:

- One or members of the social group to undertake explicit information search and idea discovery in a conceptual space of possible ideas;
- These members to explicitly implement creativity services and affinity spaces that support different forms of transformational, exploratory and combinational creativity in a conceptual space.

An example of an established creativity service that affords exploratory information search and idea discovery is a creativity trigger. A creativity trigger is a generic desirable quality of a future solution that the social group is directed to discover new ideas to deliver – in software-based solutions, these qualities can include convenience, choice and trust. For example, use of the creativity trigger convenience guides one or members of the social group to undertake explicit information search and idea discovery in a space of ideas that can deliver the convenience of quality – and the search can be supported through the retrieval of information related to the quality of convenience.

Setting of Goals that Render Effective Periods of Individual and Group Flow Achievable

Any creativity service and affinity space should have assigned to it:

- A rating of the prototypical distance between the current set of ideas and the set goal that can be achieved through effective application of the creativity service or affinity space – the creative potential of the service or space;
- A rating of the prototypical distance between the content of the current set of ideas and the set goal content that can be achieved through effective application of the creativity service or affinity space – the creative potential of the service's or space's content;
- A difficulty rating indicating the potential level of difficulty that one person or a social group might encounter when learning and/or applying the service or space.

An example of a creativity service that demonstrates goal setting for individual and group flow is analogical reasoning. Analogical reasoning is the systematic transfer of a network of related information from a source domain to a target domain in order to generate new ideas in the target domain based on the transferred information (Gentner, 1983). Analogical reasoning has considerable potential to reconceptualise problem and solution spaces, hence the service's creative potential is high. Key to its success is the selection of source domain(s) from which to transfer knowledge for idea generation. Source domains semantically close to the target domain are easier for people to map to, but can lead to less new idea generation, and can risk boredom. In contrast, source domains semantically further from the target domain can lead to greater idea generation, are more difficult for people to map to and risk anxiety. Moreover, empirical evidence has revealed that people find analogical reasoning difficult (Gick & Holyoak 1983), hence they are likely to encounter difficulties during its use compared with creativity services that are easier to use such as creativity triggers.

The maintenance of group flow in groups of distributed individuals

Any creativity service and affinity space should afford:

- Collaborative creativity and learning by the members of the social group;
- The externalization of new ideas and knowledge that can be shared effectively with the members of the social group as part of a creative process;
- Explicit support for turn taking by members of the social group during the collaborative creative process.

An example of an affinity space that can afford the maintenance of group flow is design storyboarding. A storyboard is a graphic organizer in the form of illustrations or images displayed in sequence for the purpose of pre-visualizing a motion picture, animation, motion graphic, interactive media sequence or, for COLLAGE, a business or service design. Developing a storyboard from a set of existing concepts and ideas can afford collaborative creativity and learning by members of a social group through focused work on individual storyboard frames – the new ideas and knowledge generated from this creative work are shared with other members of the social group through the emerging storyboard, which acts as common ground in the collaborative creative process. Moreover, the development of discrete storyboard frames by individual members of the social group can afford turn taking based on game mechanics.

Guiding Individual Learners into Zones of Proximal Development

Any creativity service and affinity space should afford:

- The acquisition and learning of new knowledge in order to achieve flow as part of the individual and collaborative creative processes;
- The adaptation of any creativity service and affinity space in real-time to guide one or members of the social group into the zone of proximal development to support learning during creative flow.

An example of a creativity service that guides learners into zones of proximal development to encourage learning is the constraint removal service reported earlier. During the create activity, one or more members of the social group are required to envision a future version of the domain in which a constraint no longer applies or has been significantly relaxed. For example, during the exploration of new, more environmentally friendly operational concepts for an airport management system, one constraint that was removed was the variability of the weather. To generate new ideas, each member of the social group was required to envision an alternative reality of the domain in which weather was predictable. This required learning by the social group.

Future Work

Clearly we have only reported preliminary research in this paper, and much work remains to be done to develop, implement and validate the concepts proposed. The next stages of the research are to complete a first description of the model and build a first computational model of creative search spaces that the model will be applied to. We have a set of available computational creativity services that can be applied to search the space, as a basis for prototypical development of first versions of the computational model. We will look forward to reporting these advances in the near future.

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