IdSpace Workshop on

Methods & Tools for Computer Supported Collaborative Creativity Process: Linking creativity & informal learning

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Methods & Tools for Computer Supported Collaborative Creativity Process: Linking Creativity & Informal Learning


Workshop held within the EC-TEL 2009 conference

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Preface

This volume contains the proceedings of the workshop on “Methods & Tools for Computer Supported Collaborative Creativity Process: Linking creativity & informal learning”. This workshop was held within the ECTEL 2009, the 4th European Conference on Technology Enhanced Learning "Learning in the Synergy of Multiple Disciplines”, in Nice on the 30th of September 2009.

The aim of this workshop is to bring together experts from R&D groups that work in the area of computer supported collaborative creativity process, and want to contribute to the discussion, validation, and dissemination of useful methods and tools in this area.

Workshop Scope

Creativity is best described as the human capacity regularly to solve problems in a way that is initially novel but ultimately acceptable in a culture [1]. Creativity process is an intense collaborative process of generating and exploring ideas meant to contribute to innovative solution of particular problems. During this process, team members go through cycles of divergence, in which new ideas are generated and explored, and convergence, in which new ideas are valued and detailed. Innovators need appropriate methods and supportive tools to generate ideas, reuse them, take them apart, criticise them, or even reject them. Empowering team members to personalise their creativity process in a supportive computer-based collaborative environment of peer assistance, reflection and critique and in interaction with experts and domain specialists can lead also to effective informal learning activities.

Networked technologies, and especially social software systems, provide new affordances that facilitate collaboration, innovation and creativity for organizations. The scope of this workshop will be to exchange ideas and know-how about the various methods and tools that efficiently and effectively support the computer-based collaborative creativity process and offer informal learning opportunities. There will be only few presentations (outcome of a review process). The main emphasis will be given to plenary discussion about the maturity of the processes, the tools as well as about what is needed for supporting such processes in industrial environments.

List of topics

Papers address the following topics:

- Design of collaborative creativity support tools that are based on methods and strategies that help distributed group members collaborate for developing innovative products (e.g. SCAMPER, Six Hats, Jigsaw)
- Research methods to evaluate the usability of collaborative creativity support tools
- Computer supported creativity processes in specific domains
- Assessment framework of collaborative creativity processes.
Acknowledgements

The workshop is organized as part of the idSpace project on Tooling and Training for collaborative product innovation [http://idspace-project.org]. It is funded in part by the European Commission FP7-IST-2007-1-41, project number 216799. The idSpace project designs, builds and pilots a web-based environment which, ultimately, will offer an integrated suite of knowledge eliciting and sharing tools, and create a collective, sharable memory of the entire design process. It should form the substrate for the emergence of a productive and lasting community of practice and learning that will maximally foster innovation.
Real Time Synchronization for Creativity in Distributed Innovation Teams

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Abstract. In this paper we introduce a synchronization approach for real time collaborative sketching for creativity in distributed innovation teams. We base our approach on reverse AJAX. This way we ensure scalable solution for real time drawing and sketching important in creativity settings.

Keywords: Creativity, Real Time Collaboration, Synchronization, AJAX

1 Introduction

Creativity sessions are usually performed in teams with a lot of interactions between team members. They usually stand at a white board or sit behind a round table discussing new ideas, organizing them, connecting them to each other, validating them and so on.

Several creativity techniques have been introduced to guide and organize such sessions such as 5WH1, SCAMPER, or Six Hats to name just few of them. The main idea behind them is that they describe common practices to elicit new ideas, group members to elicit them, the ways of involving different members and giving them sufficient space in the session and so on. The techniques can be seen as different social conventions depending on what the creativity session goal is (idea generation, exploration, validation and a like). Another strong character of the creativity sessions is the real time collaboration which needs to be supported also in distributed teams as well.

Creativity is a knowledge co-construction process from learning perspective. Participant himself as well as its peers in the creativity session learn by performing brainstorming and by co-constructing knowledge about new ideas when generating them, when validating them and so on.

The creativity techniques inspired us in developing the idSpace platform. As different phases in creativity process are supported by different techniques, we believe that idSpace platform should support a choice from the techniques and an ability to mash them up. Furthermore, it needs to support idea management for further exploration and learning from the work of the others and mash-up such knowledge into the work of the others.
In this paper we discuss a prototype which sets a baseline for supporting such a creativity and knowledge co-construction. We describe a prototype which allow for meshing up different editors for sketching the ideas and subsequent idea management. We describe a solution to synchronize the editors in real time by using so called comet approach which contributes to the fact that the collaboration in the distributed creativity sessions is perceived as real time.

2 Related Work

The use of creativity techniques in industry varies. Some companies just use paper and pencil, some have adopted ICT-based techniques, which are used mostly in isolation though. The frequency and distribution of techniques and tools used varies from country to country. Brainstorming [6] is conducted widely, with mind mapping [1] as the most used supportive technique (see for example [5, 8, 3].

The reasons for using particular techniques differ slightly as well, reflecting culture, industrial domain and working style. Various techniques for the systematic structuring and refinement of ideas have been proposed. Examples are morphological analysis [10] and methods of structured inventive thinking like TRIZ (Teoriya Resheniya Izobretatel’skikh Zadatch i.e. theory of inventive problem solving) and SIT (systematic inventive thinking) [4, 7].

In this paper we propose a solution which enables a real time combination of sketches performed under different editors when participants are distributed and are using Internet to collaborate. We do not limit ourselves yet to any of the mentioned creativity techniques as all of them might benefit from the solution we propose in this paper. We base our solution on the Liferay portal. This way we enable the use of any technique as a plugable toolset to the Liferay.

There are different possibilities for realizing real time collaborative editing. As we focus on Internet browser based collaboration, we look here only at those which are commonly used in such situation. One approach is to query server which keeps the share copy for editing in regular time interval. This creates performance problems. Another approach is to used recently introduced AJAX (Asynchronous Javascript) for subscribing and receiving back the request. Our approach is based on AJAX and we will discuss several approaches how to implement real time collaboration in the next section.

There are several real time collaborative editors available such as Adobe Buzzword\(^1\), ZOHO\(^2\) and the others. Most of them however support only text editing. We base our solution on MxGraph\(^3\), graph editing software, to provide scalable solution for creativity sessions. We cannot use supported shared editing functions as they are based on one single model. We need to extend the synchronization to support synchronization of related models which are stored

\(^1\) http://www.adobe.com/acom/buzzword/
\(^2\) http://www.zoho.com/
\(^3\) http://www.mxgraph.com/
separately. Furthermore, comet based approach we have implemented seems to provide more scalable solution.

3 Ensuring Real-Time Synchronization

![Outline of the centralized client/server architecture.](image)

The general architecture is designed as a centralized client/server architecture. Meaning that the model layer is handled by the server and clients can show a representation of the model. The centralized server pattern is used to ensure consistency in the graph models and collaborative editors. The architecture is outlined in Figure 1.

The real-time collaboration on sketches in creativity sessions is based on synchronization of work performed under different instances of editors in distributed fashion. Traditional way of performing real-time synchronization between web clients is limited by the HTTP protocol. The HTTP protocol is built on a client creating a request for a web page and the server responding with the source of the page. In order to create a traditional real-time synchronization in collaborative editors would involve every client constantly asking the server if there is new updates. This creates a performance and scalability problems. An example of using this technique could be old chat rooms refreshing every second or so, and updating the screen accordingly.

Another approach lies in so called reverse AJAX. As AJAX it is not a technology by itself, but a technique using existing technology. Of course it is not possible to actually push data from the server directly to the clients, without them asking for it, but it can be emulated at a performance level, which is close to real-time.

There is a lot of different implementations of this technique, but the most widely used is the DWR framework. The DWR framework offers three different strategies for reverse AJAX: “Polling”, “Comet” and “Piggybagging”.

**Polling:** The browser makes a request to the server in regular intervals and receives updates when the server responds.
Comet: The client sends a request to the server, which then starts to answer very slowly. It answers so slow, that the connection is kept open at almost all time, which in fact eliminates the limitations of the stateless HTTP protocol. Data can flow in each direction at all times with this technique, so there is no blocking communication either.

Piggybagging: The client does not get updated until it sends a request to the server, the server then sends all updates back.

The solution chosen for the reverse AJAX technique between the client and server is comet, because it gives the best results in terms feeling the application runs in real-time. Figure 2 illustrates a sequence of events happening on both client and server, and outlines how they transmit data between each other. Holding the connection open at all times leads to the question of whether or not it will create thread starvation. Normally it will, but the DWR framework comes with implemented strategies to resolve the issue and ensure that the solution is scalable [9].

DWR is implemented client side by adding auto generated javascript libraries. The libraries is auto generated by a DWR servlet running on the tomcat server. Thereby eliminating synchronization issues, because the client will automatically get the last compiled server interface.

Collaborative editing uses a shared model, which different client represents and is able to manipulate. In order to create the one-to-many dependency between the model and the clients, an observer pattern is applied [2]. Figure 3
Fig. 3. Observer pattern applied to the sketch editor.

shows the class diagram of the observer pattern applied to the sketch model, which is observed by the clients. This design creates transparency for the developer and allows for further extensions to other editor types, such as idea editors, topic map representations etc.

4 Conclusions

In this paper we have introduced an approach for real time synchronization of different sketching editors for real time collaboration in creativity sessions. The approach uses comet and reverse AJAX as techniques of doing that. The advantage of the proposed architecture is that it keeps the communication channel between connected clients and server almost constantly allowing to send any kind of information between each other. However, with large models, we might still encounter performance issues. We will further study how to exchange only changed part of the model to improve performance and study further technologies to improve collaborative real time sketching supporting also larger teams. In the future work we plan to evaluate this approach with real users in the context of idSpace project.

Acknowledgement

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References

Collaborative Moderation — Fostering Creativity with a Corporate Wiki

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Abstract. Voluntary participation in a corporate Wiki can be low due to personal priority preference. But high participation of professionals is necessary to enable group innovation through a Wiki. We present a tool that offers rewards to committed users, and triggers a sportive competition that fosters the creativity process through knowledge exchange.

1 Introduction

Creativity is the human’s ability to solve problems in a way that is initially novel but ultimately acceptable in a culture. Finding such solutions often depends on the collaboration of multiple individuals. Modern means of communication open up opportunities for entirely new ways of computer supported collaboration in creativity processes. Creativity processes are characterized by different dimensions like synchronous vs. asynchronous communication, long vs. short term, or planned vs. ad-hoc processes. De Bono’s “Six Thinking Hats” method [1] is a typical example of a synchronous, short duration, face-to-face and planned creativity process. Recent achievements in information technology such as video conferencing support such creativity processes or even enable all new ones.

This paper investigates on employing a Wiki as a creativity process that is typically asynchronous, long term, remote, and ad-hoc. In 1995, Ward Cunningham invented the Wiki principle [2] aiming at replacing static web pages with dynamic ones that can be edited online. A Wiki supports the free exchange of ideas in a group of people that are spatially distributed. All they need is Internet access. As the largest and most popular Wiki, Wikipedia represents a success story and covers more than 2.7 million English articles written by over 285,000 users¹. Wikipedia interlinks the knowledge of many different people, and thus, combines own knowledge and views with those of others.

However, a Wiki is not geared towards solving a specific problem, since the writers cannot anticipate what results they will finally obtain. All participants share their knowledge voluntarily and in their spare time (see Section 2). A Wiki requires a moderation process, in order to channel the contributions and ideas

into a certain direction, and thus, become a support mechanism for creativity. Moderation also helps to reduce destructive conflicts among engaged individuals, prevents the discussion from getting polluted with superfluous information, and ensures a fair distribution of attention. Numerous social rating tools exist for Wikis (e.g. MediaWiki Review\textsuperscript{2} extension, see figure 1) but the feedback is confined to an article and does not touch the authors; going beyond this border is hence necessary for moderation.

This paper presents an approach towards collaborative moderation in a corporate Wiki that enables a group of professionals to collaboratively drive the creativity process (see Section 3). Instead of an external moderator prescribing the discussion of certain topics, the group moderates and manages itself. The impressions and comments of the group are fed back into a rating system that takes over moderation and thereby gears the Wiki’s evolvement towards the right direction (see Section 4). The paper describes the initial phase of a study of a long-term creativity process supported by a collaboratively moderated Wiki.

2 Participation and Moderation in a Wiki Process

Thousands of people worldwide use Wikipedia; willing to share their knowledge and manpower for free or for the reputation of participating creatively and actively in such a huge project - a world wide online encyclopedia. In contrast, the users of a corporate Wiki represent a small working group consisting of employees. If the Wiki principle should work for a company information system then active contribution of every workgroup member is required.

Conducting an inquiry and observing long-term usage of our department corporate Wiki revealed interesting findings. The Wiki’s content does not display much variety of topics, articles have a short length and their number is quite small. Much content should be upgraded or extended so that the meaning of the current subject becomes clearer. Readers, who are not familiar with the subject, are unable to quickly understand such articles and extract valuable information from them. Furthermore, there are obsolete articles that have not been updated for a long time, and therefore represent inappropriate or outdated knowledge.

Members of the workgroup use the Wiki very little, and thus, new entries are written infrequently and only few extensions to existing articles are made. Due to heavy workload and an unknowable benefit from investing one’s own time in sharing knowledge, people typically put a lower priority on working with the Wiki. They experience few individual benefits or rewards for themselves as individuals compared to the effort and time they invest, which results in decreased motivation. When analysing the inquiry, we identified five key requirements:

- a \textit{continuous participation} in extending the Wiki content must be achieved to change the users’ attitude from consumption towards contribution,
- an \textit{increased amount of topics} in the Wiki is necessary to extend the information not only quantitatively but also thematically,

\textsuperscript{2}http://www.mediawiki.org/wiki/Extension:Review
– an increased motivation of the participating users is necessary to take the initiative of extending the Wiki content by themselves,
– an improved article quality is required to allow for more effective and more efficient knowledge transfer between participants, and
– an increased knowledge exchange is needed to direct and guide creativity within the group.

We think that lacking moderation in a corporate Wiki leads to insufficient communication, collaboration and cooperation between the team members. A certain organization body which controls the working process and encourages the writers would increase efficiency and the quality of results. The following chapter describes how a collaboratively moderated corporate Wiki addresses the enumerated requirements and unleashes the creativity of the working group.

3 Utilizing Community Feedback for Wiki Moderation

An important issue in the companies is how to motivate personnel to high performance. Basically, the workforce can be motivated through the promotion of inner satisfaction with the own work and identification with joint norms; or through external rewards, punishment or force [3]. However, it is practically impossible to directly influence the intrinsic motivation of humans. It is only possible to try to motivate humans with the aid of external factors, and to awaken their interest for the activity itself or its subject. Yet enforcing a certain kind of behavior would require issuing instructions by superiors. This would be contradicting to the idea of self-organizing groups and self-reliant creativity.

There are two methods to motivate the employees extrinsically namely by rewards and punishments, which are based on negative or positive stimulus valence. Better results are achieved with rewards because the personnel gets the impression that it earns something for its efforts [4]. Punishments are inherently unpleasant and easily become a dead end for motivation.

Our concept is to reward individuals who provide the community with interesting, valuable and high quality contributions. In a Web 2.0 fashion the consumers of information review the quality of the articles they read and feed this information back into an information system. The information system then accumulates the different opinions and thereby democratically determines the quality of an article. This kind of interaction is quite common in the various Web 2.0 applications. We take the concept one step further, and not only determine the quality of articles but also find out who is responsible for an article and assign different weights to articles. Combining article quality, responsibility and weight we are able to determine individual contribution scores for every user.

We hope to trigger a beneficial and sportive competition for high quality information exchange among contributors. Depending on quality and quantity of their contributions users win awards (e.g. gain levels that are presented as funny icons similar to the levels of Wakoo3 depicted in Figure 2, and described in Section 4.2).

3 http://wakoo3a.com/about/reputation/#awards
4 Realizing Collaborative Moderation

This section explains the implementation, including calculations performed by the backend, and shows how user interfaces work.

4.1 Determining Personal Scores

CollabReview is a rating tool for an increasing source code quality. Developers while working with code form an impression of it. The tool then enables them to capture their impressions and manifest them in a rating which is then used to identify good and bad code. In combination with the responsibility determination this should effectively prevent cowboy-coding [5].

Personal scores are the basis on which rewards are granted. Similar to CollabReview the scores are obtained through combination of three values:

**The Quality** of an article is determined democratically. It is the average rating users gave to the article by writing reviews (see Figure 3(b).) Every user has at most one review per article at a time but is able to update his review whenever he wishes to. As an article is considered to be under continuous change a review might refer to an earlier revision of it; a review might be no longer completely accurate but also not be completely out-of-date. We therefore determine how much an article has changed since submission of the review and weight reviews by timeliness.

**The Responsibility** describes how much an individual contributor influenced the collaboratively written article. This value enables distributing scores to contributors and is the percentage of sentences he modified or added. Responsibility information per author is obtained by comparing the different article revisions. It is computed at a textual level using a modified Levenshtein distance: we determine the sentence insertions and deletions that transform one revision into the next. The user who added or modified a sentence is its author.

**The Weight** is an article’s importance. Articles with higher importance score more points and thereby attract attention and commitment. Determining interesting articles is crucial for collaborative moderation as it sets the Wiki’s evolution direction. We considered several strategies but have not yet decided which ones are best to combine:

- **User-defined:** users provide feedback on how important they deem an article.
– Viewing frequency: attracting attention from users indicates importance.
– Change frequency: frequent changes indicate importance in a similar way.
– Search: many queries for article or its key words through the search menu.
– Keywords: presence of designated keywords makes articles more important.
– Navigation paths: important articles appear early in navigation paths.
– Timeliness: recent changes indicate current interest for an article.
– Length: for fairness reasons longer articles should award more score points.
– Backward links: referenced articles are deemed important by other authors.
– PageRank: advanced weighting of Backward links method.
– Forward links: interconnecting the Wiki by references makes important.
– Viewing time: articles that keep users attracted are more interesting.
– Observers: being on many people’s Watch List indicates article importance.

4.2 User Interface

This is the description of the user interfaces that are integrated into the Medi-aWiki software to provide the new functionalities.

Collecting User Feedback  Reviews are submitted using a form embedded in all article pages. The form consists of several rating buttons and a text area to add comments on how the page could be improved (see Figure 3 (a)). It is directly visible hence users can easily submit new reviews or update earlier ones.

![Review form](image1.png)

![Article Rating](image2.png)

![User Ranking](image3.png)

Fig. 3. Wiki extensions: (a) reviewing an article, (b) showing ratings, (c) user ranking.
Presenting Scores and Awards to Users Our reward system gives points to users for contributing to important and well-rated articles. The system includes the following components:

- **Level hierarchy:** Every user has a level, initially starting as a newbie. A new level is reached if the user has acquired a certain number of points. Each level has an indication and a corresponding funny icon.
- **Ranking List:** The ranks of all users are listed in a table, which is announced on the Wiki main page so that everybody can see it (see Figure 3 (c)).
- **Awards:** Users can win awards for outstanding performance (in a certain time interval), e.g. “Wiki-Author of the Week”, that are attached to their accounts. Award winners are published on the main page of the Wiki using their photo, level-icon and awards.

5 Conclusion and Future Work

Writing articles in a Wiki constitutes a creativity process. Yet voluntary participation in a corporate Wiki turns out to be very low due to various reasons. We present collaborative moderation as a way to motivate group members to actively contribute to the exchange of ideas in order to foster creativity and group innovation. The concept builds upon rewarding individuals who provide the community with interesting, valuable and high quality contributions. Our Wiki plug-in allows participants to provide feedback for an article. Quality, responsibility and weight values determine which rewards authors receive.

In the next step we prepare and conduct an appropriate user study. The results will reveal how the rewarding system triggers a sportive competition among Wiki users. Furthermore, we will analyse to which degree such a collaborative moderation fosters the creativity process through knowledge exchange.

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References

Fostering creativity in online collaborative learning environments
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Abstract. The present contribution tackles the issue of creativity in educational contexts and in particular in online collaborative learning environments. The contribution proposes a model to evaluate collaborative learning activities oriented to the development of skills and attitudes underpinning the creative expression. The model is used in this study to evaluate two real online activities, based on two different collaborative techniques (namely the Role Play and the Discussion), so that it is possible to make some considerations about the two techniques and their ability to foster those skills and attitudes underpinning creativity.

Keywords: creativity, cognitive, affective, meta-cognitive, online learning context, collaborative technique, Role Play, Discussion, evaluation.

1 Introduction

The debate around the concept of creativity is quite recent and has even recently received a new impulse given the fact that 2009 has been declared Year of Creativity1. Usually, when one considers the “creative act”, one thinks at ideas or discoveries which have had an impact on the human history. Shneiderman (2000) refers to such kinds of episodes by defining them as “revolutionary” and in doing this he stresses the extemporaneousness of the creative act, as well as the unpredictability of the innovative discovery. Nonetheless, Shneiderman refers also to another kind of creativity, namely an “evolutionary” act resulting from the re-elaboration of existing parts/data into a new, coherent whole. Obviously, this latter kind of creativity may spring out of a single mind, but – even more frequently – may stems out from interactions among people while working together, sharing paradigms and know-how (Fischer, 2005; Fischer et al., 2005). Thus, nowadays there is a growing tendency to consider creativity also as a result of a social activity, by recognizing that the creative process may well take place thanks to the interactions of an individual with the environment and with others as well. Thus the complex concept of creativity can be placed in between evolutionary and revolutionary creativity, individual and social creativity, where all these terms should not

1 http://www.create2009.europa.eu/
be considered dichotomies, but rather they are components of a multi-facet system, where one component may support and strengthen the other ones. Sternberg (2005) even argues that there is not only one creativity, but rather we should talk of a number of “creativities”.

While on the one hand such a debate on creativity definition is still ongoing, on the other one the concept is very often associated with that of innovation (Markku-la, 2006). Innovation, as it is defined by the Council of the European Parliament², is the follow up of the creative process, something which stems from the application of new, creative ideas into concrete and specific contexts and which is explicitly recognized as valuable by the society (Fischer, 2005).

Starting from these considerations and thanks to some research studies (Nickerson, 1999; Csikszentmihalyi, 1997; Torrance et al., 1989), creativity has started been increasingly looked at as something that can be potentially stimulated through adequate learning tools and methods (UNESCO, 1972); at the same time – if one assumes that creativity is something that must have an impact on society and brings some kind of innovation - it is evident that it would be a non-sense to try to evaluate creativity in an educational context, as here - while it may well happen that students produce original artifacts – it is far less probable that they are able to create something which will impact on our society. What might alternatively be pursued (and thus evaluated) is the ability of students to combine ideas, links concepts, their curiosity and positive attitude towards new solutions and finally their capacity to look at what they are doing, judge it and find out suitable (re)actions. In other terms, in order to understand whether and to what extent an educational activity is able to cultivate students’ creativity, one should look at the process along the learning activity itself (Burleson, 2005; Edmonds & Candy, 2002) and keep under control the development of a set of skills and attitudes that might lead to the creative expression.

This paper, after proposing a model for the evaluation of learning activities oriented to creativity, illustrates the results obtained by the application of such a model in two real online collaborative activities, based respectively on a Role Play and a Discussion, with the aim of reflecting on the ability of each of the two collaborative techniques to develop those abilities and attitudes that may constitute the background of creativity.

2 Towards a model to evaluate learning activities oriented to creativity

In order to tackle the issue of evaluating TEL experiences aimed at developing skills and attitudes oriented to creativity, one should start from the substantial

²http://db.formez.it/FontiNor.nsf/b3f0568a004094c0c1256f57003b7fa1/F18BCC24BAECCE91C125742C004A61B2/$file/Anno%20europeo%202009.pdf
agreement that seems to exist among researchers (Amabile, 1996; Sternberg, 1999; Torrance et al., 1989) that creativity is grounded on cognitive capacities (understanding and building knowledge), on meta-cognitive abilities (i.e. the capacity of perceiving and elaborating weaknesses and strengths of own reasoning and/or actions), and also on an affective involvement in the tasks to be performed (which implies positively accepting the task and actively work to reach the intended goal).

As to the cognitive aspects, three fundamental indicators have been identified by referring to the New Taxonomy of the Educational Objectives proposed by Krathwohl (2002), where creativity (defined as the ability of “putting elements together to form a novel coherent whole or make an original product”) is considered the top educational objective to be met. Following the arguments put forward by these authors, in fact, the three cognitive indicators of creativity are:

- **Generating**, a process which involves the mental representation of the problem at hand (whatever it could be), in all its aspects and details, possibly making comparison with other problems/situations (instantiated by actions such as: combine, estimate, compare, state…).

- **Planning**, namely the process of figuring out and mentally designing problem solutions or even defining methods and plans to achieve a goal (instantiated by actions such as: predict, infer, hypothesize, design, define…).

- **Producing**, that is the process which deals with the actual enactment of what was generated and then planned and that may give rise to the creative act or product (instantiated by actions such as: build, enact, apply, test, verify…).

As to the affective aspects, by referring to the existing research in the affective domain field (Bloom et al., 1956; Rovai et al. 2009), two indicators have been adopted, able to account for students’ attitudes towards:

- **Receiving**, or paying attention to stimuli. This is denoted by involvement and immersion in learning activities and includes being curious, motivated, trying over and over…

- **Responding**, or reacting to stimuli. This refers to the actual expression of positive/negative feelings: satisfaction, joy, disappointment, excitement, depression, fear….

As to the meta-cognitive aspects, following the recent works of both Kim et al. (2009) and Murphy (2008), three main indicators have been considered, namely those related to the students capabilities of:

- **Monitoring** the enacted learning process, which implies the attitude and the ability of recalling and evaluating one’s own cognitive process, by also evidencing strengths and weaknesses.

- **Regulating** one’s own behavior on the basis of the perception/understanding of previously performed actions (which also means reviewing, controlling and tuning the activities by carrying out possible improvements, etc.).

- **Evaluating** one’s own activities/performance from the viewpoint of the final outcome; this implies acquiring the awareness of what has been done by cri-
ticizing single actions in the light of a comprehensive estimation / judgment of the results obtained.

3 Context and method of research

In recent years the Istituto Tecnologie Didattiche (ITD) – CNR has designed and run several editions of a blended course for the “SSIS”, which is the Italian institution providing initial training to secondary teachers. The courses commissioned to ITD are on the topic “Educational Technology” and their main educational goal is promoting the development of instructional design competence, with special focus on the evaluation and selection of learning strategies, techniques and tools and on the implementation of educational technology in the school context. The courses proposed by ITD are based on a CSCL (Computer Supported Collaborative Learning) approach. During online activities students are usually subdivided in groups (typically 20-25 persons per group) and they are engaged in tasks (discussing a topic, solving a problem, studying a case, etc.) with concrete outputs to produce, which act as catalysts of interaction and collaboration among peers. This paper reports on a particular edition of the course, namely the one run by ITD in Veneto in 2008. During that particular edition of the course students were 21 and were coordinated by a tutor. Interactions among students and with the tutor occurred within Moodle. During the course students were proposed, among the others, two online activities, lasting 3 weeks each, the former being based on a Role Play, the latter being based on a simple Discussion among peers. The total number of messages exchanged during the examined activities is 439 (209 messages exchanged during the Role Play, 230 exchanged during the Discussion).

In order to gather data within this study, content analysis techniques have been used to analyze the messages exchanged among students. The unit of analysis chosen was the “unit of meaning” (Henri, 1992) and a total of 1517 units were found in the selected messages (each unit could be assigned one indicator only)

4 Results and Discussion

The following Figure illustrates the main results obtained by the content analysis of the messages exchanged by the students during the two activities. In particular the Figure shows the number of units detected by the coders for each indicator of the model during the Role Play and the Discussion.

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3 The inter-rater reliability between the two coders (i.e. the agreement between the two) was calculated on a sample of 140 messages (30% of the total messages), and resulted 0.87 (Holsti coefficient) and 0.82 (percent agreement).
As one may note in Figure 1, indicators follow a similar trend during the two activities and the differences in values are not so evident. This may suggest that none of the two techniques is in principle better than the other as far as developing skills and attitudes oriented to creativity (at least not in our study). Still, some differences exist when looking at the various indicators of the model singularly. For example, the Role Play shows a better capacity to develop both Generating and Planning indicators (cognitive aspects), while the Producing indicator is rather low in both the activities. This can found a reason in the fact that none of the two techniques explicitly envisaged a phase of “application” of the solution negotiated by the students.

The Discussion reports higher values in the affective dimension (both for Receiving and Responding indicators) and this may be explained by the fact that, while during the Discussion students were let free to express themselves, during the Role Play students were instead asked to pretend a certain role and thus they may have not felt the need to express their feelings, attitudes or behaviors, that consequently remained tacit.

Finally, the meta-cognitive aspects are more triggered during the Role Play (Monitoring, Regulating and Evaluating indicators) than during the Discussion.

All in all, as one may expect, our data indicate the Role Play as more able to foster the cognitive and meta-cognitive skills, while the Discussion seems to be more effective as far as the affective sphere is concerned. This should be taken into account by the designer/teacher of the learning process, who may choose a technique or another depending on which creative-oriented skills and attitudes s/he wants to foster more.
References

A unified process model for creativity-technique based problem solving processes

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Abstract. In this paper, we present a unified model for creativity-technique based processes that considers the key properties of each of these creativity techniques. For the construction of this model we first analyze processes of various creativity techniques with respect to their key properties. Afterwards, we use these findings to formalize a unified model and discuss its use for more flexible creativity support systems.

Introduction

Creativity techniques are used in many domains to guide creative problem solving processes [1]. Depending on the domains, context, problem type or people involved in the creative problem solving process, specific creativity techniques can be more or less adequate for finding appropriate solutions. Hence, their effective use is driven especially according to their strengths and weaknesses.

Collaborative tools for the support of creativity-technique based problem solving processes should address the main shortcomings of these processes which may also include typical problems for interacting groups such as the factors production blocking, group pressure and social loafing [2]. In addition certain creativity support systems (CSS) allow for the collaboration of distributed groups and virtual teams in creative problem solving processes.

As of today, CSS are tailored for a specific creativity technique (e.g. Mindmanager\(^1\)) or have a quite limited portfolio of supported techniques for idea generation (divergent phase) and idea evaluation (convergent phase) (e.g. Thinktank\(^2\)). Hence, for a given context (i.e. problem type, group, situation, etc.) the available techniques may be not appropriate or be less effective than an alternative technique. Furthermore, using different techniques on the same problem can be beneficial for the process.

In order to support a broad set of creativity techniques, CSS need a unified model of creative processes that considers each of these techniques. As in any modeling process, the question of the appropriate level of abstraction has to be faced: A higher level of abstraction increases flexibility, but decreases the semantic information. E.g. a collaborative drawing tool on a virtual whiteboard may be very flexible for the use of creativity techniques. However, because of

\(^1\) http://www.mindjet.com
\(^2\) http://www.groupsystems.com/technology/thinktank
its high level of abstraction, the key properties of creativity-technique based processes are not comprehensively supported. This includes e.g. the possibility to anonymize group members or to set time limits for the divergent phase as required in specific techniques. Additionally the semantic of the single user contributions may be lost (e.g. no differentiation between ideas, evaluations or messages in the system).

In this paper, we present a unified model for creativity-technique based processes that considers the key properties of each of these creativity techniques. For the construction of this model we first analyze processes of various creativity techniques with respect to their key properties. Afterwards, we use these findings to formalize a unified model. This model can in turn be used to implement a corresponding software system that can support different creative-technique based problem solving processes.

**Process analysis**

The aim of the process analysis is to examine creative problem solving processes and to identify the key properties that can have a positive impact on the process outcomes. Obviously, a process model of a CSS should focus on these properties.

Creative processes are typically seen as a sequence of divergent and convergent process phases [3] [4]. In the divergent phase, the participants try to find ideas for a given problem. In the convergent phase, the participants evaluate the previously generated ideas [5]. Keeping the two phases strictly separated improves the effectiveness of the process [2]. Hence, a process model for CSS should comprise both types of process phases and avoid improper mixing of the phases.

The abstract perspective on the process is helpful to set the frame for a model for creative processes, but no advice is given on how the activities within the phases can be supported. Since creativity techniques claim to support creative problem solving processes, they can be regarded as a source for such parameters. Given their highly practical orientation, it is likely that they can give more concrete advice than an abstract process model. Based on this idea, we analyzed a multitude of common creativity techniques [6]. First, we wanted to find out if the processes the techniques imply actually fit in the cyclic model of divergent and convergent phases. Second, we were interested in the parameters the techniques impose on the different phases. Our analysis confirmed that the creative problem solving processes implied by the investigated creativity techniques could all be appropriately modeled as sequence of divergent and convergent process phases. Furthermore our analysis showed that there is a surprisingly low number of different parameters the various techniques impose on the processes.

In the meanwhile, we examined 14 additional creativity techniques and further refined the list of important process phase parameters in creativity-technique based processes. The following parameters were found for both phase types:

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3 For descriptions of all mentioned creativity techniques in this article see [7] and [8].
Anonymity: In divergent phases, shame or fear of rejection can inhibit the expression of unusual ideas. In convergent phases, group pressure can influence the voting behavior. It has been shown that by making anonymous contributions, this negative effect can be avoided [9].

Time limit: Imposing a time limit on a process phase can be necessary due to organizational reasons, since this way, an upper limit for the duration of creative processes can be set. Time limits are also helpful for synchronizing creative processes in which the initial group is split up in smaller subgroups (e.g. Brainwriting-6-3-5).

The following parameters were found for the divergent phases only:

- Stimuli: Mental stimuli are pieces of information that are presented to participants in order to influence their thinking processes during the convergent phases. Stimuli are only rarely statically defined by the creativity technique itself. Instead, they are often contributed by the participants in previous phases (e.g. random stimuli technique).
- Start ideas: Start ideas are available from the beginning of a divergent phase and can directly be used to combine new ideas with. The ideas are typically generated in preceding divergent phases (e.g. morphological analysis).
- Constraints of idea representations: While for most techniques a verbal or textual representation of the generated ideas is assumed, a few techniques restrict the way the participants may express their ideas. The greeting card technique specifies the use of pictures that should be combined to compose ideas. During brainsketching, participants can only use sketches to explain their ideas.
- Limitation of idea quantity: Looking futile at the first glance, bounding the idea quantity may be necessary for practical reasons (e.g. Brainwriting-6-3-5).

The following parameters were found for the convergent phases only:

- Scenarios: A scenario is the description of a plausible future. A scenario defines a hypothetical context for the idea evaluation. The scenarios may be defined by the technique itself (e.g. four future technique) or may be generated by the participants in a previous process.
- Criteria: With criteria, the evaluation of ideas can be restricted to a certain aspect. Techniques mostly define static criteria (e.g. the castle technique defines effectivity, practicality and originality), but the criteria could also be dynamically generated by the participants in a previous process.
- Scoring: Scoring refers to assigning numerical values to ideas. Many techniques for convergent process phases imply using scores of a given range as evaluation measure (e.g. sticking dots technique). Idea evaluations from numerous participants expressed as scores can be easily processed and merged (e.g. by computing average values).
- Comments: By using comments, participants can evaluate ideas with free texts. With comments, participants can advance their opinion in a much more detailed way than with scoring. However, it is harder to aggregate these pieces of information than in the case of scoring.
Formalization of a unified process model

The parameters presented in the previous section can be regarded as requirements for a unified process model since we empirically found out that the processes implied by the techniques can be seen as a sequence of divergent and convergent phases based on these parameters. For being used in the context of a computer system, the process model has to be formalized. For the process phases, we suggest the formalization depicted in figure 1: \texttt{ProcessPhase} acts as the base class for the two different types of process phases. \texttt{ProcessPhase} must declare the following attributes:

- \texttt{problem}: The problem that should be solved in the process phase. Problems are commonly represented as plain text strings, but as concrete implementations of CSS (e.g. for special domains) may have additional requirements we suggest to define a dedicated class \texttt{Problem}.
- \texttt{participants}: The persons that are participating in the process phase.
- \texttt{ideas}: The ideas of the process phase. For divergent phases this attribute can be initialized with start ideas if needed, but in most cases the set is empty at the beginning of a divergent phase. In convergent phases, the set is initialized with the ideas from the precedent divergent phase so the ideas can be evaluated by the users. The results of the process analysis makes some implications about the functionality of the \texttt{Idea} class. For the divergent phases, it should support the expression of ideas as text, with images and with sketches. For the convergent phases, it should be able to store user ratings as numerical values and as text. Further adoption to a target domain of a CSS can be necessary.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{fig1.png}
\caption{Formal model of the phases of creativity-technique based processes.}
\end{figure}

The remaining attributes of \texttt{ProcessPhase} are formalizations of the creativity technique parameters found for both types of process phases:
– **timelimit**: Timelimits in a process phase are represented with an integer value that stores the remaining seconds for the phase or is undefined if no timelimit is set.

– **anonymous**: The need of anonymity can be represented by a boolean flag. If the flag is set, the CSS must keep all person-related information hidden during the process phase.

The divergent phases are represented by the class `DivergentPhase`, having the following attributes in addition to the ones from the base class:

– **stimuli**: A set of mental stimuli which must be presented to the participants by the CSS. If the value is not set, no stimuli are used in this divergent phase. Since stimuli are often generated by the group in previous phases and thus are formulated as ideas, the `Stimuli` class should be modeled similar to the `Idea` class or the same classes should be used.

– **maxIdeas**: Integer value that limits the number of ideas that may be generated in the process phase. If the value is not set, the number of ideas is not limited.

– **allowSketch**: If the boolean value is set, the users may sketch to express their ideas.

– **allowText**: If the boolean value is set, the users may use text to express their ideas.

– **allowImage**: If the boolean value is set, the users may use images to express their ideas.

The convergent phases are represented by the class `ConvergentPhase`, having the following attributes in addition to the ones from the base class:

– **scenario**: The scenario that should be considered when evaluating the ideas in the process phase. In most cases it will be sufficient to represent scenarios as a string describing the particular scenario, but a dedicated class is preferable. If no scenario should be considered, the value is not set.

– **criterion**: The criterion that should be evaluated in the process phase. For the representation of criteria, the same considerations apply as for scenarios. If no criterion is set, the idea is to be evaluated as a whole.

– **allowComments**: If the boolean value is set, the users may evaluate the ideas using textual comments.

– **allowScoring**: If the boolean value is set, the users may assign scores to the ideas.

– **maxScore**: If scoring is allowed, this value defines the scoring range (from 0...maxScore).

The simplicity of the presented formalization for process phases of creativity-technique based processes makes it easy to be used in CSS implementations, yet it is powerful enough to represent creative problem solving processes of numerous creativity techniques and even combinations, since it contains all the key properties found in our process analysis.
Example processes

To illustrate the use of the unified process model, we present formalizations of creative processes that correspond to some well-known creativity techniques. As explained beforehand, a creative process is understood as a sequence of divergent and/or convergent phases, each having a particular set of attribute values. The complete set of possible attributes was presented in the previous section. In this example section, for clarity we will omit attributes that are not important for the given creativity technique. For the not-listed attributes, default values (e.g. "no restriction" for restricting attributes or "arbitrary number of participants" for the participant attribute) can be assumed.

Brainstorming (and variants)

The major principle of the brainstorming technique is to avoid any idea evaluation during the idea generation phase. Since idea evaluation is not possible in divergent phases of the proposed model, this principle is achieved by modeling brainstorming as a divergent phase. Additional information to the given problem (here labeled #P) in the problem attribute makes the participants aware of the remaining brainstorming principles (wild ideas, building up on ideas of others). The classic brainstorming needs no further attribute values in the divergent phase, since no further restrictions are made by the technique. Alternative brainstorming variants can be achieved by setting attributes of the phase, e.g. Anonymous Brainstorming by setting the anonymous attribute (as depicted in the figure on the left) or Brainsketching by setting allowSketch to true and allowText as well as allowImage to false, so only sketches can be used for expressing ideas.

Brainwriting 6-3-5

A creative process with two participants U1, U2 based on the Brainwriting 6-3-5 technique can be modeled by DivergentPhase objects as shown in the figure to the left. In the first round (upper two phases), the participants are asked to find three solutions for the given problem. The participants have to work separately on their solutions, so U1 and U2 are in separate phases (participants attribute). The technique imposes a timelimit of 5 minutes, which is modeled with a value of 300
for the \textit{timelimit} attribute, and sets an upper limit of 3 ideas with the \textit{maxIdeas} attribute. When the timelimit has exceeded, the ideas generated by the participants are exchanged and placed in the \textit{ideas} attributes of the successive phases. The participants are now asked to improve the received ideas instead of generating completely new ones.

\textbf{SCAMPER}

The SCAMPER technique can be modeled as a sequence of divergent phases, where in each phase a slightly different approach towards a solution is suggested using the \textit{problem} attribute of the phase object. The figure on the left shows the first 3 phases of the SCAMPER technique (Substitute, Combine, Adapt), the remaining phases (Modify, Put to another use, Eliminate and Reverse) are modeled similarly. This way, all type of checklist-based technique (e.g. Osborn-checklist, CATWOE) can be represented. Since the techniques impose no further restrictions, the remaining phase attributes are not set. By setting some of the attributes, combinations of techniques could be achieved: e.g. setting the anonymous attribute in the phases leads to an Anonymous SCAMPER process.

\textbf{Castle Technique}

The Castle Technique is an evaluation technique that suggests to judge ideas in sense of their effectivity, practicality and originality. To speed up the decision process, the participants may only say if the criterion is met or not. Formalized by the unified process model, a castle technique process is a sequence of convergent phases (\textit{ConvergentPhase} objects). In each phase, the participants have to decide if the given ideas (in general coming from a previous divergent phase) fulfill the criterion defined by the attribute \textit{criterion}. To express their decision, participants may only use score values (\textit{allowScoring} is true while \textit{allowComment} is false) and can only make a binary decision, since the \textit{maxScore} attribute is set to 1.
Conclusion

In this article we proposed a formalization for creativity-technique based problem solving processes as sequence of process phases. We first described how creativity techniques are currently supported in creative support systems. Then, we argued why a unified process model is a way towards more flexible CSS. In the second section we summarized the results of our analysis of a large set of creativity-techniques with respect to their key properties. Finally, we presented a formal unified model comprising the key properties of creativity-technique based problem solving processes and illustrated the approach with some example process formalizations.

Since creativity techniques guide creative processes by affecting the parameters we identified in the process analysis, they can be interpreted as presets of attribute values in the process model (e.g. a specific configuration of the attributes timelimit, stimuli etc.). Following this concept, a formalization of creativity techniques (in contrast to concrete creative processes) can be achieved.

Furthermore, the key properties of creativity techniques can be regarded as a framework for analyzing creativity techniques themselves: by varying single attribute values of the specific process phases it is possible to investigate the effects on the produced outputs. For instance by varying the timelimit attribute value in different creative processes, a better general understanding on the effect of time limits in creative problem solving processes can be gained.

As a framework for evaluation, we are currently implementing a CSS prototype which is based on the here discussed unified process model. Thereby, our goal is to assess the completeness of the proposed key components.

References

Knowledge Sharing Strategies for Collaborative Creativity

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Abstract. This paper proposes the use of Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC). These KSS4CC are a combination of learning and collaboration flow patterns and creative techniques. This approach allows for collaborative learning, whereas using creative techniques merely focuses on the generation of ideas. By formalising them in XML documents, they may be used to support moderators and users during the collaborative idea generation process. Future work may include the formalisation of KSS4CC using RDF, OWL or IMS Learning Design.

Keywords: idSpace, creativity, learning, collaboration, knowledge sharing strategies, NPD, workflow.

1 Introduction

In new product development (NPD), people work together to arrive at new and innovative products and solutions. This requires teams to be creative. Creativity may be seen as a way of collaborative learning and thus needs support appropriate to that. To support dispersed teams working in the context of NPD, the idSpace project develops an integrated, web-based environment in which context-sensitive tools and techniques together with pedagogy-based recommendations enhance a team’s learning and collaborative creativity during the creative phases of NPD. Creative techniques merely aim at fostering creativity, whereas pedagogical strategies promote collaborative learning. We propose a merger of pedagogical strategies and creative techniques into something we call Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC).

For many European firms, being innovative is crucial to sustain their market share. To keep up with today’s dynamically changing global economy, they need innovative solutions and effective product-to-market cycles. They do however face a number of challenges, ranging from idea generation failures, transformation from concept to product shortcomings, managerial issues and marketing problems. Structural limitations in creative team performance include (1) ineffective learning in the project team and (2) a lack of effective tooling to support collaborative creativity [1].
The missing link, in our view, is the use of pedagogical strategies that foster knowledge sharing and development in collaborative learning settings. These strategies include Progressive Inquiry, Think Pair Share and Jigsaw. They provide predefined workflows that foster the co-creation and sharing of knowledge through, for instance, a series of inquiry or structured knowledge sharing activities. This is complementary to the use of creative techniques in the sense that pedagogical strategies focus on fostering collaborative learning, whereas creative techniques focus merely on the generation of ideas.

The KSS4CC will be used to generate recommendations on the workflow to be used during a collaborative creativity session. Such recommendations may be divided into three categories [2]:

1. Higher order recommendations, which will help a practitioner to choose among the most suitable creativity strategy for a specific scenario/case. This choice will be based on elements such as the type of learning objectives that need to be accomplished, the complexity of implementing a whole strategy and its constituent activities.
2. Organisational recommendations, that will involve decisions about the formation of groups, leadership schema, etc.
3. Technological recommendations, that will concern the use of specific tools, features for the implementation of the strategy into a real specific scenario/case.

In this paper, we will only focus on the first recommendation type, the higher order recommendations.

The structure of this document is as follows. In section 2 we will elaborate on the concept of Knowledge Sharing Strategies for Collaborative Creativity. KSS4CCs consist of higher order recommendations, which focus on the workflow during ideation sessions. Section 3 we provide a way of formalisation of the KSS4CCs described in section 2. In section 4 we envisage the output to the users of the system. We draw our conclusions in section 5 and propose future directions of research.

2 Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC)

As discussed, we propose to combine pedagogical strategies and creative techniques in order to support dispersed teams in being creative collaboratively. When combined, they form workflows we call Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC). The KSS4CC aid the moderator, who in our view should always be available to guide collaborative creative processes, in choosing the right actions to present to the user. In other words, they provide workflows for collaborative creation of knowledge (collaborative learning), whereas the creative techniques and creative flow patterns (CreaFP) such as Six Hats Thinking [3] provide strategies for collaborative creativity, that is, a specific type of collaborative learning.
The KSS4CC may thus be regarded a superset of the creativity techniques. This is shown in Figure 1.

![Figure 1: an overview of the relation between Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC) and Creative Flow Patterns (CreaFP)](image)

2.1 Higher order recommendations

As already discussed, in our view, the KSS4CC is a specific type of support that is on a high order (macro level) rather than support aimed at fostering the generation of ideas, which is on the micro level [4]. KSS4CCs occur in the form of recommendations to the ideation session’s participants and moderator. After thorough examination of the characteristics of both pedagogical strategies and creative flow patterns, we suggest to combine the following strategies and techniques into KSS4CCs.

Table 1. Matrix overview of pedagogical strategies and creative flow patterns compatibility.

<table>
<thead>
<tr>
<th>CreaFP ped. strategies</th>
<th>Progressive Inquiry</th>
<th>Jigsaw</th>
<th>Pyramid</th>
<th>Think Pair Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>5W1H</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCAMPER</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Disney</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Six Hats Thinking</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1 is based on characteristics of patterns and techniques defined by Grube et al. [5]. They include operation types, such as the Boden creativity types exploration, combination, transformation and evaluation [6]. Besides, the characteristics include
whether or not they focus on the problem and use question lists to facilitate the co-
creative process. Lack of space prevents us from detailing our arguments for each and
every combination. Details may be found in deliverable 1.3 of the idSpace project [2].
However, our choice for the combination of Progressive Inquiry and the Six Thinking
Hats strategy may for instance be justified by pointing out that both take into account
the problem definition and use different views for critical evaluation of ideas.

3 Implementation

We laid down our suggested combinations of strategies and techniques into
KSS4CCs informal XML documents. Other ways of formalising this knowledge
include the use of RDF, OWL(2) and IMS Learning Design. The reasons for not
choosing such languages are:

- There is a time constraint in building the current system prototype,
  which is the first version of the system. We therefore choose to test the
  use of KSS4CC by the participants of an ideation session first, before
  investing time in more complex representations of our knowledge.
- The amount of relational data is not large enough such that it pays off to
  use RDF or OWL(2)

These XML specifications mention several characteristics, such as the problem
complexity, how well the problem is defined or whether or not a problem is divisible
into sub problems. Below we provide an XML snippet containing such characteristics
for Progressive Inquiry.

```
<strategy id="pi">
  <identifier>pi</identifier>
  <problemType>open</problemType>
  <problemDefinition>ill-defined</problemDefinition>
  <complexity>medium</complexity>
  <problemDivisible>yes</problemDivisible>
  ...
</strategy>
```

The workflow of Progressive Inquiry is modelled in an XML document that
consists of states and transitions between these states. These states are mapped to
processes or functions of the idSpace platform [7]. For instance, the state (action)
“Create Working Theories” may contain a link to the idSpace prototype process
number 10 (“Individually Generate Ideas”), which is denoted by the bold XML text
shown below.

```
<state>
  <state_id>create_working_theories</state_id>
  <moderator>no</moderator>
  <co-operative>no</co-operative>
```
By comparing the XML specifications with characteristics of the actual context given, we will able to distinguish which KSS4CC to use. This will be explained in the next section.

4 Exemplification of use

There still exists a gap in the formalisation of the knowledge and the actual use of this knowledge by the users of the idSpace system. Therefore, we distinguish two ways of presenting the user with information on the knowledge we formalised. Firstly, we define user-directed support to be support provided to the user in the form of textual explanations of the KSS4CC we would like them to work with. Secondly, we distinguish workflow-oriented support, which is directed at the moderator of a session. This type of support is aimed at recommending the moderator with an appropriate workflow, given a certain problem.

4.1 User-directed support

When the system user would like to know about Progressive Inquiry, the idSpace system switches to the appropriate XML specification and extracts the description of the strategy Progressive Inquiry, which is:

*Progressive inquiry relies on an idea of facilitating the same kind of good and productive practices of working with knowledge -- progressive inquiry -- that characterize scientific research communities in education. By imitating the practices of scientific research communities, students are encouraged to engage in extended processes of question- and explanation-driven inquiry. Accordingly, an important aspect of progressive inquiry is to guide users in setting up their own research questions and working theories. In practice, this means that users are making their conceptions public and working together for improving shared ideas and explanations. It is also essential to constrain emerging ideas by searching for new information. Participation in progressive inquiry, in the present case, is usually embedded in computer-supported collaborative learning environments that provide sophisticated tools for supporting the inquiry process as well as sharing of knowledge and expertise.*

Similarly, the ideation session’s participant may be presented an explanation of the actions that need to be performed within a KSS4CC. Below, we include such an explanation for the Progressive Inquiry action “Create working theories”. Whenever
this action has to be taken, the idea generation participant will be shown the following text:

“Think about /Write down your own working theories how to solve the problem. Explore and combine steps from other problem solving meetings.”

4.2 Workflow-oriented support

We envisage the following use of the KSS4CC workflows. For example, when a project starts, the moderator has several choices: (1) the moderator assigns participants to the session or not, (2) the moderator defines the problem or not, (3) the moderator chooses an appropriate technique. The first two choices are kept in memory and the system subsequently analyses which of the KSS4CCs is most suitable to assist the session’s participants. For instance, an ideation participant may be facing a problem that is open, but ill-defined. If one looks at the specification of the KSS4CC shown earlier, one sees that Progressive Inquiry is especially useful to support ill-defined and open problems. The moderator may thus choose Progressive Inquiry to be the main workflow for the ideation session. The system recommends a combination of Progressive Inquiry and the Six Hats Thinking method to be the most suited type of KSS4CC. The moderator is presented with the workflow of Progressive Inquiry and he or she subsequently instructs the ideation process participants accordingly.

5 Conclusions and Future work

We proposed the application of collaborative learning strategies to the domain of creativity. Combined with the creative techniques they form workflows that we have called Knowledge Sharing Strategies for Collaborative Creativity (KSS4CC). The added value of KSS4CC lies in their combining of pedagogical strategies and creative techniques. We exemplified the formalisation and implementation of our knowledge in the idSpace platform. Besides, we indicated how the formalised knowledge can be used within the idSpace platform that is currently being developed.

We envisage a number of directions for future research. First, we think that support for the reuse of knowledge and expertise should be combined with the creative process. For example, when teams are in an ideation session, and run into a problem that is out of their scope, they need additional knowledge. This additional knowledge may be provided by a person who participated in a previous project. During the previous project, that person entered his or her knowledge and expertise in a profile that was saved to the system’s database. The use of public profiles on networking websites such as LinkedIn, Facebook and Myspace to foster social interaction in Learning Networks has already been argued by Berlanga et al. [8].

Second, we think that formalising the knowledge we have at this moment by means of an ontology language such as OWL(2) may provide us with a more elaborate picture of our knowledge. Another option may be the use of IMS Learning Design [9] that allows for reuse. Both result in more reasoning power for the system about the workflow and thus better support for the higher order recommendations.
Similar work has been done by Villasclaras-Fernández et al. [4], who modelled CSCL scripts in an ontology to assist moderators in creating pedagogically sound collaboration scripts. They do not, however, use problem characteristics to determine which script to use. By formalising our knowledge, we will take this a step further by recommending the moderator which script to use, depending on the problem characteristics.

Third, we think a focus on the interactions between people in an ideation session would help improve the KSS4CC recommendations. When people support each other’s ideas by either consciously supporting them, or unconsciously through building on someone’s idea, they form sub groups, or coalitions [9]. Various factors influence the way people form such coalitions during the idea generation process. Hierarchy, for example, could severely hinder the process of generating ideas, as people necessarily tend to follow their boss’ idea that is of low quality, while other people may have generated ideas that are of higher quality. Hence, people need to be made aware of the value of their interactions in order to develop intrinsic motivation for group behaviour [9].

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References