A new approach to collaborative creativity support of new product designers

Marlies Bitter-Rijpkema*, Simos Retalis†, Peter Sloep*, Rory Sie*, Mary Katsamani, Peter van Rosmalen*

* Centre for Learning Sciences and Technologies Open Universiteit Nederland
† University of Piraeus, Department of Technology Education & Digital Systems

Abstract:

Effective collaborative creativity is crucial to contemporary professionals who have to continuously produce innovative products and services. The technological nature and complexity of the innovations require team work, among specialists from different disciplines. Often these teams work in a distributed fashion, across boundaries of time and place. Therefore they need electronic “spaces” that support (“afford”) their creative collaboration. Co-creativity support is not only a matter of making appropriate groupware spaces available but also of providing concurrent support in all these dimensions. These considerations inspired the development of the idSpace platform. idSpace is a collaboration platform integrating a variety of creativity tools with pedagogy-based guidance. It aims to optimize both the use of creativity techniques themselves and of the supporting processes of team collaboration and knowledge creation. In this paper we zoom in on Knowledge-sharing Strategies for Collaborative Creativity (KS4CC). We show how collaborative creativity can be enhanced via integration of pattern-based pedagogical flow support, including suggestions of optimal use of creativity techniques. The KS4CC strategies consist of a merger of learning and collaboration flow patterns with support for the application of creative techniques.

Keywords: work-based learning, collaboration, creativity, innovation, pedagogical flow patterns, adaptable recommendations, spaces for co-creativity.

Introduction

Technological opportunities, global, web-based connectivity and the dynamics of the globalized economy confront us with new challenges, and demand new solutions. (European Commission, 2002). The development of creative solutions (creative problem solving, CPS) has even become so pressing that Prahalad & Krishnan (2008) refer to the first decades of the 21st century as the “age of innovation”. As a result the capability to collectively invent new solutions and products has become a core competence of today’s knowledge workers (Bhaksar & Martens, 2008, Cerinsek & Dolinsek 2009, Drucker, 2002).
Analyses of creative projects indicate that it is not only lack of creativity per se that stands in the way of successful co-creative teams and communities. Both the technological nature and the complexity of creative problem solving require contributions of specialists from various domains and communities. These professionals have to collaborate to produce innovative products and services. However, often they are distributed across locations, firms and countries. Their collective performance therefore demands affording electronic “spaces” that support their distributed work and especially their creative collaboration.

Lack of knowledge and experience of useful creativity techniques can of course also be a barrier to success. Not knowing which method might be helpful to specifically address the problem at hand and lacking an integrated set of tools and knowledge assets on how to apply creative techniques in practice, it is unlikely that a team will succeed. Additionally, also the way in which team members collaborate and learn from each other is a potential barrier. Therefore, we argue that creative team performance not only needs support focussed on creativity per se but also integrated supportive actions that cater for all relevant dimensions of the creative collaboration process.

Multiple failures pave the road to success. Often failure proves to be a matter of learning. Sometimes the team’s problems are caused by unclear articulation of ideas (Bitter-Rijpkema et al., 2002, Brodbeck & Greitemeyer, 2000, Hakkarainen, Lipponen & Järvelä, 2002); at other times they result from miscommunication during collaboration (Bitter-Rijpkema et al., 2002, Schmid, 1996). If initial ideas are not picked up or if they fail to be thoroughly assessed for their value to the team’s problem, useful knowledge may easily be discarded at an early stage already (Schmid, 1996). Flaws in knowledge communication hinder not only the process of knowledge building that is meant to realise common ground, they can also frustrate motivation or otherwise block progress (Fischer, Scharf & Ye, 2004). Since innovation has become a team activity, coordination of each team member’s contribution to the collective goal therefore is decisive for any teams’ success (Nemiro, 2004).

One has become aware that success in creative problem solving is crucial to professional work - whether in face-to-face, well-defined project and team settings or in community-based open formats of innovation. This in turn has stimulated investigations into computer support for creative problem solving. (Gasco-Hernandez & Torres-Coronatas, 2004, Farooq et al., 2005, Huber, 2009, Nemiro, 2004, Resnick et al., 2005). The foci of these research initiatives differ. Among them we find learning aids to enhance creativity, software tools to support the articulation and processing of ideas, and dedicated support systems that help to implement specific creative techniques. (Boland & Tenkasi, 1995, Shneiderman 2006).

In general, in the abundance of creativity research and supportive tools the user has to find out which methods and tools are useful for his purposes. Next he will have to select the most suitable tools from this fragmented landscape of tools that usually are not interoperable nor open to integration with other tools.

It was the existence of this landscape of abundant but fragmented support tools for collaborative creativity that triggered the work on idSpace. The ambition of the idSpace project was to investigate and design a web-based, integrated support suite that would be able to support innovation teams and communities. The suite should take into account
relevant dimensions of the context in which the team acts and in which the applications of creativity techniques are embedded.

**An integrated web platform for co-creativity**

The *idSpace* environment features an integrative toolset that allows a distributed team of innovators to collaboratively create new ideas, contribute to and preserve existing ideas, as well as increase the collective knowledge. *idSpace* takes an idea as its starting point; it is viewed as a standalone, first class semantic entity. An idea is used for reference purposes, whenever a refinement is made or whenever it becomes part of a new point of view. Referrals (i.e. links) between idea entities and their refinements are used for navigation, exploration, as well as context-aware recommendation purposes. The *idSpace* project designed and developed a web-based, extensible platform that facilitates the co-construction of novel ideas through distributed collaboration. The platform facilitates the exploration of different viewpoints through the support that its different tools offer.

*idSpace* hence harbours two notions of ‘space’:

- Semantic – a network of ideas, meaning, relationships and their refinements.
- Technical – a platform which supports collaborative, distributed innovation and creativity.

The platform therefore contains:

- an integrated toolset, which helps to track and to store semantic relationships among conceptual models (the space as a network of ideas), to be used to describe innovative ideas, product features, stories about the ideas and all other kinds of knowledge towards product creation.
- extensible, informal, pluggable pedagogical (knowledge sharing) recommendations aimed at enhancing the appropriate application of creativity techniques for innovation. Jointly, these knowledge sharing and development recommendations drive specific uses of the integrated toolset.
- context-aware support mechanisms that dynamically adapt the *idSpace* platform to learners’ actions, contexts and competences.

The platform employs techniques for exploring new ideas (e.g. concept mapping and brainstorming) and for refinement of ideas (e.g. morphological analysis). It also supports traceability and reasoning among the ideas presented in the concept maps. This can be achieved because the *idSpace* environment preserves semantic relationships among the different concepts for further exploration, retrieval, and navigation purposes.

The integrated toolset allows a design team to generate new ideas, contribute to and preserve existing ideas, and to learn about them. *idSpace* is designed to employ a large variety of creativity techniques for exploring new ideas, such as mind mapping in story writing, brainstorming, lateral thinking, critiquing (the current prototype features only support one technique fully, though). The platform preserves semantic relationships among the different viewpoints for exploration, retrieval, and navigation purposes. A
sketching tool is part of the platform, which allows one to contribute without fully structuring one’s ideas and connect them with existing ideas.

The project also carried out a comprehensive analysis of pedagogical approaches which are useful in the various stages of product innovation. They provide an educational perspective on how to engage people in the generation of new ideas and in the definition of innovative designs and features or the combination thereof. Characteristic of the idSpace platform is its responsiveness to changes of the context, such as tools currently displayed at a user interface, learning state and competence, stage of the innovation process, activity currently performed.

In short, the idSpace platform enables the use of various creativity techniques. After having chosen a creativity technique (Figure 1), the moderator selects the appropriate collaborative learning strategy (Figure 2), which will prescribe the flow of the collaborative creativity process; this will be explained in the following section. The moderator can also compose groups and subgroups (Figure 3) for the various collaborative tasks. Group members are selected on the basis of their profiles and their availability.

Figure 1 Screenshot of idSpace platform Creativity Technique selection screen.
Title

Figure 2 Screenshot of idSpace platform Pedagogical Strategy selection screen.

Figure 3 Screenshot of idSpace platform Group Formation screen.
The *idSpace* platform is built using the Liferay multi-awarded, open source platform [http://www.liferay.com/] where the required functionalities have been incorporated as portlets. Liferay uses Java and Web 2.0 technologies. It offers dynamic and intuitive content management, web publishing, collaboration and social networking options.

**Pedagogical flow patterns for creative collaboration**

The design of tools that can support collaborative creativity sessions is a complex task. Designers (particularly novices) need guidance, advice and support in order to produce effective designs. On the one hand, guidance and advice need to be based on solid research and empirical findings. On the other hand, they should not be too prescriptive, or based on a single model, since then they will not help designers to create innovative designs, that are suited to their particular context and make the most of new and evolving technology. As pointed out by Hernandez et al. (2005), design patterns (DPs) provide software developers with information about the flow of learning activities that are expected to occur during a collaborative learning scenario based on a pedagogical strategy which the flow pattern analyses.

Furthermore, Borchers (2001) suggested that DPs have more advantages than style guides, guidelines, and standards “through their structured inclusion of existing examples and insightful explanation not only of the solution, but also of the problem context in which this solution can be used, and the structured way in which patterns are integrated into the hierarchy of the language”. This opinion is in line with several other researchers in the domain of interaction design such as Tidwell (2008), Bayle et al. (1998), who asserted that DPs are very valuable because they are driven from design practice, are based on examples, are presented into multiple levels of abstraction, and are interrelated and thus facilitate piecemeal development.

---

**KS4CC**

KS4CC consists of combinations of (parts of) CLFP’s and CreFP’s, based on
- user selection
- customized recommendations (awareness)
Figure 4 Flow Patterns in *idSpace*

Figure 4 shows the way in which DPs are used in the *idSpace* platform. Starting from a conceptual level which concerns the pedagogical and creativity strategies, more specific designs in the form of flow design patterns (collaborative learning flow patterns – CLFP and creativity flow patterns – CreFP) can be created. The term “flow” is used to portray coordination and sequencing of learning tasks. In order to support the mix and match of the flow design patterns, the KS4CC framework has been proposed, as will be explained in the next section. KS4CC consist of combinations of CLFPs and CreFPs, based on user selection and customized recommendations (awareness).

DPs play the role of *lingua franca* so that the *idSpace* environment designing team can understand its functional requirements. A similar concept of the way DPs can be used to bridge the gap between instructional designers and software engineers can be found in Turani & Calvo (2006).

**Knowledge-sharing Strategies for Collaborative Creativity - KS4CC**

*Collaborative creativity: team creativity as a matter of collaborative learning*

Thusfar, we have argued that the process of collaborative invention of new products or services, whether in the context of a (consumer) community or of a well-defined (corporate) team, requires more than availability of computer support for the execution of a specific creativity technique, such as brainstorming, Scamper or the Six Hats method (Bitter-Rijpkema, et al., 2009, Georgiakakis et al., 2009).

To optimize creative collaboration and achieve collective creative results team members need to realize effective creative collaboration across all phases of the project and all project dimensions (Boland & Tenkasi, 1995, Fischer et al., 2009). We assume that unleashing the collective creative potential of the team asks for coordinated action, for example by respecting each person’s creative problem solving style while at the same time finding concurrent ways for coordinated team progress.

Being successful with co-creation is very much a matter of learning. First of all learning to select and use new creative problem solving methods. Each creative technique has its specific characteristics. For specific problem types, contexts and team types some creativity technique (CT) is more appropriate than another one. The *idSpace* platform creativity technique selector (Grube & Schmid, 2008) supports guidance to select an appropriate technique (i.e. Six Hats) based on context (i.e. web based), activity (different perspectives) and operation type (i.e. idea exploration) and team type (single group) (Boden, 2004, Grube & Schmid, 2008).

Support that the creative techniques provide aims at fostering creativity through processes of systematic idea articulation, visualisation, systematic questioning, etcetera, whereas pedagogical strategies promote necessary collaborative learning. It is our conviction that merging learning strategies with support of creative techniques, to which
we refer as Knowledge-sharing Strategies for Collaborative Creativity (KS4CC), is what is needed. KS4CCs have a wide scope in addressing the innovation team’s needs. They deal with challenges that collaborative creativity pose, such as how to stimulate the generation of enough and qualitatively good ideas for the problem at hand, how to prevent ideation failure, how to enhance comprehension of individual perspectives brought to table, how to concurrently nurture transformation from initial concepts into matured contributions to a shared solution, as well as how to keep up a team’s motivation high till the end.

Barriers to the learning flow of a creative collaboration with respect to any of these dimensions will seriously hinder the creative process and limit the quality of its outcome. This was reason for us to focus on what in our view is missing: application of collaborative learning strategies that foster knowledge sharing and development in settings of collaborative team or community based innovation.

Figure 5 KS4CC knowledge-sharing strategies for collaborative creativity.

We use KS4CC, knowledge-sharing strategies for collaborative creativity, to label the type of recommendations we think are needed to support the workflow of virtual teams and communities involved in collaborative creativity session, i.e. sessions supported by idSpace. As the name KS4CC suggests, the objective of support is a matter of knowledge building and sharing aimed at enhancing the collective creativity of the team.

To realise that ambition we have to search for available heuristics, and develop patterns that address the key dimensions of the co-creative endeavour.
We divide the recommendations into three categories.

1. Strategic or higher order recommendations, recommendations that help team members to choose a creativity technique optimal to their case. Depending on the complexity strategic recommendations might consist of a whole set of interdependent strategies and constituent activities.

2. Organisational recommendations, recommendations that foster the formation of optimal groups, give suggestions for suitable leadership, etc.

3. Technological recommendations, recommendations that suggest how to use and integrate specific (technological/ computer) tools, and how to implement creativity techniques, computer supported teamwork etc.

Multiple explorations: guided by creativity techniques and learning heuristics

Based on the observations of the awareness mechanisms, the idSpace flow patterns steer the composition of a set of KS4CC recommendations. As the case may be, patterns aim at enhancing constructive learning processes, at collaborative creative actions (based on creativity flow patterns) and at reflections at that stage of the invention process. Concurrent advice is given on optimal organisation of collaboration (based on a CLFP, collaboration learning flow pattern) and on taking advantage of the available computer tools. KS4CC generate customised sets of suitable recommendations that match the situation of the team. Customisation relies on user input (via the session moderator) and indications from the awareness monitoring mechanism. In this way integrated strategic support is provided including the creativity technique per se.

KS4CC gives two types of input: 1) user-directed support and 2) workflow-oriented support. User-directed support is given when a user interacts with the idSpace platform. A user of the platform may be either a moderator or a participant of a (collaborative) creativity session. When a user would like to know about a specific pedagogical strategy, idSpace adopts the specification that represents that strategy. Subsequently, idSpace extracts a definition and shows it to the user. If a user is already familiar with the
A definition for first-time users of the technique might look as follows (paraphrased for idSpace use, based on Hakkarainen et al, 2002):

Progressive inquiry relies on an idea of facilitating the same kind of good and productive practices of working with knowledge that characterize scientific research communities in education. By imitating the practices of scientific research communities, team members are encouraged to engage in an extended process of question, exploration and explanation-driven inquiry. An important aspect of the strategy of progressive inquiry is to guide the investigation journey by working from systematic questioning that originates in articulated working theories. In practice, this means that users make their assumptions and conceptions public and work together to discover shared ideas, explanations and opportunities for new use: combining and transforming existing components. Search for new information and re-use of other ideas, i.e. ideas from earlier or other sessions, is essential.

As you may notice, the above definition lacks a practical guide on how to operationalise progressive inquiry into a pedagogical strategy. By operationalisation we mean actions that are necessary as part of the pedagogical strategy’s goal to develop new knowledge. The progressive inquiry technique for instance consists of 14 (recurring) actions. One of these actions is called ‘Create working theories’ and is explained by the following text:

‘Write down your own working theories on how to solve the problem. Explore and combine steps from other problem solving meetings.’

In an electronic environment, these steps have to be translated to functions within the idSpace platform. Therefore, we have decided to develop workflow-oriented support. This kind of support provides the moderator of a creative session with a number of actions that have to be taken to foster collaborative learning, as part of a pedagogical strategy.

We define four types of elements within the specifications of the pedagogical strategy Progressive Inquiry: 1) states, 2) steps and 3) processes. States are actions that have to be taken when using a pedagogical strategy. Below we show what such a state specification for the action ‘Create working theories’ looks like, using XML snippets:

```xml
<state>
  <state_id>create_working_theories</state_id>
  <description>Think about /Write down your own working theories how to solve the problem. Explore and combine steps from other problem solving meetings.</description>
  <process_id>10</process_id>
</state>
```

The state specification includes a unique identifier `<state_id>`, which is important for linking states to one another by means of a transition called a ‘step’. Such a step consists of an identifier and two subsequent states (fromState and toState), which is shown below:

```xml
<step>
  <step_id>4</step_id>
  <fromState>create_working_theories</fromState>
  <toState>distribute_expertise</toState>
</step>
```
When we combine several such steps, we have a pattern. A pattern thus is a step-by-step workflow that guides one through a pedagogical strategy for collaborative learning. Such a pattern looks as follows:

```
<pattern>
  <step>1</step>
  <step>2</step>
  <step>3</step>
  ...
  <step>n</step>
</pattern>
```

Now, all we have to do is translate this XML specification to *idSpace* functions, in our XML specifications, referred to as *processes*. For every function in the *idSpace* platform, we define a process specification, which includes a unique identifier for links from states to processes. In the XML specification for states this is denoted by for instance `<process_id>10</process_id>`, which links the state to process number 10. Briefly summarized, we have system functions that are linked to states. These states are linked to one another by steps, and a sequence of step makes a pedagogical pattern. To simplify understanding, we depicted the structure below.

Figure 7. Overview of a KS4CC workflow specification

**Piloting the *idSpace* prototype: first experiences.**

Although only a first, prototypical implementation of the *idSpace* platform is available, we nevertheless conducted two evaluation studies to find out how integration and implementation of the ideas expounded here are experienced and valued by prospective users. In this paragraph we summarize the set up of the evaluation and point to findings relevant to the focus of this article.
Experiment set-up

Prototypical versions of the *idSpace* platform were trialled in 6 user studies with in total thirty user (including 6 moderators). The users followed a scenario with 6 pre-designed tasks that covered the main functionalities of the system, i.e. ‘profile definition’ to enter the users relevant background; ‘project definition’ (moderator only) to characterise the actual project; ‘common grounding’ to establish a framework of reference; ‘goals setting’ to define the specific goals that should be achieved; ‘ideation’, the actual process of creating and relating ideas; and ‘find solution’ to evaluate and link goals and ideas to create solutions.

Focus

The evaluation focussed on the effectiveness of the *idSpace* platform as (1) a tool for supporting actively and in a context-aware manner the creation of new ideas and (2) as a tool for representation, storage, and management of ideas. Since this was the first integrated version of the platform, we wanted to identify at this moment in time specific problems users encountered in interaction with the system and the usability of the system’s interface. The 2nd expert evaluation followed the design of the first evaluation.

Data collection

We collected data via (1) a background questionnaire, intended to identify the user background including their experience in creativity session and tools; (2) a post questionnaire containing 55 Likert-type rating-scale questions and 7 open questions to gain feedback on the major indicators of user experience, i.e., effectiveness, efficiency, learnability and user satisfaction; (3) Finally we used the observer notes that were made of all sessions.

Participants

All users had academic degrees. The majority claimed to have experience in at least one creativity technique and some experience in distributed work. Participants’ ages ranged from 28 – 56. Two of the six groups consisted of members of different organisations. They did not know each other in advance, and worked from different locations. The other 4 teams consisted of members of a single organisation. A variety of problem statements has been addressed, ranging from searching for new business possibilities, mobile learning applications to identifying the main themes of a conference. In addition to the *idSpace* platform, the teams used Skype. In the second evaluation two expert users, took part. They were both experienced *idSpace* platform users, with experience of more than 4 complete ideation sessions.

Results

Participants of the first evaluation pointed to the potential of the *idSpace* platform. They especially appreciated,

- the structured, distributed and collaborative approach
- and the easy and straightforward access via the web – without separate installation requirements.
Unfortunately, various usability issues hindered serious user exploration. Results from the small-scale additional expert-user evaluation that was done after the major usability flaws in the system had been remedied indicate that this resulted in improved effectiveness and usability of the *idSpace* platform. This bodes well for a further exploration of the *idSpace* system in the future.

At present, the overall outcome of the user validation can be summarised in the following user quotes:

- “I can feel that there is a potential for a useful tool to be developed to help ideation”
- “The prototype nicely presents the core idea of the project. But there are many usability issues in the software and some logical problems in the ideation and solution screens”

**Conclusion and future work**

Knowledge professionals are expected to find new – often technologically-advanced - solutions to rather complex problems. This requires professionals from different domains and communities to work together in distributed settings. However, it proves to be quite difficult for such teams and communities to successfully realise the envisaged inventive results.

Analyses of existing practices point to multiple problems that prevent smooth development of creative collaboration. Inadequate, fragmented tooling, lack of knowledge and experience with creativity techniques, problems with learning, unawareness of existing ideas and problems when choosing optimal collaboration and organisational strategies for a team’s specific context all block the creative potential of the group.

Hence the ambition of the *idSpace* project to develop and present a platform that offers integrated tooling for co-creativity. The platform takes into account concurrent support across all key dimensions with the aim to optimally enhance creative collaboration of teams and communities. In this paper we specifically described how we provide support based on patterns, i.e. heuristics of successful knowledge-sharing strategies for collaborative creativity (KS4CC) that fit a team’s needs. Figure 8 shows junctures within the workflow where KS4CC advice is given. Elaborating the number of strategies and developing new patterns is one way to provide creativity support. However, we are convinced dedicated advice is possible at yet other areas in the workflow.
The idSpace platform was originally developed with creative collaboration in mind by teams working on new product design. In our view though, the conceptual framework as well as the platform are suitable for groups working in different contexts, domains and work settings. The idSpace platform is able to provide support for a well-defined project team that applies creative problem solving methods to incrementally improve an existing product. But it can just as well enhance creativity of user groupings in communities that share a passion for sports, create new equipment, or are led by consumers in their exploration of new opportunities (consumer-led innovation, cf. Von Hippel, 2001, Huber et al 2009, Sawhney & Prandelli, 2000). Knowledge about the actual interactions between people in ideation sessions can help to improve existing KSS4CC recommendations. When people support each other’s ideas by either consciously supporting each other, or by unconsciously elaborating on someone’s idea, they form sub-groups, or coalitions (Sie et al., 2009). This is another issue that needs further investigation.

To conclude, idSpace tries to respond to the need for support for ideation and solution finding. We defined new ways to approach collaborative creativity and support group members. It can be used by web-based teams and communities, whether engaged in work related activities or addressing leisure-related problems. The effectiveness of the integrative platform is currently tested by exposing it to innovation experts and innovators; this will provide input to further develop the platform, also for other users groups.
Acknowledgement:

We would like to thank our idSpace peers for our collective work and discussions that inspired this paper. The present work was carried out as part of the idSpace project on Tooling and Training for collaborative product innovation (http://idspace-project.org). This project is partially supported by the European Community under the Information and Communication Technologies (ICT) theme of the 7th Framework Programme for R&D (FP7-IST-2007-1-41, project number 216799). This document does not represent the opinion of the European Community, and the European Community is not responsible for any use that might be made of its content.

References


