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A new approach to collaborative creativity support of new product designers

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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 optimise 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; adaptable recommendations; spaces for co-creativity; pedagogical flow patterns.

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1 Introduction

Technological opportunities, global, web-based connectivity and the dynamic of the globalised 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 and 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 (Bhaskar and Martens, 2008; Casallini et al., 2007; Cerinsek and 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 CPS 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. Hence, their collective performance 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-Rijkema et al., 2002; Brodbeck and Greitemeyer, 2000; Hakkarainen et al., 2002) at other times they result from miscommunication during collaboration (Bitter-Rijkema 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 already at an early stage (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 et al., 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 CPS 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 CPS (Casallini et al., 2007; Gasco-Hernandez and Torres-Corronas, 2004; Farooq et al., 2005; Huber et al., 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 and 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 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.

2 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. Any 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.

1 idSpace thus 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.

2 The platform therefore contains

- An integrated toolset, which will help 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 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.

It 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 supports 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.

Figure 1 Screenshot of idSpace environment (see online version for colours)

The screenshot displays the idSpace interface for a project titled "On the move: Mobile learning for working professionals". The interface is organized into several sections:

- Navigation:** A top bar with "Welcome", "Projects", "Resources", and "Profile". Below it, a secondary bar contains "Overview", "Commonground", "Goals", "Ideation", and "Evaluation".
- Groups:** A panel on the left showing "groups: 3". It lists "On the move design team", "TPS group 1", and "TPS group 2".
- Members of TPS group 1:** A sub-panel below the groups, showing "members: 2" and listing "Kees Pannekeet" and "Marlies Bitter".
- User details:** A central panel titled "User details" for "Marlies Bitter". It includes a "Confirm" button and a table of user information:

Name	Marlies Bitter
Email address	
Date of birth	
Job title	
Previous experience	
Education	
Current location	OUNL Heerlen
Jigsaw expertise	Advanced
Progressive Inquiry expertise	Advanced
Pyramid expertise	Advanced
Six Thinking Hats expertise	Advanced
Mind mapping expertise	Advanced
SCAMPER expertise	Advanced
5W1H expertise	Advanced
- Available users:** A panel on the right showing "users: 53" and a list of users: "Bruno", "Bruno Admin", "Christos", "George", "Mettouris", "Een normalere naam Tjaaa", and "Felix Gelpke".

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 that it responds 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 environment enables the use of various creativity techniques. After having chosen a creativity technique, the moderator selects the appropriate collaborative learning strategy which will prescribe the flow of the collaborative creativity process which will be explained in the following section. The moderator can also compose groups and subgroups for the various collaborative tasks. Group members are selected based on their profiles and their availability. A screenshot of the idSpace environment is shown in Figure 1.

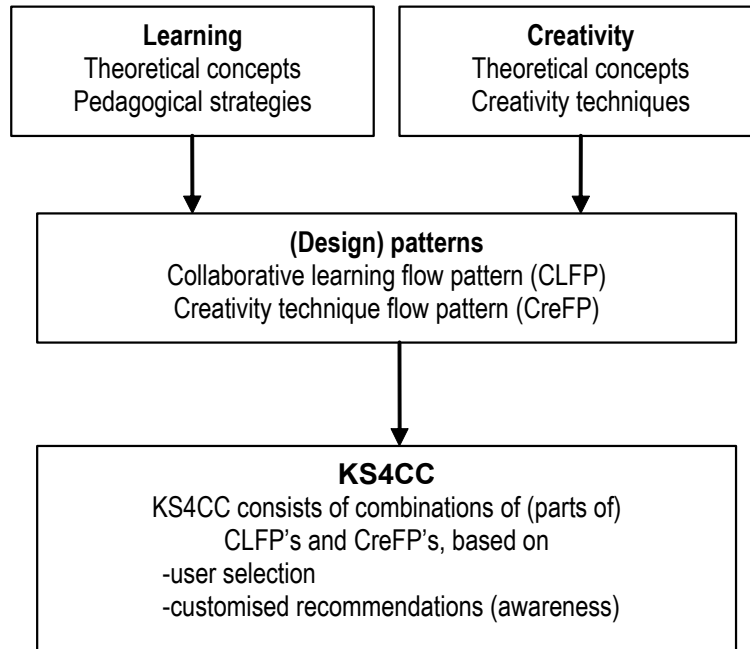
The idSpace environment is based on the Liferay multi-awarded, open source platform (<http://www.liferay.com/>) in which the required functionalities have been incorporated as portlets. Liferay uses Java and Web 2.0 technologies. It offers dynamic and intuitive content management, web publishing, collaboration and social networking options.

3 Pedagogical flow patterns for creative collaboration

The design of tools that can support collaborative creativity sessions is a complex task. Designers (particularly novice ones) 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 they will not help designers to create innovative designs, suited to their particular context, that make the most of new and evolving technology. As pointed out by Hernandez-Leo 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) and 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.

Figure 2 shows the way in which DPs are used in the idSpace environment. Starting from a more conceptual level which concerns the pedagogical and creativity strategies, more specific designs in the form of flow DPs (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 DPs, the knowledge-sharing strategies for collaborative creativity (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 customised recommendations (awareness).

Figure 2 Flow patterns in idSpace

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 and Calvo, 2006).

4 Knowledge-sharing strategies for collaborative creativity

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

As you have noticed we argue 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-Rijkema et al., 2009; Georgiakakis et al., 2009).

To optimise creative collaboration and achieve collective creative results team members need to realise effective creative collaboration across all phases of the project and all project dimensions (Boland and Tenkasi, 1995; Fischer et al., 2009; Franke and Shah, 2003). We assume that unleashing the collective creative potential of the team asks for coordinated action, for example by respecting each person's CPS style while at the same time finding concurrent ways for coordinated team progress.

The act of co-creation is very much a matter of learning. First of all learning to select and use new CPS methods. Each creative technique has its specific characteristics. For specific problem types, contexts and team types a specific creativity technique (further

on abbreviated as CT) is more appropriate than another technique. The idSpace creativity technique selector (Grube and 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 and Schmid, 2008).

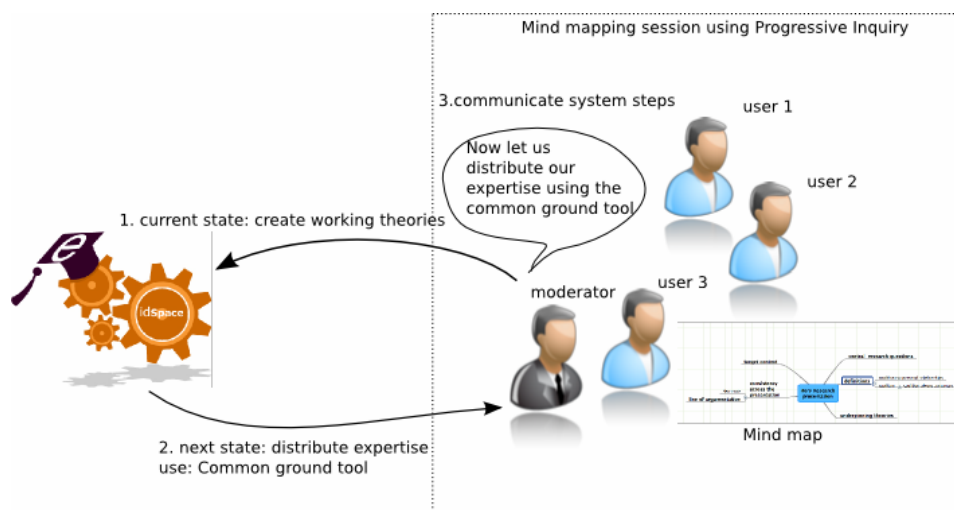
Support that the creative techniques provide aim at fostering creativity through processes of systematic idea articulation, visualisation, systematic questioning etcetera whereas pedagogical strategies promote necessary collaborative learning. Our idea is that merging learning strategies with support of creative techniques to which we refer as KS4CC is what is needed.

KS4CCs have a wider scope in addressing the innovation team’s needs. They deal with challenges that collaborative creativity pose, like how to stimulate generation of enough and qualitatively good ideas for the problem at hand, prevent ideation failure, enhance comprehension of individual perspectives brought to table and concurrently nurture transformation from initial concepts into matured contributions to a shared solution, as well as managing to keep up a team’s motivation till the end.

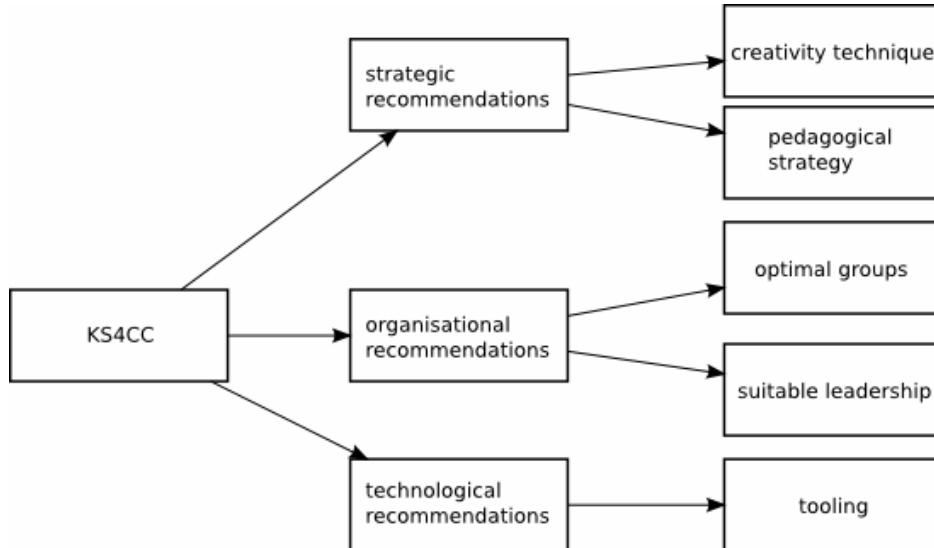
Problems concerning the aforementioned dimensions, i.e., barriers to the learning flow of a creative collaboration, can seriously hinder the process and limit quality the project outcome. Reason for us to focus on what in our view is missing: application of collaborative learning strategies that foster knowledge sharing and development in settings of collaborative team or community based innovation.

We use KS4CC 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.

Figure 3 Knowledge-sharing strategies for collaborative creativity (see online version for colours)



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

Figure 4 KS4CC for idSpace

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 strategies recommendations might consist of a whole set of interdependent strategies and constituent activities.
- 2 *Organisational recommendations*, recommendations that care for 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.

4.2 *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 CreFP) and at reflections at that stage of the invention process.

Concurrently advice is given on optimal organisation of collaboration (based on a CLFP) and 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
- 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 technique in question, which the awareness module then would indicate, the presentation will have a more condensed format than it otherwise would have had. 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 characterise scientific research communities in education. By imitating the practices of scientific research communities, team members are encouraged to engage in an extended processes 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 the 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 so-called workflow-oriented 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 defined four types of elements within the (XML) specifications of the pedagogical strategy progressive inquiry:

- 1 states
- 2 steps
- 3 processes.

States are actions that have to be taken when using a pedagogical strategy. Below we show how such a state specification for the aforementioned action ‘create working theories’:

```

<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:

```

<step>
  <step_id>4</step_id>
  <fromState>create_working_theories</fromState>
  <toState>distribute_expertise</toState>
</step>

```

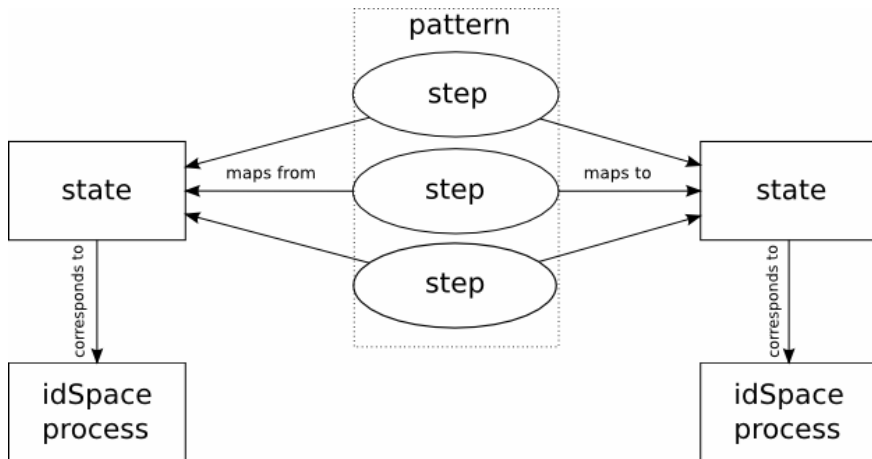
When we combine several steps, we have a pattern. A pattern is a step-by-step workflow that guides you through a pedagogical strategy for collaborative learning. Such a pattern looks as follows:

```

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

```

Figure 5 Overview of a KS4CC workflow specification



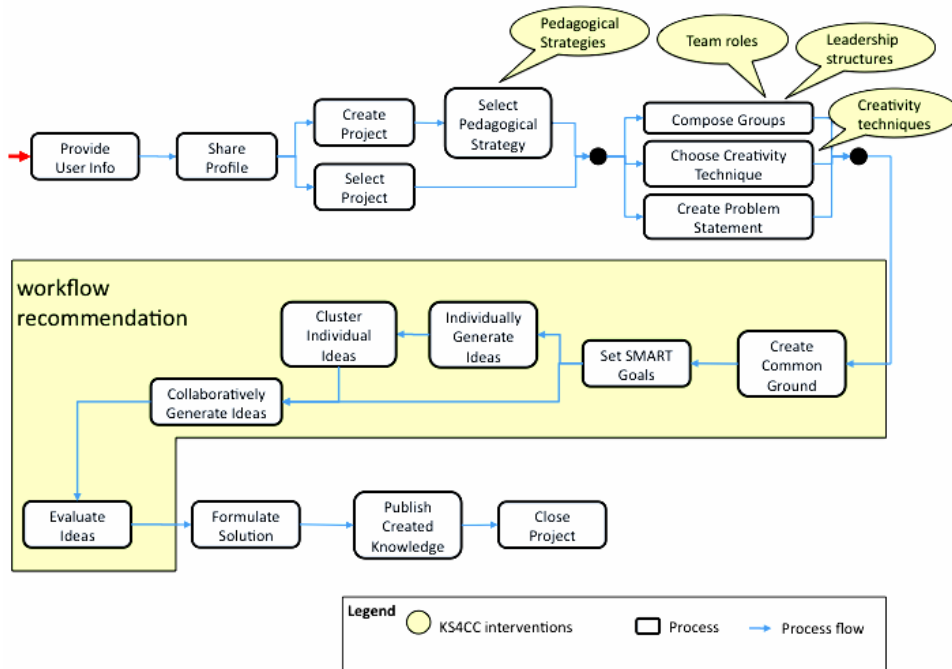
Now, all we have to do is translate this XML specification to idSpace functions. In our XML specifications, referred to as *processes*. For every function in the idSpace platform, we define a process specification, which includes a unique identifier for links from states to processes. In the XML specification for states this is denoted by for instance `<process_id>10</process_id>`, which links the state to process number 10. Briefly summarised, 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 in Figure 5.

5 Conclusions 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 block the creative potential of the group.

Figure 6 KS4CC recommendations (see online version for colours)



Hence, the ambition of idSpace to 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 described how we provide support based on patterns, i.e., heuristics of successful KS4CC fitting the team's needs. Figure 6 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 environment 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. IdSpace is able to provide support for a well-defined project team that applies CPS methods to incrementally improve an existing product. But it can just as well enhance creativity of user groupings in communities that sharing a passion for sports or 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 and Prandelli, 2000). Knowledge about the actual interactions between people in ideation sessions can help to improve existing KS4CC 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 an issue that needs further investigation.

To conclude, idSpace tried 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.

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