Recommendations for e-learning in New Product Development teams

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Abstract

Development of new products (NPD) requires professionals to collaboratively find new, creative solutions and approaches in order to come up with new products. In the context of NPD, professionals seldom are co-located. This implies that work and learning take place via electronic facilities. The *idSpace* project aims to develop an integrated, web based environment for collaborative distributed product innovation. This paper investigates which requirements need to be taken into account to optimally support a team's collaborative learning while working on new product design.
After a short introduction of the *idSpace* project we will investigate the specific learning needs of NPD-teams. To meet these needs we propose development of tailored recommendations in which creative problem solving. learning and collaboration strategies are combined. We will focus in this paper on the methods and requirements for the design of configurable recommendations for creative task support of NPD teams that can be derived from CSCL and CSCW research.

Keywords:
work-based learning, team-learning, collaboration, creativity, innovation (NPD), e-learning, adaptable recommendations.

1. Introduction

The *idSpace* project aims to develop an integrated, web based environment to support collaborative work, learning and creativity necessary for the inventive design of new products. Design and implementation of innovative products is referred to as New Product Development, further abbreviated as NPD. NPD requires people with a variety of expertises to collaborate in

multidisciplinary teams, learn from each other while working on the development of a new product. Since these NPD-teams more and more work distributed across locations, this implies that work and learning take place trough computer-based facilities. Hence facilitating NPD teams to enhance their collaborative creativity has to provide learning and performance support in their electronic workspaces.

Provision of support for learning of computer-based activities is not the only difference with mainstream learner support. Collaborative inventiveness of NPD teams asks for new forms of e-learning support, that recognize contextualized character of creative problem solving and knowledge development and the concurrency of collaboration and coordination processes involved in NPD teamwork (Cross, 2008). To meet these needs we propose the composition of adaptable, tailored recommendations integrating guidance on relevant dimensions matching these to the context and state of work of the team as a potential solution to enhance co-creativity and collaborative learning in NPD teams.

In the 2nd section we will characterize the requirements for *idSpace*'s integrated creativity support of NPD teams. In section 3 we argue that learning in NPD-contexts can be seen as a special form of work based learning. Section 4 reports how findings from CSCL and CSCW research provide input for *idSpace* guidance for computer supported collaborative performance and learning support. Section 5 investigates the idea of composing adaptable, tailored recommendations based on CSCW and CSCL heuristics as solutions for *idSpace* creativity performance support. Finally section 6 finishes with concluding remarks.

2. The need for integrated creativity support.

Industries increasingly rely on innovative design of new products. Innovative design is characterised by intense, collaborative processes of generation and exploration of ideas which might contribute to solving a particular product design problem. In new product design innovators go through cycles of divergence and convergence. First new ideas are generated and their potential is explored. Next these ideas are evaluated. Both idea generation and evaluation heavily rely on articulation of personal knowledge and knowledge sharing and learning of team members. These new product inventors need appropriate tools. Tools to enhance their creativity, ideas generation, and idea processing and idea selection. In the

process of ideation one needs to take ideas apart, transform or combine ideas, criticise them, reuse ideas and reject ideas. Currently, collaborative product designers use a variety of separate tools that function relatively independent of each other. With little or no regard to the design context, existing ideas, past efforts or possibilities of future re-use. Second creativity performance support tools tend to focus on instrumental support of applying the specific creativity technique. Context factors and surrounding learning and collaboration and coordination processes often stay out of scope. Therefore the *idSpace* project aims at development of an integrated web based environment that provides knowledge expression and sharing tools as well contextualized learning support across the creative stages of new product design collaboration.

3. Support of NPD teams: more than just work based learning.

A dominant characteristic of work based learning is that it is fully embedded in ongoing operational work. Learning needs to be immediately applicable to the professionals' work. Explicit formal learning, via training only covers a very small portion of workplace learning needs. At least 70% of workplace learning is based on non-formal interactions with peers at work (Loewenstein & Spletzer, 1999). Learning takes place via all means, processes and activities by which employees can "learn" in the workplace. It includes non-formal but intentional learning activities as well as un-intentional learning that take place in encounters with peers. Work settings offer a wide array of natural opportunities for non-formal, (intentional) and informal (unintentional) learning. Team workers are continuously exposed to the opinions, practices and feedback from their peers (Billet, 2000, 2001; Boud, 1994, Van der Klink & Streumer, 2006). Context and surrounding organization too offer triggers for learning. Support for NPD teams needs to recognize this non-formal contextualized character of learning, its link with performance and the need for immediate applicability of what is learned.

Mezirow (1997) states that in essence learning at work is a transformative activity. Learning in his view takes place in the dialogue between workers. Discussions mediate transformations in knowledge of the individual and the co-construction of collective understanding. The observation of the interactive dialogical nature of workplace learning implies that supportive action for NPD teams should support workers in interactive sense making,

debate and decision making. Learning support includes suggestions to articulate and communicate individual ideas, enhance open discussion of ideas and underlying assumptions and accommodate to negotiation and transformation of their ideas into the emergence of the collective proposition.

Marsick (Marsick & Watkins, 2001) emphasize that support for learning at work cannot focus on one issue. It has to address multiple relevant dimensions in parallel: both technical, interpretative as well strategic dimensions. Effective learning support for working professionals has to help the acquisition of specific knowledge needed for the task at hand. It has to support the professional with the interpretation of the current situation, reflect on it, learn from it, evaluate past experiences and take a decision. Help is also needed to critical assess the debate and examine the underlying assumptions and values of participants that play a role the collaboration and getting to collective results.

Based on these workplace characteristics *idSpace* support for NPD teams should create affording conditions for non-formal learning. On the one hand by providing enablers for sharing of ideas in informal encounters and on the other hand by providing concrete suggestions for knowledge development and access to relevant knowledge. Finally it should provide adequate tools to express ideas and dynamically manipulate and structure these along their evolution during the creative design process. The creative nature of the task and the multiple dimensions support wants to address, poses the problem that supportive action cannot be proposed in a standardized, and conventional, sequential way. One cannot predict when certain activities take place, what its outcomes are how the context changes and hence which support is needed for that team at that stage of NPD. (Mawson, 2007)

Aforementioned suggestions point to generic suggestions on accommodation the specific needs of learning at work. For more dedicated ideas on computer based collaboration we turn to the domain of computer supported collaborative learning (CSCL) and computer supported work (CSCW) research.

4. Learning support for NPD teams.

Directly applicable suggestions to enhance collaborative creativity and learning for NPD teams are hard to find. Relevant insights are spread across

domains. Inspiration can be obtained from the domains of engineering, new product design, creative problem solving, virtual collaboration and team learning. The most important and coherent source of inspiration are the CSCL and CSCW communities. Investigations in these communities led to supportive instrumentation and scenarios for computer supported collaboration and learning in contexts of learning (CSCL) and work (CSCW).

CSCL strategies originally are designed to enhance student's learning in educational settings. In this respect they differ from scenarios for CSCW since the latter concentrate on creating enabling methods and instruments for the work to be done. CSCL typically aims to enhance personal learning; while CSCW concentrates primarily on team performance. Since CSCL roots lie in formal education, the recommendations focus on improvement of the learning process targeting at predefined goals of the individual person and team. CSCW research concentrates on stimuli to improve effective knowledge collaboration aimed at collective performance in distributed work practices.

Table 1: Comparing regular, work based, and NPD learning.

Learning in regular (education) settings	**Work based learning**	**Learning in NPD**
Planned	Both planned and just in time.	Just-in-time.
Predefined	Both predefined and unpredictable.	Mainly unpredictable.
Usually aimed at the individual (he or she has to be able to…)	Both aimed at the individual and team.	Primarily aimed at the team (project unit). Aimed at enhancing collaborative creativity. Aimed at enhancing collaborative learning.
Formal	Formal , non-formal	Non-formal

Carl Bereiter and Marlene Scardamalia (2003) developed the idea of scaffolding collaborative knowledge building to education. They argued

that knowledge is socially constructed via inquiry, questioning, systematic research, reflection and debate. Learner support therefore doesn't consist of presenting information or prescribing procedures but in assisting collective inquiry to achieve deeper understanding. The proposed learning support consists of scaffolding to provide explicit support at the start which fades away after time once the need for guidance diminishes. Knowledge building support in this way helps to a) systematically generate research questions, b) to construct intuitive working theories, c) critical evaluate the generated intuitive concepts, d) search for new scientific information, e) generate additional subordinate questions and conduct further investigation, f) which again leads to definition of new working theories etc (Hakkarainen, et al, 2002)

Researchers from the Media Lab of Helsinki University specified a method for progressive inquiry (Hakkarainen et al. 2002, Muukkonen, et al., 1999)[1]. This method entails that new knowledge needs to be constructed via a question based and explanation-driven inquiry as part of systematic problem solving (Mukkonen, 1999). Stages of the progressive inquiry process relate to methods of scientific problem solving, which stages include: 1) context creation 2) definition of research question 3) articulation of working theory 4) externalization of own thoughts 5) searching new information 6) critical evaluation. Advancement towards new collective knowledge in the investigation process proceeds via construction of shared knowledge expressed in hypotheses, theories, explanations and interpretations (Bereiter & Scardamalia, 2003; Hakkarainen et al. 2002, Muukkonen, et al., 1999) which then become objects of discussion, reflection and further elaboration.
Scaffolding as well as progressive inquiry originating in educational settings are relevant for and transferable to the creative problem solving in NPD.

Gerry Stahl (2005) and Gerhard Fischer (Fischer et al, 1995; Fischer & Mandl, 2001) took support for computer supported collaborative work a step further. In their research Stahl and Fischer put extra emphasis on articulation of team members' tacit knowledge and on the process of sense making. Learning is the joint activity of shared meaning making a social activity". (Stahl, 2005) Collaborative design processes are processes of

[1] Fle3 was largely developed in the Innovative Technology for Collaborative Learning and Knowledge Building (ITCOLE) project, funded by the European Commission in the Information Society Technologies (IST) framework's 'School of Tomorrow' program

articulation and negotiation of perspectives, of mutual learning (Brown & Duguid, 1991, Stahl, 2005, Boland & Tenkasi 1995) aimed at construction of shared understanding to produce collective results. Affording functionalities are needed to express, process, share and modify ideas. These CSCW investigations on the importance of artefacts as objects of discussion and reflection are important and transferable for NPD learning.

In sum ideas from both worlds on scaffolds and supportive action for collaborative sense making are valuable for NPD teams. Suggestions are (Bitter-Rijpkema, 2005, Ostwald, 1996; Stahl, 2005) that multiple formats are necessary to express new ideas, followed by adaptative support during the further evolution of these ideas. It should be noticed however that context in which these strategies were developed differ. CSCL was designed for formal classroom contexts and CSCW strategies were developed to support software design. This implies that these strategies provide a source of inspiration, but are not directly applicable for *idSpace*. The next step is to find a method to translate these CSCL and CSCW suggestions into appropriate support for NPD learning In the next section we will explore a method to construct support fitting NPD learning needs to enhance product design creativity.

5. Adaptable, tailored recommendations.

Invention of new products has become the work of innovation teams in which professionals from various backgrounds are brought together. In practice distributed creative collaboration for new product design proves to be quite problematic. Teams miss among others flexible tools to support articulation and expression of their ideas. At the same time they experience problems with idea generation expression and communication, with effective collaboration and learning from their peer's contributions.
Creative problem solving differs substantially from traditional collaborative (classroom) work. NPD work consists of a type of collaborative problem solving where nor the outcome nor the process are predictable. In contrast to work on well defined tasks NPD work cannot be handled by known solution paths. Enhancing creativity in NPD requires not straightforward application of prescriptions but suggestions on strategies to spot new perspectives and opportunities to discover. For creative problem solving one looks for investigation strategies to look to problem and solution space from various perspectives, to test new assumptions and find new combinations of ideas.

Consequently standard strategies that work in well-defined settings of education and at work will not match the support needs of workers on creative tasks. To match with the context and creative nature of the task at hand and the actual state of problem solving demands tailorization of support As argued earlier support has to address multiple dimensions: creativity, knowledge development, collaboration, tooling and organization in the context of the team.

We therefore propose to integrate support on use of creativity techniques with suggestions for effective learning and working. Since the support needs to be fine tuned to the needs of the particular NPD team and its context we propose a format in which based on analysis of the team's specific needs an appropriate set of recommendations is composed. The recommendations are based on proven heuristics from the domain of creativity, learning, CSCL and CSCW research, systematically written down in design patterns. Heuristics for collaborative learning are captured in systematic ways in design flow patterns for e-learning (Retalis et al, 2006). We believe that these design patterns, well known solutions to recurring problems, based on theoretical insights from learning sciences, psychology, creativity, computer supported collaboration, system design (Alexander, 1977) provide input for customized support scenarios.
The scenario provides appropriate suggestions on how to act, which creativity technique to use and helps with the use of enabling tools and functionalities, matching to the specificities of that particular NPD teams.
To get started for example the proposition could be a combination of design patterns on getting acquainted, organize collaboration and use brainstorming as first ideation activity.
Recommendations for creativity will offer suggestions to use multiple forms of exploration, articulate ideas in free visual formats, take time for new iterations, reflect and take the investigation yet another step further, create reflection time and space for surprise. Support also spots opportunities for creativity to its users suggesting the use of a specific creativity method that has proven to be helpful in similar circumstances.

Thus the stimulation of learning in NPD settings consists of application of design patterns. On the one hand advice suggests methods to create stimulating circumstances, for example for fruitful interactions between the collaborators. On the other hand recommendations suggest how to act what to do, which technique to use, how to evaluate ideas generated, etc. Helpful support that based on available information (from the system or the team facilitator) on the state of the team at that moment in time In this way

enhancing creativity can be customized by clever use of existing heuristics combining these in a flexible way to accommodate the NPD setting.

5. Conclusions.

In this article we focussed on the support needed by a NPD team using *idSpace*. We especially looked into the fact that the *idSpace* environment has to support professionals for whom performance is the prime and learning is part of the job. Even though for the achievement of creative result, learning to act creatively and learning from each other is so crucial to its success. Against this background we analyzed the implications for e-learning support for *idSpace* type of settings. Starting point was the fact that NPD team learning basically consists of creative problem solving which takes place at work via computer based collaboration
We noticed that support for NPD learning effectively needs to address multiple dimensions in parallel: creativity, learning, collaboration, context and organization. Our analysis surfaced various differences between regular e-learning requirements and NPD support needs. Apart from the work based nature of learning. Process and outcome in creative problem solving are less predictable. Its knowledge building processes require more freedom of expression and different inquiry strategies.

Therefore we need recommendations matching these needs. For an adequate fit to the needs of the particular situation and team we proposed customization via composition of dedicated sets of recommendations. Scientific theories and heuristics from pedagogical, creativity, computer and design sciences lie at the foundation of these recommendations to facilitate distributed learning and creative collaboration in a particular NPD team.

Yet the applicability of existing heuristics and new patterns for *idSpace* settings requires validation by experts and investigation is needed into the optimal pattern combinations for creative problem solving in specific NPD settings and communicating interactions and information to the users.

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