ECTEL meets ECSCW 2013: Workshop on Collaborative Technologies for Working and Learning

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ECTEL meets ECSCW 2013: Workshop on Collaborative Technologies for Working and Learning

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Abstract. With this workshop, we brought together the European communities of technology-enhanced learning, which typically meets at the ECTEL, and of computer-supported cooperative work, which typically meets at the ECSCW. While the ECTEL community has traditionally focused on technology support for learning, be it in formal learning environments like schools, universities, etc. or in informal learning environments like workplaces, the ECSCW community has traditionally investigated how computers can and do mediate and influence collaborative work, in settings as diverse as the typical "gainful employment" situations, project work within university courses, volunteer settings in NGOs etc. Despite overlapping areas of concerns, the two communities are also exploiting different theories and methodological approaches. Within this workshop, we discussed issues that are relevant for both communities, and have the potential to contribute to a more lively communication between both communities. More information about the workshop program and follow up activities is available at http://know-center.tugraz.at/ectel-meets-ecscw-2013/

Workshop Proposal

With this workshop, we brought together the European communities of technology-enhanced learning, which typically meets at the ECTEL, and of computer-supported cooperative work, which typically meets at the ECSCW. Clearly, the communities overlap in knowledge work settings, where informal learning is an integral part of (successful) work, and collaboration the typical modus operandi.

Despite overlapping areas of concerns, the two communities are also exploiting different theories, methodological approaches and technologies. For example, the ECSCW community has traditionally followed multilevel research paradigms that capture complexities of work situations in more holistic ways such as activity theory or distributed cognition (Halverson, 2002), and qualitative and ethnographic methodologies (Randall 2007, Schmidt 1999) have been of paramount importance. ECTEL has been traditionally drawing on approaches from more formal educational settings. Hence, pedagogical theorizing such as self-regulated learning or collaborative learning has heavily influenced design and application of technologies. Methodologically, paradigms rooting in experimental research have been employed that could exploit the more formal setup of the learning context. Technologies were highly influenced by the adaptive learning systems and user modeling research paradigms. Only recently has there been a shift towards more qualitative and observational paradigms that take the realities of workplaces into account (e.g. Lindstaedt et al. 2010; Kaschig et al. 2012).

Common perspectives in the two communities can be observed with more design oriented research strategies, as well as in a focus on data-driven approaches (such as Crowdsourcing or Learning Analytics) that exploit the traces of collaborative activity (e.g. through Social Network Analysis).

The explicit **goal of this workshop** was to bring together two communities and to act as a seed for further exchange of ideas and cross-community fertilization. It was held as a **joint workshop between ECTEL2013 and ECSCW2013**.

Topics and Format of Contributions

This workshop served as a forum to discuss topics like

- (Collaborative and cooperative) workplace learning
- (Collaborative and cooperative) Knowledge work – which encompasses, following Kelloway & Barling (2001), the application, creation and transmission of knowledge
- Technology support for workplace learning and knowledge work
- Technologies that exploit traces of collaborative and cooperative activity in the workplace

When selecting the papers for discussion at the workshop we explicitly looked for contributions that

- Survey relevant developments in either of the addressed communities (ECTEL, ECSCW) and thus contribute to a mutual understanding between both communities.
- Describe original empirical or theoretical work that sheds light on the workshop topics
- Describe original technology design that is relevant for the workshop topics
- Discuss similarities and differences in theoretical and methodological approaches

Workshop Format

The workshop was held on September 21st, as this was be the last day of ECTEL2013 and the first day of the ECSCW2013.
The morning session contained presentations with an emphasis on discussion. In the afternoon organized group activities to refine the overlap between the two communities and identify common challenges at the theoretical and methodological level.

Organizers

Monica Divitini is professor of Cooperation Technologies at the Norwegian University of Science and Technology (NTNU). Her research interests lie primarily in the area of CSCW and mobile technology for collaborative learning, e.g. in the area of crisis management. She has consolidated experience with the collaborative organization of international workshops.

Tobias Ley is a professor of Digital Ecosystems at Tallinn University in Estonia. His research interests lie in the application of adaptive and social technologies in workplace learning and knowledge management. He has organized numerous international workshops at EC-TEL and I-Know conferences, and is acting as a programme chair of EC-TEL 2013.

Stefanie Lindstaedt is professor and head of institute of the Knowledge Management Institute at Graz University of Technology and is Scientific Director of the Know-Center in Graz (Austria). Her research focuses on context-aware knowledge services that combine the power of Web 2.0 approaches and machine learning methods to augment semantic technologies in order to support individual, community, and organizational learning.

Viktoria Pammer is division manager in the area "Knowledge Services" at the Know-Center. Viktoria's research focus is to design mobile and context-aware technologies that support knowledge work and work-integrated learning. She is interested in observing users both in the physical and virtual world to create an added benefit for users in work and learning information technology systems.

Michael Prilla is a senior researcher at the University of Bochum. His research interest is centered on the themes of cooperation and collaboration support in areas such as healthcare, consulting or service provision, including collaborative learning, reflection and collaborative modeling. His work focuses on the integration of technical support and technical support. He is active both in the areas of TEL and CSCW and has organized multiple workshops in both. He is a member of the German CSCW steering committee and co-chair in conferences such as ACM Group.

Papers

The workshop included presentation of 12 peer-reviewed papers that together allow addressing the workshop´s topics from different perspectives:

- Merja Bauters, John Cook, Jo Colley, Brenda Bannan, Andreas Schmidt and Teemu Leinonen. *Towards a Design Research Framework for Designing Support Informal Work-Based Learning*
- Martin Böckle, Svenja Schröder and Jasminko Novak. *Collaborative Visual Annotations For Knowledge Exchange in Practical Medical Training*
- Irene-Angelica Chounta, Christos Sintoris, Melpomeni Masoura, Nikoleta Yiannoutsou and Nikolaos Avouris. *The good, the bad and the neutral: an analysis of team-gaming activity*
- John Cook, Brenda Bannan and Patricia Santos. *Seeking and Scaling Model for Designing Technology that Supports Personal and Professional Learning Networks*
- Ines Di Loreto and Monica Divitini. *Games for learning cooperation at work: the case of crisis preparedness*
- Mojisola Erdt, Florian Jomrich, Katja Schüler and Christoph Rensing. *Investigating Crowdsourcing as an Evaluation Method for TEL Recommenders*
- Sean P. Goggins and Isa Jahnke. *Computer-Supported Collaborative Learning at Work: CSCL@Work goes TEL@Work*
- Birgit Krogstie and Monica Divitini. *Reflecting on emotion: Design challenges for cooperation technology*

- Michael Prilla and Thomas Herrmann. *Guiding Articulation for Learning at Work: A Case of Reflection*
- Inga Saatz and Andrea Kienle. *Mobile Support for ad-hoc learning Communities*
- Ivan Srba and Maria Bielikova. *Designing Learning Environments Based on Collaborative Content Creation*
- Vladimir Tomberg, Mohammad Al Smadi, Tamsin Treasure-Jones and Tobias Ley. *A Sensemaking Interface for Supporting Doctor's Learning at the Workplace – A Paper Prototype Study*

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Table of Content

Towards a Design Research Framework for Designing Support for Informal Work-Based Learning

[1]Bauters, M., [2]Cook, J., [3]Colley, J., [4]Bannan, B., [5]Schmidt, A. and [1]Leinonen, T.
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Abstract. This workshop aims to bring together different experiences of various design approaches for active and early scaling up of the appropriation of tools and practices. There exists, many Design Research approaches for developing TEL, but synthesising these approaches into a systematic framework is rare, even more so for scaling the use of TEL to support informal work-based learning. We briefly describe the work of four cases: Integrative Learning Design Framework (ILDF), the Design Process for scaling agility, Co-design approach, and Agile approach. In the workshop we drive for the framework that enables aggressive scaling. The design approaches are described with the goal to point the similarities and challenges for forming a synthesised framework.

Keywords: Design Research, Research-based design, Informal Learning, Work-Based Learning

1 Background, problems and questions

In the workshop we will describe that the various Design Research approaches for developing Technology Enhanced Learning or TEL (e.g. ILDF, Design Process, Co-design and Agile approach), that are used in the Learning Layers project (http://learning-layers.eu/). Learning Layers is a large-scale research project co-funded by the European Commission’s 7th Framework Programme. Layers will develop a set of modular flexible technological layers for supporting work-place practices in SMEs that unlock peer production and scaffold learning in networks of SMEs into two sectors: health care and building and construction. There is a growing need to scale the use of TEL to support informal work-based learning. Therefore, the context of Learning Layers project, with its emphasis on scaling is relevant and good grounds to test and develop new scaffolding and learning practices in work as well as find the potential of tools to integrate the learning, work and context (used physical artefacts). The tools and artefacts used provided by the new technologies have affordances, which are in constant flux driven by a powerful interplay between technological innovation and emerging enacted cultural practices. Significantly, they transcend the everyday life-worlds of users and permeate the workplace and its practices. Design Research has been often introduced as a modern approach suitable to address complex problems in educational practice for which no clear guidelines or solutions are available [1]. The approaches of: Integrative Learning Design Framework (ILDF) and Shared Conceptual Models for Agility in Interdisciplinary Research have been tested in previous projects for scaling and maturing of knowledge (e.g. MATURE project http://mature-ip.eu/, ended March 2012). These aspects are important to take into account because they enable the focus to remain on aims other than tools and practice design. Especially scaling has proved to be problematic in various EU-projects (e.g. KP-LAB project, http://www.kp-lab.org/). Scaling is often related to uncovered drivers and obstacles for adoption, which have to be found out. Knowing these aids the acceptance of innovation and related processes early on in the design research cycle, which again will aid opportunities for new modes of learning to scale beyond the local context. The other two approaches: Co-design and agile process are intended to get the most out of the design process. The first is focused more on ways of integrating all stakeholders into the process to deepen engagement and ownership of the stakeholders. Agile methods ([2, 3 and 4]) aim at being efficient in design and development whilst still keeping the stakeholders involved. These two approaches work hand in hand, with the emphasis on rapid iteration between establishing requirements, designing alternatives, and building and evaluating prototypes. Through the early and regular involvement of users, these approaches enable simultaneous exploration of how users and the establishment of technical and pedagogical requirements work, but if the approaches fall into the technology-first approach they lose the end-users/stakeholders voice. Gulliksen et al. [5] have identified that holistic design is a key principle in designing for work and learning (learning in work). It explicitly considers the work context, physical and social environment. The broader and deeper insights into the users holistically has been highlighted in the UK, on issues surrounding the National Health Service's ongoing National Programme for Information Technology (see [6]). This holistic aspect is the one where the Integrative Learning Design Framework (ILDF) and the Design Process for scaling agility can complement the other two selected approaches. Agile methods are mostly concerned with end-user requirements, and often make the simplistic assumptions that: (a) suitable users are available to interact with the development team and (b) the user requirements are congruent with broader organisational requirements. Thus, the focus on interaction with individual users does not address the need for broader socio-technical awareness in systems. These focus differences point out further needs for the more holistic approaches, which ensure that the scaling, physical and social environment, feelings and practices are taken into account. These should be integrated with the Agile methods and co-design approaches. [2]

2 Design approaches

The Integrative Learning Design Framework (ILDF) has the general intent of generating research-based insights about informal or formal teaching, learning and/or training situations as well as applied solutions that provide and inform practical understanding and applicability to real-world design projects. The ILDF is a design-based research model that incorporates design process efficiencies from multiple disciplines such as instructional design, object oriented software development, product development, and diffusion of innovations research. It aims to provide the opportunities to leverage the design process as a vehicle for analysing, codifying and documenting what is learned when the designed artefact is enacted in the context of the design process. The progressive yield from *iterative and connected* research and *design cycles* is often lost because it is not always *carefully documented* [7]. It is expected that the design process for creating e.g., mobile **social learning** (content and interactions) will offer several new opportunities to generate best practices and guidelines for both *co-design and design research*. The claim of this approach is that following the ILDF model will inherently result in documenting designs. The approach consists of four phases (Informed Exploration, Enactment, Local Evaluation and Broad Evaluation) and aims to solve the problem often encountered in traditional research of not capturing the research-based knowledge and important factors relating to **learning context, culture, and technology within the design process**.

The aim **of the Shared Conceptual Models for Agility in Interdisciplinary Research** is to support and enhance the **collective knowledge development** ("knowledge maturing") in organisations from various perspectives. To be able to do this, an agile project management approach is adopted to *integrate parallel design teams, empirical activities (ethnographic fieldwork, interviews, case studies) as well as evaluation and theory building.* It has been found that Design Research fits very well with agile methods for design of software systems, but agile methods encounter challenges when they are scaled towards interdisciplinary research in larger teams. Broad projects such as EU-projects (e.g. The MATURE project, http://mature-ip.eu/, ended March 2012), have shown that such contexts of many parallel interdependent activities necessitate trade-offs between (i) relevance and usefulness to practice, (ii) research advances, and (iii) technological innovation. By taking the assumption of Design Research seriously that the design process itself is a *learning and problematisation* process that interweaves the deepening of understanding of a broader concept and the design of tools, the projects are able to *adopt a design process that is iterative, spiral-shaped approach where in each cycle we have the same recurring generic activities* (prioritisation, investigation, design, evaluation). This iterative process corresponds to sprints in the scrum methodology, but *needs to take into account the fact that there are parallel activities* that have different timelines and mutual dependencies. The core mechanism to achieve coherence between theoretical, empirical, and design and implementation activities, and to foster negotiation processes between conflicting interests, has shown to be *a strong shared conceptual model* as a mediating artefact that *continuously evolves*. All activities are informed by the model, and all *activities feedback their results into the model* [8].

The co-design taken as participatory design has been developed during a decade of international research and development projects. In *research-based design*, the artefact, which can include tools, are considered to be outcomes. The researcher is the facilitator that guides the way to the outcomes. Certain phases can be distinguished in the process, although, one of the most important aspects is that many activities are going on in *parallel*, and often in the *iterative cycles* (to the previous process the strongest difference being that co-design here underlines the activity of end-users especially in the creative practices of designing the “tool”) [9]; indeed one may be required to go back to previous cycles. The process also claims to allow different strands of design that are in different phases to go forward within the same project. This is important to note because one of the advantages is that even though there are strands that are on different phases these can potentially *still feed knowledge into each other due to the iterative nature of the cycles*. The tolerance for parallel design threads allows to change and take into account information and end-users through-out the process. The main phases that can be distinguished are: Contextual inquiry, Participatory design, Product design and Software prototype as hypothesis phase. In co-design, artefacts, tools, and services are used as a means of providing boundary and shared objects (mediated artefacts) to communicate between different participants during design activities.

In **professional agile development in tool design** the aim is to produce a prototype which could be tested in a large scale *evaluation process*, and following *feedback, produce further iterations* of the app which could be appropriate for a broad base of work-based users, for example: military during deployment, NGO personnel and aid workers, and those working in emergency relief[1]. Although an extended period of prototyping is enabled, there are issues over the process of involving so many stakeholders dispersed over many countries. Difficulties emerge surrounding direct access to the intended user group. In effect, the research process is carried out with the expert input of the main user groups with little contribution from others. It is becoming increasingly clear, as users themselves become more “expert”, that to design without their input will not result in a successful product. Making use of all the research data gathered, the core project team develops the initial proposition, and design, via an iterative process, early prototypes of how the mobile learning app might look and function. This is complex process and it is difficult to identify single sources of content, or single functional requirements that would suit all users. The ability to move quickly through rapid iterations in small teams is a key attribute of the agile design process. [10]

3. Towards a synthesised framework

The above approaches have similarities in their processes and aims. It could be said that differences are in the emphases of the approaches. The similarities that all approaches stress as important are: Iterative design cycles, The process itself is a learning and problematisation space; various activities go on in parallel and allow these to feed into each other and All stakeholders (end-users included) come along into the design process.

[1] MoLE Project’s (Mobile Learning Environment) http://www.mole-project.net/research

The challenges and differences that appear in these four processes are: Level of involvement of the stakeholder; Iteration scale varies from narrow to broad; Position of produced artefacts (the boundary and mediating or shared artefacts) varies; Meaning and position of research in the processes varies (research-based/design research) and how broadly the context and scaling is taken into account.

We have gathered potential starting points for synthesised framework. These points are the following ones: there is a need for creating and agreeing on on the conceptual model that provides the direction and aims for the design, development and research; There is a need to find out 'core principles' of the design and research – these could be based on the shared conceptual model; Deeper connection iterations based on the feedback of end-users – aim is to have continuous evaluation; The stakeholders need support in their Professional Learning Networks [11] to build ownership for sustained continuous work.

In the workshop after the description of the four approaches and, the above points work as staring part for the discussion and generating of experiences and previous 'best practices'. After which, a joint effort to integrate these into framework is attempted. All required material are brought along to the workshop.

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Collaborative Visual Annotations For Knowledge Exchange in Practical Medical Training

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Abstract. This paper presents an approach to applying a visual annotation system for informal learning through knowledge exchange between physicians in post-graduate training in general medicine. The system is part of an online platform for creating and sharing physician-generated medical cases from their work practice. Collaborative visual annotations of medical images are used to support knowledge exchange through online discussion and cooperative creation of medical cases. First results suggest that this can provide valuable support for informal learning through knowledge exchange in this specific domain.

1 Introduction

Knowledge exchange in practical medical training plays an important role in connecting theory and practice. After obtaining their degree physicians go through a period of post-graduate education of five to six years to specialize in a given medical field. An important part of this is practical training through independent work practice supported by experienced physicians. During this specialization, general physicians run through different medical institutions, which are geographically dispersed and functionally not related (e.g. hospital, general practitioner's surgery). Thus, it is a challenge to keep their peer-network stable and to use it for informal learning through peer-based exchange. We present an approach to support such settings by building specific tools for facilitating problem-oriented knowledge exchange in work practice. We focus on the use of collaborative visual annotations within a community platform for the creation and sharing of medical cases between general physicians in post-graduate training (the KOLEGEA project[1]).

[1] http://www.kolegea.de/

2 Collaborative annotations of medical images for physicians

2.1 Related work

Current research on knowledge exchange through user-generated content in medicine has largely addressed patient portals and online medical communities. Solutions for knowledge exchange between physicians have been little addressed. Several community platforms for physicians exist (e.g. DocCheck, Coliquio[2]) but they largely offer general-purpose solutions, with forum-based support for discussing patient cases. Little work has considered how to support physicians in specific medical domains. In this context, we have been investigating the application of collaborative visual annotations to support work-related knowledge exchange in practical specialization in general medicine. On one hand, this builds on current research in collaborative visual analytics and CSCW that has explored new kinds of collaborative commenting and analysis (e.g. Willett et al. 2011) for knowledge exchange. On the other hand, previous work on collaborative learning has also shown the usefulness of collaborative annotations for engaging users in learning-related behaviors such as showing support, self-reflection or internalization (Gao et al. 2013). In addition, healthcare professionals are increasingly accessing visual information from the Internet such as medical images (Carro et al. 2006) to support their work-related problem solving and continuing education. This points to increasing importance of visual support for knowledge exchange in medical practice.

2.2 Application concept and design

The KOLEGEA[1] platform supports the creation and sharing of medical patient cases from the daily practice of general physicians. A core concern is the design of tools for cooperative creation and use of patient cases. These cases are conceived as visual artifacts combining a medical structuring with multimedia information (Novak et al., 2013). A patient case is presented as a slideshow (Fig. 1) organized by phases of medical consultation (examination, diagnostics etc.). Different types of media like text, video, audio (e.g. voice memo) and image files (skin

[2] http://www.doccheck.com/, http://www.coliquio.de/

eruption, injury etc.) can be uploaded through mobile devices (tablets) or the web.

Fig. 1.0 Visualization of a patient case / cooperative visual annotations

The cases can be linked to medical guidelines (best practices) and tagged with symptoms, diagnosis keywords or counseling purposes. In order to stimulate peer-exchange the author adds an initial question to state his motivation for posting the case (e.g. asking about unusual symptoms). Physicians can discuss the case through plain comments or by using the special visual annotation tool. The latter allows them to highlight a region of interest in a case image and add a comment (*"Can this skin eruption be a side-effect of the furosemide medication?"*) as in Fig. 1 (left). Medical discussions often revolve around specific details, such as direct observations of patient symptoms or diagnostic information (e.g. EEC diagrams). Linking comments to specific parts of visual material could improve the quality and precision of knowledge exchange among the physicians and increase the motivation for participation under time pressure of work practice. Such annotations could also help gain new insights in complex cases that might be difficult to recognize otherwise. By stimulating collaborative analysis and discussion of problems from practice they could increase the effectiveness of informal learning in the workplace and connect it with problem-based learning in formal medical education (Ziebarth et al., 2013).

3 Preliminary evaluation results and discussion

To evaluate the practical suitability of our approach, we conducted a formative evaluation of the patient case application in two sessions of

1.5h each with 5 participating physicians (in total). The participants performed typical tasks that would occur in practice: creating a patient case, sharing it with their learning group and discussing it online with their peers and a mentor. To assess user acceptance we applied selected elements of the UTAUT model (Venkatesh et. al 2003) elicited by a Likert-scale questionnaire. All users perceived the application as useful for their medical training ("strongly agree") and all but one perceived that it simplifies their medical training ("strongly agree"). Regarding the functionalities for visual annotations, the participants found the possibility of marking regions of interest on medical images and commenting them directly very useful (four out of five "strongly agree"). The same result applies to adding free comments and linking them to an entire image. The usefulness of the related knowledge exchange through peer-based and mentor-assisted discussion also obtained the same level of agreement (four out of five "strongly agree"). Such findings indicate that the specific functionalities of collaborative visual annotations for case discussion could provide appropriate support for stimulating knowledge exchanges between the physicians in this specific domain. Accordingly, this suggests that visual annotations *could* provide specific support to improve the process of informal problem-based learning through peer-based knowledge exchange in workplace-based training and related settings. This explorative hypothesis will be investigated through further work and evaluations, such as a planned real-world (longitudinal) pilot study.

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The Good, the Bad and the Neutral: An Analysis of Team-Gaming Activity

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Abstract. This paper describes a preliminary study where a multiplayer location-based game's logfiles were used for the assessment of the overall practice of teams. We explore the use of activity metrics previously introduced and applied to CSCL settings. We argue that these metrics, if adapted in a meaningful way, will provide insight of the progress of a location-based gaming activity and its quality regarding the score. Moreover, we assert that this can be achieved in an automated way. A small set of activity metrics, related to game characteristics and player activity, is applied to a set of gaming activities. The results are analyzed regarding team performance and score. The paper proposes a way to analyze group activity in the context of location-based games while taking into account the characteristics of successful collaborative activities. Future work is proposed towards the development of automated metrics for the analysis of location-based gaming activities with emphasis on collaboration and group dynamics.

Keywords: location-based games, activity analysis, collaboration, evaluation

1 Introduction

During the past few years, the widespread use of mobile devices affected not only the way we communicate, but also the way we learn and interact with others. A common scenario involves players of location-based mobile multiplayer games in places such as museums, archaeological sites or historical city centers. The notion of location-based playful learning activities has been introduced and various games are designed to support it [1, 2]. However the analysis and evaluation of gaming practices is mainly carried through qualitative methods, using audio/video recordings, interviews and observation notes [3, 4]. In this paper the gaming activity of teams in a location-based playful setting is analyzed using simple metrics previously introduced for the assessment of collaborative, learning activities. Metrics of activity or interaction have been widely used in CSCL methodological frameworks for the assessment of collaboration. Simple metrics such as the volume and rate of activity [5], the temporal locality [6] or the distribution of activity in time [7] have been proposed and used in CSCL studies.

In this paper, we explore whether the application of activity metrics to location-based gaming practices can offer an insight regarding the fulfillment of the game's objective in relation to the effectiveness of team collaboration. We argue that due to the characteristics of mobile, collaborative learning, the activity metrics proposed will capture the performance and reflect the quality of their practice. Learners in a mobile scenario, especially like the one analyzed here, are expected to be on the move and to continuously interact with the location. The players have limited time to plan future actions or reflect on the activity. They are not expected to spend much time standing in order to discuss and argue, as opposed to the collaborative practice in a non-mobile setting. Instead in a mobile setting the key to a successful practice is for learners to be able to coordinate their actions effectively across time and space. We claim that this can be mapped in the logfiles of the activity.

The study presented here does not directly relate to workplace learning or workplace collaborative practices. However due to the special nature of mobile learning requiring users to be on the move and associating action and/or learning with motion in space, we believe that the proposed setting could be successfully adapted into a workplace mobile learning context as well.

2 Case Study: The MuseumScrabble Game, the Aftermath

In the case study we present here, we analyze the recorded activity of the MuseumScrabble game, a location-based multiplayer game which was designed to facilitate children visiting a museum, and which was previously evaluated in the field [8]. It is a real-time multiplayer game where the players form competing teams and use handheld devices to scan the RFID tags of museum exhibits and to "link" topics –as imposed by the game- to relevant exhibits. Successful linking is rewarded with points and the team with the highest score is the winner of the activity. Seventeen pupils participated in the field evaluation, which lasted approx. 25 minutes, forming seven teams of 3-4 players. All teams were formed randomly before the beginning of the activity. Each team shared one handheld device. The teams either assigned the operation of the handheld device to one team member for the whole duration of the game, or the team members took turns. Observation on the field showed that decisions regarding the use of the PDA were taken mainly at the group level and not at the level of the operator. In that sense, the logfiles portray the activity of the team. The purpose of the analysis presented is to explore whether the use of descriptive statistics and activity metrics can provide insights on the efficiency of team strategies towards the game objective. To that end, we classified the teams into three categories regarding their scores, as computed after the end of the activity:

- the Good Teams (gt): Good teams (2 teams, referred here as gt00 and gt01) are characterized by the highest game score (more than 17 points) and therefore good performance
- the Bad Teams (bt): Bad teams (3 teams, referred here as bt00, bt01 and bt02) are those with the lowest gaming score (zero points)

– the Neutral Teams (nt). The teams that achieved a medium score of four to eight points are categorized as neutral (2 teams, referred here as nt00 and nt01).

It is worth mentioning that after the end of the activity, users were asked whether they had used a PDA device before. The majority of players in the teams characterized as good were experienced with PDA devices while this was not the case with the other teams [8]. For each team the descriptive statistics of the activity and its projection in time were computed and compared. The objective was to track any indication of metrics that could be further used for the automatic evaluation of a gaming activity.

The descriptive statistics of the activity were computed for all the teams participating in the game. Various metrics that have been previously used for the assessment of CSCL activities, were originally considered but the ones that appeared to differ among teams of different quality regarding the game score, are: total sum of events[1] (#events), difference of (#link actions - #unlink actions) (#dlu), average time between consecutive actions (#avg_time_gap). In Fig. 1 the activity statistics per team are pictured. It is evident that the good teams (gt) portray intense activity, temporally dense (high number of events within short time) which fades out and scatters in time for the neutral teams (nt) and bad teams (bt). This is a rather trivial finding that justifies nonetheless the original notion: Teams that appear to have a high activity, temporally dense and without delays also score higher in the game. However one could claim that an intense activity could also portray a team that acts spontaneously/hastily/without planning. To investigate this point, the activity metrics were analyzed in time. In order to portray the unfolding of the activity, each team's practice was split in time periods of 60 seconds.

The events which took place within these time periods were summed and visualized per category (Fig. 2). The good teams (gt) exhibit intense, continuous activity throughout the game. Periods of zero activity are extremely rare while the teams appear to be more productive in the middle of the activity. On the other hand, the neutral (nt) and bad (bt) teams have low activity in comparison to the good teams. Periods of zero activity are more frequent and last longer, throughout the whole duration of the game. The difference between good and neutral/bad team practices is even more distinctive in the case of linking/unlinking actions. The linking/unlinking actions are directly connected to the overall score (a correct link is rewarded with points). Therefore good teams are expected to have a higher number of linking/unlinking actions than the rest. However the interesting point is the distribution of linking/unlinking actions in time. For the case of neutral/bad teams, the linking/unlinking actions take place mostly during the first minutes of the activity, gradually fading out and coming to a halt almost after the first half of the activity duration. For the good teams the links are evenly distributed throughout the duration of the activity.

[1] An event can be a) a successful scan, b) an unsuccessful scan, c) a link action, d) an unlink action, e) enter a topic, f) exit a topic

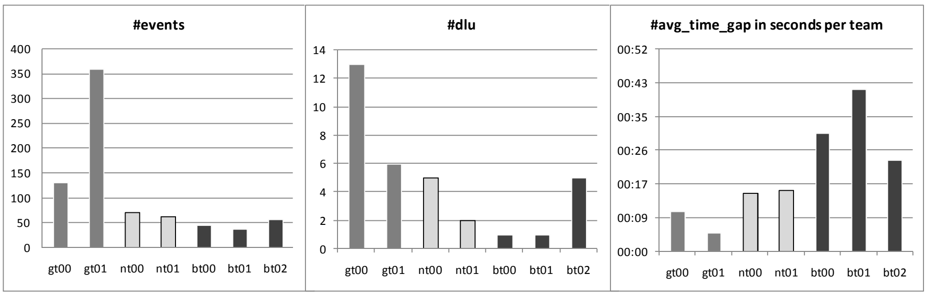

Fig. 1. Total sum of events (#events), difference of (#link actions - #unlink actions) (#dlu) and average time between consecutive actions (#avg_time_gap) for good, neutral, bad teams (gt, nt, bt) as calculated from the logfiles of the application

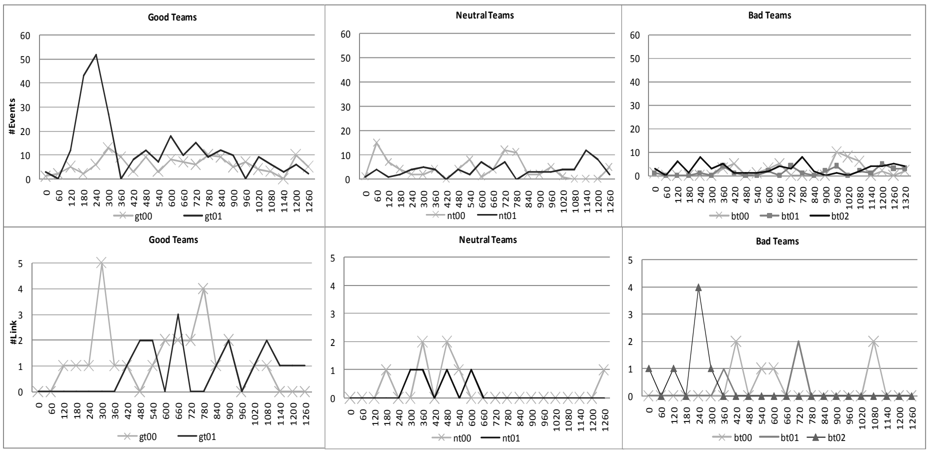

Fig. 2. The timeline activity for the event metrics of #Events and #Link action events for all teams (good -gt, neutral -nt, bad –bt)

3 Discussion

In this paper we study the use of simple activity metrics deriving from CSCL frameworks to gain insights on group collaborative activity during location based games. Since the game is played by teams, we argued that automated metrics for the analysis and evaluation of CSCL activities will also apply to a location-based gaming context. Yet, the special characteristics of mobile collaboration and learning require the analysis and evaluation of practices on a whole different basis than traditional CSCL frameworks suggest. Mobile learners are always on the move and therefore argumentation, response and action has to be immediate and continuous. Unlike what happens in a classroom, mobile learners do not usually gather around a table to discuss on a plan or to reflect on the outcome so-far. Therefore careful planning, good coordination and effective communication within a team in a mobile learning scenario are expected to result in a continuous activity, which is well balanced and equally distri-

buted in time. On the other hand, an unsuccessful collaboration within a team, may lead to loss of interest towards the common goal and failure to fulfill the goal.
In order to fully support this assumption and propose an automated analysis framework, extensive, large-scale studies must be designed and carried out on collaborative location-based gaming activities where each and every player will be supported by a mobile device to analyze not only the team's activity as a whole but also the interaction of team members. Additional parameters such as the type of mobile device, the learning context, the age of players, team size, etc., should be further examined not only regarding the gaming experience but from a collaborative perspective as well.

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Seeking and Scaling Model for Designing Technology that Supports Personal and Professional Learning Networks

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Abstract. This paper contributes a new model for Design Research that extends existing approaches by taking into account the neglected areas of design seeking and scaling in the underexplored area of workplace informal learning; we place an emphasis on design that is based on a new empirically base. We use PANDORA as an exemplary case study to identify and illustrate the research benefits of the Design Seeking and Scaling model. PANDORA explores, amongst other things, designs for collaborative technologies for processes surrounding a Significant Event Audit (SEA) in UK Health Sector's General Practices. We claim that the model is useful as a tool for improving collaboration through Personal Learning Networks.

Keywords: Design Research, Workplace learning, Learning in informal contexts, Technology Enhanced Learning (TEL), Scaling TEL, Personal Learning Networks

1 Introduction

This paper contributes a new model (Fig. 1) for Design Research [1] that extends existing approaches by taking into account the neglected areas of design seeking and scaling; it is specially oriented towards guiding research in the underexplored area of designing technology for supporting workplace informal learning across contexts. We claim that our approach is new particularly with respect to the scaling of TEL in workplace informal learning and its emphasis on design that is based on a new empirically base in this context. However, another purpose of this paper is to engage the community in debate that tests our claim and uncovers other research related in our area.

The model takes as a starting point Rogers' [2] notion of diffusion of innovation. However, we extend it by drawing on the PANDORA design team case study from Learning Layers[1], a project which investigates scaling in workplace informal learning. PANDORA explores, amongst other things, designs for collaborative technologies for processes surrounding a Significant Event Audit (SEA) in UK Health Sector's

[1] http://learning-layers.eu/

General Practices. SEA is an increasingly routine part of General Practice that can discuss events that range from an unexpected death to an unforeseen response by a patient to a prescription. "*It is a technique to reflect on and learn from individual cases to improve quality of care overall*" (http://tinyurl.com/lfh5qpj). Our model has five related phases; each phase is characterized by internal iteration. Due to space limitations, the focus of this position paper is on phase one (Prior conditions) and five (Diffusion at scale) and phase two (Agreement). These phases are selected because they relate directly to the workshop theme of scaling workplace learning. We use PANDORA as an exemplary case study to identify and illustrate the research benefits of the Design Seeking and Scaling model; furthermore, we claim that the model is useful as a tool for improving collaboration through Personal Learning Networks.

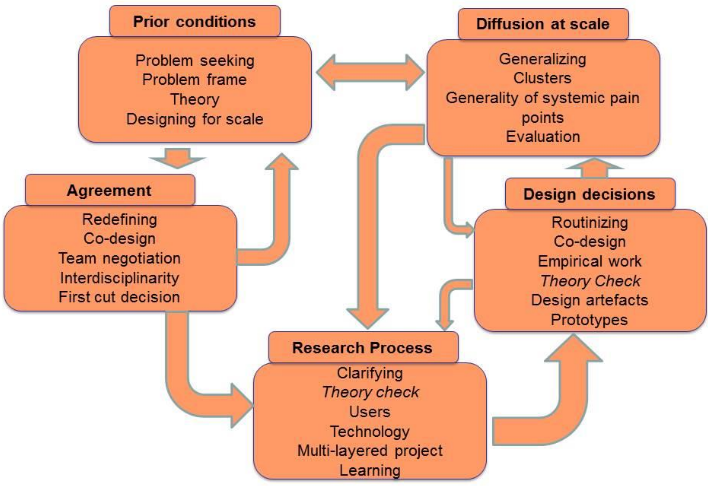

Fig.1. Design Seeking and Scaling Model

2 Prior conditions phase (with reference to Diffusion at scale)

The Prior conditions [2, p. 170] phase recognizes the need to look at previous practice, felt needs/problems, innovativeness and the norms of the social system. We extend this notion of prior conditions and also 'agenda-setting' [2, p. 421] by making an explicit link to ideas surrounding design creativity and seeking and the question *'how do design ideas arise'?* Design seeking is a key concern here, and this draws on the concept of problem seeking [3] rather than mere problem solving. In the early design process (Prior conditions) we can say that "*knowledge is essentially problematical: it is not just a question of solving a problem, it is more a question of seeking out the nature of the problem and then devising an approach to solving it*" [3]. A key problematic issue that we have encountered when analyzing ethnographic research (conducted by Learning Layers partners) is that there is a need to consider scaling from outset when design seeking. 'Designing for scale' needs to consider three key aspects: (i) Diffusion of innovation, (ii) Systemic pain points and (iii) Clusters. 'Diffusion of innovation' [2] is a theory that seeks to explain *how*, *why*, and at *what* rate new ideas and technology spread through cultures. A key notion for us is that for technology to be adopted on a large-scale it needs to seek empirically based 'Systemic pain points' that, if addressed, have the potential to attract significant take up by other groups of professionals who face the same problem (see below for an example taken from UK Health Sector). Scaling through 'Clusters' involves a "*geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities (external economies)*" [4]. It is important to distinguish managed from unmanaged clusters or agglomerations/lumps with no organisation or team working on behalf of the cluster members to get them to move in the same direction. The Learning Layers project is working with clusters in Healthcare and Construction by building sustainability beyond project horizon by promoting a network of Education Innovation Clusters to serve other clusters with services and technologies to speed uptake of new learning methods and technology. Key additional concepts (which link this phase in a double headed arrow to the fifth phase) are organisational cultures and contexts; this work is pertinent here in terms of drivers and barriers. The 'learning theory' for one aspect of the PANDORA Design Team involves the objective of designing to support the construction of locally trusted Personal Learning Networks [5]; an environment where clinical staff can seek collaborative support by interacting with their peers about a SEA by using relevant guidelines, and the outcomes of the Practice; the outcome is a local SEA document which needs to identify any 'learning needs' and 'actions to be taken and changes to be made' and 'agree how these will be progressed'. As a worker's or group's connections and confidence grow, they then go on to build what we are calling a Shared Learning Network. Thus the first stage of collaborative work for us is the *building*, *maintaining* and *activating* Personal Learning Networks. The second stage is where professionals move from local trusted personal networks out into wider networks that can potentially include anyone; thus the SEA living document from stage one has the potential to be shared more widely (cascading); this is what we are calling Shared Learning Networks. We consider interactions of people and the resources in the Shared Learning Network as an emergent distributed cognitive system**.** Grounding acts in networked community serve like *internal scaffolds*, which help to establish common ground in cognitive and metacognitive domains and the *collaborative scaffolding* situation emerges.

3 Agreement phase

Our second phase is called Agreement and is based on Roger's notion of Persuasion [2, p. 170]; this relates to the perceived characteristics of the innovation as well as the need to keep large heterogeneous research project teams (like Learning Layers) 'on board'. 'Redefining' in Fig. 1 [2, p. 421] is a key notion here, whereby the "*innovation is modified and reinvented to fit the organization, and the organizational structures are altered*". Other key concepts for us, based on our experience, are as follows. 'Co-design', e.g. designing with Health professionals in

NE England. 'Team negotiation' in is also required, especially with larger projects, namely there is the need for a shared theoretical concept ([6] is the first outcome of this process). 'Interdisciplinarity' (Fig. 1) and different cultures are an issue in larger projects – we are evolving the notion of the use of artifacts as tools for design discourse. In particular, by engaging the wider community and assisting scaling via an innovative Open Design Library (ODL), a collaborative environment that captures the design-based research process followed in PANDORA. The ODL is a collaborative wiki-space where the main design artefacts derived from PANDORA are shared with the community in order to obtain feedback and more iteration with the redefining stage.

'First cut innovation decision' in Fig. 1 represents the point where the innovation is modified to fit the organization. The PANDORA Design Team emerged from the Layers Open Design conference in Feb 2013 and has subsequently engaged in iterative Design Seeking/Redefining using a participative, co-design approach. Focus groups, part of Layers ethnographic study, and expert interviews have confirmed that engaging interactions among professionals to cascading 'local living' SEA documents can be a problem (it represents a Systemic pain point). More recently (June 2013) a consortium meeting, that included application partner representatives, has concluded that innovation design decisions in Layers should take the form of Use Cases and Research Questions around the SEA scenario. For us the Seek Support Use Case is key area in PANDORA (see Fig. 2). After several co-design meetings with clinical staff in Leeds (UK) the problem identified in the Prior Condition phase was redefined with the staff: When clinical professionals are immersed in clinical and management work, they do not have much opportunity for discussion around topics of interest (e.g. cascading SEA) or time to exchange questions. The Use Case (based on feedback obtained in the co-design meetings) envisaged usage is as follows: a General Practitioner (GP) uses an app to seek support in the course of her/his activities; asks a question by recording herself, annotates the type of problem and selects her group of trusted colleagues for the question to be circulated to. Automatically related guidelines for SEA, meeting notes and questions are 'flagged' for her, the GP checks the information and authorship and adds a new person to her network as appropriate. After some minutes, some colleagues provide short responses. In order to redefine the use case, wireframes (e.g. Fig. 2) and interactive prototypes are developed. As *first cut decision* we proposed to use mobile devices to support collaborative seek support basically due to the lack of time and mobility issues of staff (i.e. GPs work in different spaces during the same day). From this Use Case one of the main research question is: *Trust has been found to be key aspect when seeking support* [5] *(e.g. finding responses about a problem treated in a SEA), but which are the specific aspects of Trust that need to be considered when individuals move from local trusted personal networks out into Shared Learning Networks?* We specifically hypothesize that:

[H1] New connections (trusted contacts) will be established by suggesting related people and learning resources created by professionals who are not included in the user's trusted Personal Learning Network (metadata and semantic analysis is used to support this action).

[H2] By facilitating new connections, the system will increase the opportunity of solving problems.

[H3] Notifications of well-recommended resources and promotion of 'hot-topics' (those which have high rates) and 'topics of interest' (those which are related with 'tags' of interest) to motivate and engage discussion and Trust across many General Practices.

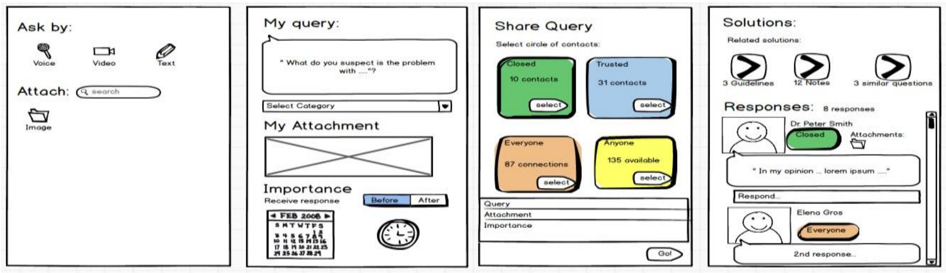

Fig.2. Seek and Support wireframe (Select format of question, Create a question and select priority, Share with your Shared Learning Network circles, Obtain support)

4 Future questions

Do the model and case illustrate key seeking and scaling issues that other projects may wish to consider?

If scaling is to work, does the model and case drive us to think about how to engage and build up trust and relationships in Professional Learning Networks?

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Games for Learning Cooperation at Work: the case of crisis preparedness

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Abstract. In order to achieve crisis preparedness a number of approaches are combined including traditional training through courses and training material, coaching, simulated emergencies to recreate realistic working experiences, and structured debriefings to learn by reflecting on specific work experiences. Recently, Serious Games have also been proposed for this domain and experiments on their usage show that games can help to address some of traditional training limitations. In this paper we describe the first steps towards the creation of a system for supporting crisis preparedness through games. In particular, based on our experience with this domain, we reflect on the use of serious games for learning cooperation at work. A set of questions for guiding further research are identified.

Keywords. Serious Games, Crisis Management, Cooperation

1 Introduction

Work in crisis situations, like earthquakes and floods, is highly cooperative [1]. First, cooperation might take place ***inter sectors/agencies*** [2]. A crisis in fact requires the orchestrated action of a myriad of actors, e.g., firefighters and medical units. It is therefore very important that the different agencies communicate and coordinate in order to achieve a common goal, within the specific areas of responsibility. Cooperation at this level is taking place both in coordination rooms and in the field. Second, cooperation takes place ***intra sector*** [2]. Within workers of any given involved sector, work is generally organized in teams. These teams in many cases involve people with different levels of competencies who do not share experience on a continuous basis, as for example volunteers who are called in only when a major crises strikes. In addition, providing optimal response requires cooperation between the agency coordinators and workers in the field as well as, if needed, cooperation across teams of the same agency. Finally, cooperation is required ***between crisis workers and citizens***. Citizens might provide an essential contribution e.g., by sharing updated local information or by cooperating to process high amounts of data [6,7]. Cooperation strategies to be adopted at the three levels might be very different and involve different actors.

Training of crisis workers has to take into account the cooperative nature of the work. Therefore, training is not only addressing learning of operational procedures and use of specific equipment, but also the development of cooperation skills, like appropriate communication styles, information sharing, and coordination [3]. Some of the required cooperation skills are general, while others are deeply intertwined with procedures for specific situations.

A number of approaches are combined for training for crisis preparedness, including traditional training through courses and training material, coaching, simulated emergencies to recreate realistic working experiences [4], and structured debriefings to learn by reflecting on specific work experiences [5]. Serious games, i.e. games designed for a primary learning purpose other than pure entertainment, have also been proposed for this domain [8]. Games for crisis management offer an interesting complement to traditional training as they support players in exploring a set of possibilities and playing with different solutions, fulfilling goals in a variety of unique, sometimes, unanticipated ways. Experiments on their usage show that games can be promising tools able to address some of the limitations of traditional training.

In this paper we briefly present the work that we have done in the area of serious games for crisis preparedness, with focus on training of cooperation skills. The main purpose is to share this experience at the workshop in order to discuss strengths and challenges connected to the use of serious games to support learning of cooperation skills in the workplace.

2 State of the art

To understand the current state of the art in the crisis management field we analyzed how cooperation was taken into account in 10 serious games for crisis management training [16]. Hereafter we present a summary of the results.

Communication: All the analyzed works put communication between the team members at the core of the learning experience. However we can distinguish two approaches. From one hand the system generates a task environment in which a group of people co-operate to deal with a crisis with an inter-sector approach [9]. Other works use a more hierarchical approach. In [10] one player assumes the role of the incident commander (again with an inter-sector approach) and establishes a decontamination zone. The others players communicate over radios and respond to the situation accordingly.

Roles and Coordination: The way teams coordinate is generally dependent on how specific game sessions evolve, but coordination generally plays an important role in training games. For example, in [9] the task of the staff is to get an overview of the situation and to co-ordinate and schedule the fire-fighting units so that they can extinguish the fire and save the houses. Most of the analyzed works take into consideration different roles inside the game. For example, [11] places its users in a crisis management team that is dealing with an evolving emergency (e.g. a huge fire close to a chemical park). Each member is assigned a specific role that has unique abilities. These roles (e.g. leader of the team) are based on the roles of members of crisis units in reality. An interesting approach used by few works is cross training – i.e., shifting to different roles - to provide learners with a more elaborate perspective of the situation or problem. Using role switching requires the learner to learn a variety of skills and provide a broader, more detailed understanding of the processes and roles of a team. [8, 12] and [13] are interesting examples about how to use role switching to teach different skills.

For what concern citizens training, in the domain of serious games we were only able to find games aimed at sensitizing the population, not at training communication and coordination skills (see e.g., FloodSim [14] and Levee Patroller [15]).

3 Towards a game ecology

Because of the importance of cooperation skill training underlined in previous sections we have designed 3 serious games for crisis training which explicitly train different kinds of cooperation skills: *Don't Panic* [17], *Modo* [18], and *Flooded*.

Don't Panic is a cooperative board game addressing ***inter sectors/agencies cooperation.*** The game is mainly targeting the leaders of different agencies involved in crisis management. The game has multiple aims linked to soft skills teaching and learning, but in particular wants to teach communication styles useful to manage crisis events and foster team building.

MoDo is a mobile game to be played in teams in a physical environment through the usage of mobile devices and technology-augmented objects. With this game we targeted crisis workers, focusing at ***intra-team coordination***.

Flooded is a location-based mobile game to be played in the player's local territory aimed at sensitizing citizens to the risks linked to flooding. Because of the target, the dynamics are less strict and the game focuses on showing ***the impact of bad coordination and communication in a crisis***. Fig. 1 shows the different interaction modalities used in the games.

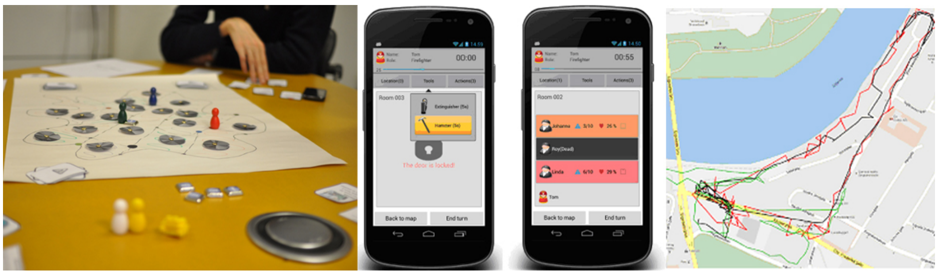

Fig. 1. Different interaction modalities for Don't Panic, MoDo and Flooded

Our first assessments [16] show that these games can be useful for soft skills teaching in crisis management, even having low development cost as a requirement.

The games we conceived until now address in a separate way the three identified cooperation levels. Our next step will be to bring these games together. For example, we want to link *Don't Panic* and *MoDo*, so that players of the first can create missions to be completed by the players of the second. In this way we can create a more holistic approach to crisis management teaching and learning problem.

4 Issues for discussion at the workshop

Basing on our experience, at the workshop we are interested in discussing issues connected to the usage of games for training cooperation skills.

Issues of relevance are:

- What are the strengths and weaknesses of games for learning cooperation skills? Our initial results are positive, showing the development of relevant skills, even if we have not yet conducted a large-scale evaluation. At the same time, it is difficult to evaluate the actual learning impact of these tools, especially in relation to cooperation skills, which are intrinsically difficult to measure.
- Are games for learning cooperation equally suitable in different work domains? I.e., is it possible to reuse the game dynamics in a different domain?
- To what extent cooperation skills can be developed with games that are independent by specific work practices? For example, the games that we have developed refer to specific crisis situations, e.g. panic management and floods. Research is needed to understand the advantages of integrating the learning of cooperation skills with other work-related skills and evaluate them against cost. In fact, more generic games not connected to specific work practices could have the advantage of being usable across domains.
- How do game dynamics strengthen or weaken the training of certain cooperation skills? The games that we have developed are all cooperative, requiring a team to work together towards a common objective, winning or loosing together. This reflects reality. At the same time, it is known that competition across teams can act as a strong motivator to playing (and therefore learning). Could competition be adopted as motivator without negatively impacting on the learning objective of the game?
- How are different modalities of interaction promoting or hindering cooperation? For example, in *Don´t Panic* the physical configuration of the game recreates, to a certain extent, a situation similar to the one in a control room and it seems to promote team building and co-located communication. A mobile game, with players physically distributed, promotes completely different styles of communication and information sharing.

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Investigating Crowdsourcing as an Evaluation Method for TEL Recommender Systems

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Abstract. Offline evaluations using historical data offer a fast and repeatable way to evaluate TEL recommender systems. However, this is only possible if historical datasets contain all particular information needed by the recommender algorithm. Another challenge is that users must have indicated interest in the recommended resource in the past for a resource to be evaluated as relevant. This however does not mean the user would not be interested in this newly recommended resource. User experiments help to complement offline evaluations but due to the effort and costs of performing these experiments, very few are conducted. Crowdsourcing is a solution to this challenge as it gives access to sufficient willing users. This paper investigates the evaluation of a graph-based recommender system for TEL using crowdsourcing. Initial results show that crowdsourcing can indeed be used as an evaluation method for TEL recommender systems.

Keywords: recommender systems, evaluation, crowdsourcing

1 Introduction

At the work place, it is increasingly common to learn on-the-job in order to accomplish a certain task or to learn about a new topic needed to solve a particular problem. These days, most of the knowledge is gained from resources found on the Web e.g. from videos on YouTube (www.youtube.com), slides on SlideShare (www.slideshare.net) or forums on LinkedIn (www.linkedin.com). Recommender systems help by suggesting resources fitting the task the person is presently trying to solve or gain knowledge about. Various kinds of recommender systems have been proposed for TEL, each having their particular aims and advantages [7].

A lot of research has gone into the evaluation of TEL recommender systems based on standard methods from information retrieval (IR) which are mostly based on determining the precision of such algorithms using cross-validation on historical or synthetically created datasets. These offline evaluation methods are fast to conduct once the datasets exist and can be repeated and easily compared to other evaluation results [7]. However getting datasets that have exactly the information needed for a specific algorithm remains a challenge. For example, in order to evaluate our graph-based recommender approach *AScore* [3], a hierarchical activity structure is required. Activities are learning goals or tasks defined by the learner in a hierarchical structure [2]. When the learner finds resources that are needed to achieve a learning goal or to solve a task, he attaches them to the respective activities. Activities thus support the learner during his learning process by helping him plan and organize his tasks and learning resources. AScore exploits these activity structures to recommend learning resources to the learner or to other learners working on related activities. There are however very few datasets that have such hierarchical activity structures [3]. Consequently, the offline evaluation of this approach based on historical data is limited. This motivated us to search for an alternative evaluation method.

Another challenge that arises when evaluating using historical datasets is if new resources are recommended to a user who did not have or know these resources in the past, there is no way of judging if the user would like this resource in the future. There have been attempts to complement offline evaluations by conducting user experiments [7]. However due to the high effort required to perform user experiments not many have been conducted thus far. There therefore exists a gap between the fast, easy-to-conduct offline evaluations and the online experiments. An attempt to bridge this gap is the online evaluation approach using crowdsourcing [5], [4], [1]. Certainly doubts arise regarding the quality of results from an evaluation performed by unknown crowdworkers for a few cents. Experiments however do show that results from crowdsourcing are just as good as from traditional user experiments [6], depending of course on the design of the task to solve [1].

In this paper, we investigate using crowdsourcing to evaluate our TEL recommender system *AScore* comparing it to the state-of-art *FolkRank*. Our goal is to test for relevance, novelty and diversity.

2 Related Work

Crowdsourcing can be described as an open call to online users from a very large community to contribute to solve a problem or to perform a human intelligent task in exchange for payments, social recognition or entertainment [6]. Advantages of crowdsourcing are the fast access to a vast population, the low cost, high quality and flexibility [1]. Limitations are the artificiality of the task, the unknown population and the need for quality control to detect spammers [1]. Crowdsourcing has been used in research to solve various tasks in many different domains e.g. for surveys, usability testing, classification or translation tasks [1]. An example in IR is TERC - Technique for Evaluating Relevance by Crowdsourcing [1], developed to test the effectiveness of IR systems. Recommender strategies have also been evaluated using crowdsourcing [5] to determine the relevance of the recommendations made. Other measures such as novelty, redundancy and diversity have also been measured using crowdsourcing where the crowdworkers state their preference judgements for certain items [4].

3 Crowdsourcing Evaluation Concept and Results

In the crowdsourcing user experiment we investigate these 3 hypotheses:
H1.Relevance: AScore recommends more relevant resources than FolkRank.
H2.Novelty: AScore recommends more unknown or new resources than FolkRank.
H3.Diversity: AScore recommends more diverse resources than FolkRank.

In order to generate recommendations for the experiment, an initial research on the topic of *"Climate Change"* was needed to create a basis graph structure (an extended folksonomy) [3] to run the recommender algorithms on. We selected climate change as this is a topic currently being debated world-wide and it can thus be assumed that the recommended resources to this topic can be understood and evaluated by most participants of the survey. Hence, prior to the experiment, we asked 5 experts using CROKODIL [2] to research for resources on the Web pertaining to specified activities and sub-activities relating to climate change - about 70 resources were found and attached to 8 activities. The graph structure thus created comprising the users, resources, tags, and activities was then used to generate recommendations with the two algorithms AScore and FolkRank. Such a limited dataset would be inadequate for an offline evaluation but it is sufficient to prepare an online user experiment.

In each questionnaire, 5 resources were recommended to the more general activity: *"Understanding Climate Change"* or to the more specific sub-activity *"Analyze the catastrophes which are currently happening or going to happen because of the higher worldwide temperature"*. These resources were either recommended by AScore or FolkRank. To each resource recommended, 10 questions were asked (see Fig. 1): 3 questions to each hypothesis (answered on a 7-point Likert scale) and one control question to help us detect spammers [1]. The participants were asked to first research on the Web for resources relating to the general topic of climate change in order to be able to judge the relevance, novelty and diversity of the recommendations following.

Hypothesis 1: Relevance
Q1: The given Internet resource supports me very well in my research about the topic.
Q2: If I could only use this resource, my research would still be very successful.
Q3: Without this resource just by using my own resources, my research about the given topic would still be very good.
Hypothesis 2: Novelty
Q4: The Internet resource gives me new insights and/ or information for my task.
Q5: I would have found this resource on my own/ anyway/ during my research.
Q6: There are lots of important aspects about the topic described in this resource that lack in other resources.
Hypothesis 3: Diversity
Q7: This Internet resource differs strongly from my other resources.
Q8: This resource informs me comprehensively about my topic.
Q9: This resource covers the whole spectrum of research about the given topic.
Control Questions
Q10a. How many pictures and tables that are relevant to the given research topic does the given resource contain?
Q10b. Give a short summary of the recommended resource above by giving 4 keywords describing its content.
Q10c. Describe the content of the given resource in two sentences.

Fig. 1. Questions asked in the Questionnaire to each Hypothesis and Control Questions

The evaluation jobs were placed on two crowdsourcing platforms: 60 jobs on microWorkers[1] and 40 jobs on CrowdFlower[2]. We had results from all over the world, most of the crowdworkers however came from USA and Bangladesh. After eliminating spammers, we had a total of 68 fully answered questionnaires from paid crowdworkers. We additionally invited 57 voluntary non-crowdworkers (mostly students) to take part in the survey in order to be able to compare the quality of results with those from crowdworkers. In total, 125 fully answered questionnaires were considered for the evaluation. The results of the experiment are shown in Fig. 2. where AScore (left in grey) is compared to FolkRank (right in red). The average answers given on the Likert scale (from 1 - 7) are shown. For each question, AScore receives a better average score than FolkRank. We conducted a two sample Student's t-test for each of the hypotheses. Table 1 gives an overview of the results. Hypothesis 1: Relevance is supported as the t-test gives a p value less than 0.05. This means the answers to questions Q1, Q2 and Q3 support the hypothesis that AScore does recommend more relevant resources than FolkRank. Hypothesis 2: Novelty is supported as well as the p value from the t-test is also less than 0.05, this shows that Q4, Q5, Q6 support the hypothesis that AScore recommends more novel resources than FolkRank . Hypothesis 3: Diversity measured by Q7, Q8 and Q9, is however not supported as the p value is greater than 0.05. Therefore it is not possible to say that AScore recommends more diverse resources than FolkRank. This could be an indication that diversity is harder to evaluate. In conclusion, the results of the experiment support the first two hypotheses: the recommendations made by AScore are more relevant and novel than those recommended by FolkRank.

Table 1. Results of t-Tests

	T-test	Inference
Hypothesis 1: Relevance	$p = 0.0065 < 0.05$	Hypothesis supported
Hypothesis 2: Novelty	$p = 0.0042 < 0.05$	Hypothesis supported
Hypothesis 3: Diversity	$p = 0.0677 > 0.05$	Hypothesis not supported

4 Conclusion and Future Work

In this paper, we argue the need for an alternative evaluation method for TEL recommender systems and propose using crowdsourcing. Initial results show this is possible, concluding that AScore provides more relevant and novel recommendations than FolkRank. We plan to further analyse the data collected to determine the impact of activity hierarchies - comparing the results of recommendations made to a sub-activity with those made to an activity higher in the hierarchy. We hypothesis that recommendations should increase in novelty

[1] `http://www.microworkers.com` (retrieved 19.06.2013)

[2] `http://crowdflower.com` (retrieved 19.06.2013)

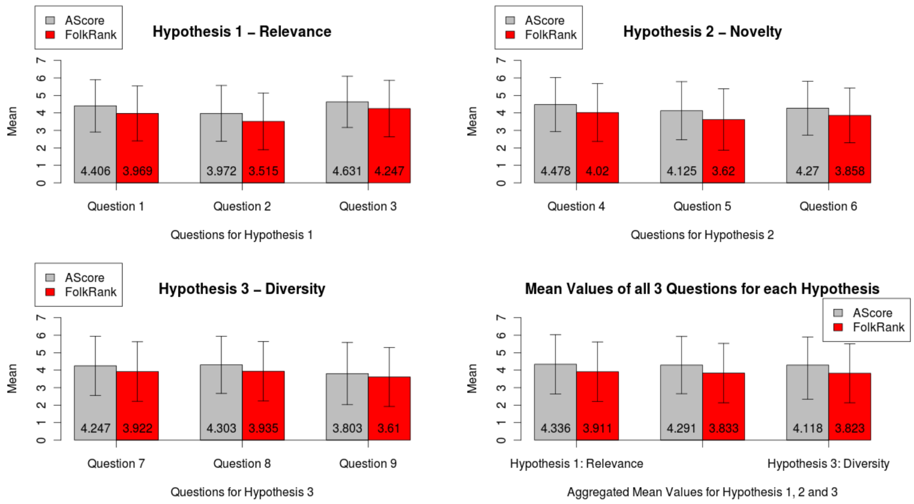

Fig. 2. Hypothesis 1: Relevance (upper left), Hypothesis 2: Novelty (upper right), Hypothesis 3: Diversity (lower left) and All Hypotheses: 1, 2 and 3 (lower right)

the further down the hierarchy. We plan to compare the results between crowdworkers and non-crowdworkers and with these insights improve our proposed crowdsourcing evaluation concept and apply it to further scenarios like evaluating recommendations of learning resources from external sources.

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Computer-Supported Collaborative Learning at Work: CSCL@Work goes TEL@Work

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Abstract. We propose the topic of "CSCL at Work" which we advanced through workshops at ACM Group 2010, ACM Group 2012 and CSCL 2013. The resulting book raises an important set of issues and potential topics for research and practice but, like any agenda setting work, does not solve thorny or controversial issues. CSCL@Work provides one possible viewpoint for bridging informal learning and work. The purpose of our proposal is to share innovative approaches discovered to date, and gain input focused on solutions aimed for understanding, studying and designing **Technology-enhanced learning at work.** From 13 case studies, three main theses can be derived that characterize how and when learning at work takes places, A) Learning occurs in unexpected and unusual online learning places, including Social Media. B) Learning activities incorporate feedback from diverse sources, which are not available within traditional organizational boundaries. C) learning takes place across established boundaries. Theses issues inform the design of collaborative technologies, technology-enhanced learning (TEL) and sociotechnical learning practices. To make learning visible, we argue that individual and collaborative learning design must support the alignment of pedagogical, social and technological design. This alignment will increase the likelihood of both surface and deep learning at the workplace.

1 Introduction and related works

Any person who is part of a traditional or virtual organization must learn new skills routinely. Goggins, Jahnke, & Wulf (2013) demonstrate that much of what a person will try to learn for herself or for the purpose to fulfill the job in the modern workplace cannot be found in a book or on the Internet. Information and knowledge are jumbled together with social connection and experience. Often a person at the workplace will need to acquire the acumen to apply skills, tools and approaches that were invented very recently, and for which there is little if any documentation. In such cases, a learner at the workplace will likely get in contact with a group of people – formally or informally – and its quite likely the people who help the learner most will not work in the same organization that the learner does. Research in the field of Organizational Learning emerged in 1978 (Argyris & Schön, 1978), and gathered increased attention beginning in the 1990's when the questions were focused on how to create a culture and practices for sharing existing knowledge within a firm. In addition to managing existing knowledge sharing, managing the creation of new knowledge is important for firms today. But are they able to create new knowledge when the answer to a problem is not available? What cultures of learning exist to support this? Contemporary answers to these questions must recognize that learning is an implicit, often invisible component of work. To build a bridge between learning *what is known* and learning *that creates new knowledge* is of crucial importance for both the computer supported collaborative learning community and the computer supported collaborative work community (dePaula & Fischer, 2005). Such a "culture of participation" (Fischer 2011) is needed for researchers, consultants and designers of Learning@Work concepts.

CSCL typically focuses on learning as a primary activity. By contrast, Learning@Work is not the primary activity in an organization – reaching the objectives of that organization are the goal. We suggest, however, that we must consider how learning is affected by the needs of employees for timely access to information needed to conduct everyday work. More significantly, the development of practice knowledge and information not contained within the firm raises new challenges. Learning in these cases is a secondary activity and work is the primary activity (Mørch & Skaanes, 2010), while both aims at performance improvement.

We distinguish Learning@Work from prior research in CSCL, TEL, (e)CSCW and knowledge management. Prior work in CSCL investigates the application of computer support for learning in the context of traditional educational institutions. This CSCL inquiry inspired new, more broadly applicable theories about how knowledge is constructed by groups (Stahl, 2006), how groups and individuals reflect their work experiences (Knipfer, Kump, Wessel & Cress, in press), and how teachers contribute to collaborative learning. Furthermore, the application of socio-technical scripts is emerging from workplace studies (Bødker & Christiansen, 2006; Crabtree et al., 2006, Turner et al. 2006). There are gaps in some of this past work that we seen to fill through our discussion around CSCL@Work.

Specifically, in order to **frame different problems** that support the development of technologies for Learning@Work, main design issues and research questions are

1) How do firms make learning practices in work processes visible and how to recognize such learning and establish a culture of learning at the workplace?
2) How to bridge formal, non-formal and informal learning activities?
3) How to design learning at work? (when work is the primary activity and learning is the secondary activity)
4) How to design learning activities when an answer does exist (e.g., routines) and when the answer is not known in the organization, or does not exist at all?

Related Work. Prior work related to CSCL@Work includes empirical research on collaborative work practices (Davenport, 2005; Lave & Wenger, 1991), the sharing of information at work (Brown & Duguid, 2000), and the development of communities of practice in workplace settings (Wenger, 1998). Other prior work examines the munificent variation of information and communication technology use in the work place, including studies of informal social networks, formal information distribution and other socio-technical combinations found in work settings (Hinds & Weisband, 2003). Prior, well-known findings like these rely on the premise that knowledge within an organization's walls can be actively diffused across the organization (Gibson & Cohen, 2003). These studies then proceed to describe various models explaining how that occurs. Such knowledge management approaches are premised on a certain degree of environmental stability inside a company; such premises no longer hold in many contexts.

CSCL and CSCW research each make distinct and important contributions to the construction of collaborative workplace learning, first identified by Billet (2002). One research thread focused on this boundary-spanning field is developed by Yrjö Engeström, who introduced "activity theory – expanding learning" – as a conceptual frame for analyzing and redesigning work (Engeström, Miettinen, & Punamäki, 1999). In his more recent books, Engeström and his team illustrate the connections among learning and work, e.g., "Between School and Work: New Perspectives on Transfer and Boundary Crossing" (Tuomi-Gröhn & Engeström, 2003; see also the works by Mørch & Skaanes, 2010, "learning across sites"). Their case studies reflect new concepts salient for a) new pedagogical practices and b) new work practices, such as "mirror therapy". New pedagogical practices include his use of a cultural laboratory, methods he describes as horizontal working and the notion of "boundary zone activities". Boundary zone activities could be conceptualized as related to the work of Lee (2007) who described boundary-negotiating artifacts.

2 Context, methods and findings

Our work to date includes facilitation, discussion leadership and intellectual guidance for 3 workshops and an edited book focused on CSCL@Work. Our workshops were at ACM Group 2010, ACM Group 2012 and CSCL 2013. Our thinking grew from 8 original case studies in 2010 up to 13 case studies in 2012. These cases and our synthesis of thinking across the cases, is presented in Goggins, Jahnke, Wulf (2013). How learning at the workplace takes place is summarized in 3 key theses:

a) Learning at work occurs in unexpected, unusual online learning places using Social Media
b) Learning activities at work incorporate feedback and 'feedforward' from diverse sources to support individual and collaborative reflections, which are not available within traditional organizational boundaries
c) Learning at work takes place across established boundaries

The theses we present inform the design of collaborative technologies and sociotechnical learning practices in our ongoing work. To make learning visible, to support and recognize it, we argue that the design of individual and collaborative learning (co-construction of knowledge) can be supported through a social, pedagogical and technological design.

2.1. TEL@Work - quality of learning?

We understand learning as "an active process of constructing rather than acquiring knowledge, and instruction as a process of supporting that construction rather than communicating knowledge" (Duffy & Cunningham, 1996). Instructions are not restricted to teaching. It encompasses scaffolding and enabling possibilities for learning. Following this, learning is defined as co-/construction of knowledge and competence development where different people get the opportunity for creative thinking, introducing new ideas and taking creative actions. Learning outcomes are newly developed skills that learners use to solve a specific problem, to create new ideas together with other people, or to create new actions (Anderson & Krathwohl, 2001).

We argue that the design of learning at the workplace needs to support both individual and group learning. Learning underlies a range of different forms of quality. Learning can take place on the "surface level" like remembering facts and understanding information to "deeper learning" which includes a critical thinking and a conceptual change (Kember, 1997). A deeper learning level leads to a member within an organization who does not only know the routines and becomes a 'good' member of a society but also can create new practices and innovations. For example, s/he questions the given understanding of routines.

This learning approach presents new insights about workplace learning, and also new challenges. Operationalizing this view of learning inspires a new set of questions about the behaviors, culture and infrastructure needed to support building a framework for TEL@Work:

- What is the underlying concept of learning within organizations and does it relate to individual, collaborative and organizational learning?
- What kinds of possibilities to enable learning in the workplace are available in the firm?
- Do sociotechnical designers, researchers and workplace learners need to focus on a new balance of formal and informal learning? To what extent?

2.2. A candidate design model for learning at work

When designing learning at work the overall research question is how to design (develop, introduce, evaluate) it *successfully* and what elements can be designed (general model). But the central problem is what does "successful" mean, to what extent is a *design* successful or not? Jahnke, et al. (2010) describes one possible model. In her study of designing remote-controlled laboratories in mechanical engineering, they demonstrate a design model with three elements, which provide a set of opening factors for CSCL@Work inquiry. The model includes three basic elements and its interconnections (*key factors*), read figure 1.

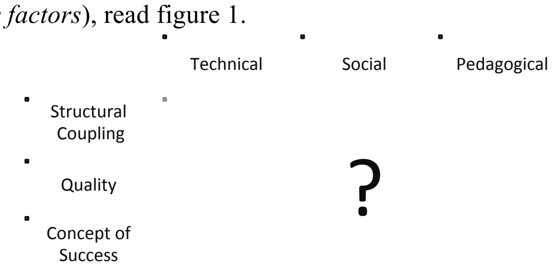

Figure 1. General design model for CSCL@Work (Goggins & Jahnke, 2013)

Summary. The presented framework contributes to a foundation for discussing a design focused TEL@Work research agenda. It is a starting point. Future Learning@Work studies can use it in order to design learning at the workplace in manner that reflects both changing societal needs and emerging information and communication technologies for learning.

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Reflecting on Emotion: Design Challenges for Cooperation Technology

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Abstract. There is a current interest in capturing and using affective data in work and learning. In this paper we argue that cooperation technology supporting reflective learning in the workplace needs to go beyond the focus on emotion as a *state* and direct focus to emotion as part of a *social process*. We propose to focus on *emotion regulation*, stressing the active role of the learner in making sense of and acting upon emotions. We outline a set of related challenges for collaboration technology.

1 Emotion and emotion regulation in reflective learning

Emotion is a key element of human experience enabling people to make sense of their situation and choose appropriate actions [1]. In the workplace, emotion influences work performance in various ways, for example promoting or hindering creativity. The importance of emotion for technology supported work and learning has lately been recognized in TEL [2] and CSCW [3].

The addressing of emotional aspects of work and learning with technology tends to focus on the capturing and representation of emotion considered as a state from which appropriate action can be derived.

We rather suggest the need to focus on the *social processes* through which participants actively interpret, act upon, and manage the emotions of self and others [4]. In particular, we focus on *emotion regulation* [5] as the basic process whereby people seek to redirect the spontaneous flow of their emotions. For example: people engage in emotion work as part of coping with work situations [6], controlling what emotions they display and conceal; Emotion influences social judgments made by individuals and groups [7]; People use cues from similar others in emotional comparison to make sense of ambiguous situations and identify their own emotional state [8].

In our research we focus of reflective learning, i.e. learning based on rethinking work experiences [9] and we take the perspective that work and reflection are intertwined through a reflective learning cycle [10]. Emotion regulation plays a role throughout this cycle in various ways as illustrated in Figure 1. For a complete discussion of the model and grounding in relevant literature, we refer to [11]. In this position paper we discuss implications for design of cooperation technology in light of the role of emotion in work and reflection on work.

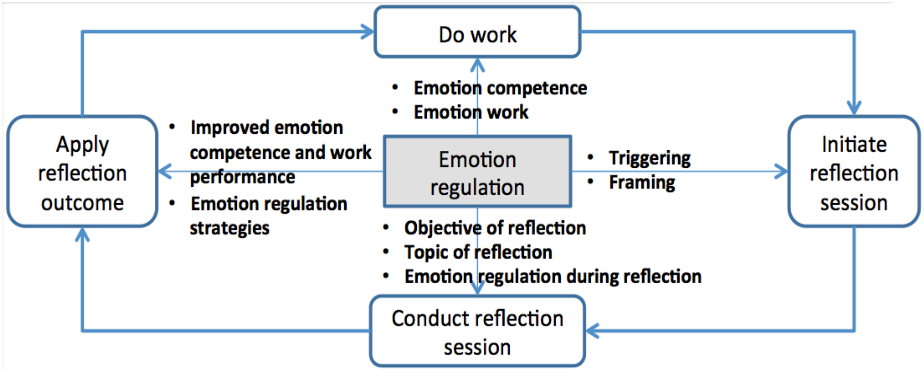

Figure 1: The role of emotion regulation in the reflective learning cycle [11]

2 Challenges for cooperation technology

Doing work - To support reflective learning, technology needs to capture data to help people reconstruct and make sense of work experiences worth learning from. Given the importance of emotion in work processes, data about it is critical. A challenge for technology is to capture not only emotional states during work, but also data to make sense of, and make use of, the social processes around emotion. Automatic collection of e.g. sensor data may produce data that are hard to interpret in this regard. It may be necessary to include people's own assessment of emotions. Characterizing an emotion in close connection to the work in which it occurred helps the person make sense of the event in addition to generating data for later reflection This may also include reporting on the (perceived) feelings of others, as e.g. in [12]. Reporting emotions during work also becomes a part of managing emotions: Categorizing an emotion can make it possible to constructively act upon it.

What emotion-related data to collect and how useful it will be as a source of learning depends on the expected type of reflection. Thus it is a challenge for technology to capture the type of data that fits the reflection sessions in which the data will be used. For example, if it is known that the reflection will involve the workers who shared the work experience, it may be that less data is needed because participants' combined memories and the social process that takes place *in the reflection session* provide useful context data for making sense of the work experience.

Initiating reflection - The triggering of reflection has an emotional component: people want to get out of the negative emotional state associated with discrepancies and situations that need to be sorted out. Thus, when using technology to help trigger reflection on collaborative work one may deliberately highlight aspects likely to lead to negative emotion. A related challenge for technology is to help people establish a frame for reflection on emotional aspects of work that relates to emotion in a way considered constructive and attainable by the participants. For instance, regarding work experiences heavily including emotion work: Should the emotion work itself be made a topic, and/or improvement of emotional competence be an explicit objective, or is it better to have a more work task directed reflection objective and let reflection on emotional aspects follow as a side-effect?

Conducting a reflection session - Reconstructing and making sense of work experience is an affective and social process. The emotions involved in the episode(s) reflected on might help the participants understand the work experience better but also represents a challenge to the reflection session (e.g. negative emotions making it difficult to create solutions or make decisions) [9]. During reflection, participants should be supported in the exploration *and management* of their emotions. This means being in control of sharing, but also getting awareness of emotion-related issues worth reflecting on.

To share or not to share is a key question in collaborative reflection sessions. Sharing experiences and insights can help in e.g., collaborative construction of knowledge useful to the collaborative work. However, for privacy reasons and/or because it might create more trouble than benefit to the continued collaboration, not everything should be shared (see Fig.2 for examples of things it could be problematic to share).

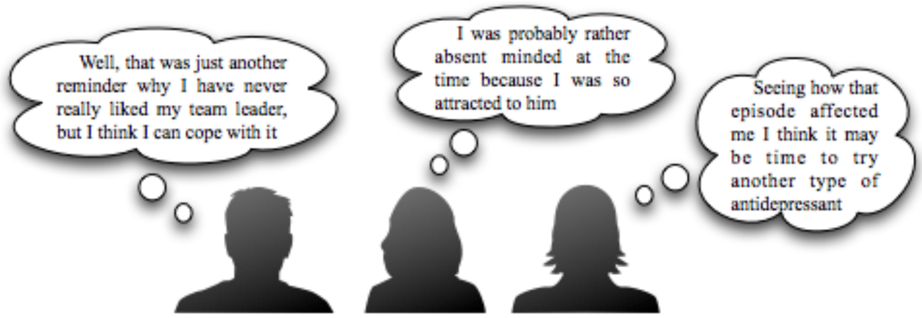

Figure 2: Not all reflection on emotion is fit for sharing with others

On the other hand, reformulating experiences might make them socially acceptable: “I know I was a bit absent-minded at the time for personal reasons”; … A challenge for technology is to support people in managing what to share and not to share (and in what form). Basically, technology support for reflection should let you do emotion work also during reflection, supporting you as a participant in the ongoing social process. Technology should not reveal to others the things you would like to hide. There are also things that should not be shared whether the learner cares about privacy (or self or others) or not – this might be a difficult thing for a computerized tool to address, but could partially be solved by mechanisms like checking for the occurrence of person names.

Reconstructing and making sense of work experience is in itself an affective and social process, where emotion regulation is key. A way of regulating emotion during collaborative reflection is to avoid the negative feeling (of self or others) associated with sharing something difficult or embarrassing. A good human facilitator will sometimes push people out of their comfort zone in order to help them learn important things from addressing difficult issues. A facilitator (or a computerized tool!) may for instance have the information that many participants are concerned about an episode or an issue (e.g. having commented on it individually), but without sharing with each other A challenge for technology is to identify situations during a reflection session for which there would be a benefit in prompting more reflection, without e.g. enforcing situations that the participants would find emotionally intolerable or unpleasant.

The fact that certain emotions affect for instance decision-making or creativity, points to a possible role of technology in encouraging certain emotions during a reflection session. This might be done independently of the handling of the actual topics discussed, e.g. by generally promoting a positive and goal-directed attitude. A challenge for technology is to help encourage certain emotions conductive to a good reflection session, adapted to the specific needs and stage of the reflection process.

Applying reflection outcomes to work - Improved emotional competence may be an example of a reflection outcome that occurs as a side effect of reflecting on something else. There may however be concrete stories of successful (or less successful) emotion work or experiences otherwise directly addressing emotion, that others may want to learn from. Taking into account the necessary control of sharing (see above), one challenge for technology is whether to capture and share insights on emotional aspects of work that emerge as a side-effect of reflection on other topics.

Conclusions

In this abstract we discussed the multiples role that emotions play in reflective learning. We also identified high-level challenges that need to be addressed when designing technology for reflective learning in the workplace.

We are currently validating the model with multiple scenarios from different work domains, including nursing and crisis management. As part of our future work we are planning to address the challenges that we described in this paper in the design of specific technology. Our final objective is to define guidelines for the design of tools for reflective learning that account for the multiple role of emotions as object and enabler of reflection.

Acknowledgements

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Guiding Articulation for Learning at Work: A Case of Reflection

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Abstract. In this paper, we present work on implementing articulation support and means for guiding users for integrating collaborative learning and work. We present a case from the MIRROR project, in which we developed and piloted a tool supporting reflection as a means for learning at work. From the insights of this study, we derive a concept of scaffolding which prompts informal learning if the reflection of work practices is not institutionalized.

1 Collaborative Learning and Work: United, yet apart?

Collaborative work and learning have considerable overlaps in terms of methods used to analyze and design learning and work as well as in tools and concepts to support them. This is not grounded in the need for support of group work, but also because (continuous) learning is an integral part of work [1–3].

Despite these overlaps communities such as CSCL, TEL and CSCW still develop tools and concepts in parallel without making systematic use of conceptual overlaps. In this paper, we focus on the challenges of integrating learning and support of collaborative work with respect to articulation and guidance for users:

- **Articulation [4]:** To learn and work together, experiences, knowledge, rationales and perspectives need to be verbalized and exchanged [5].
- **Guidance, scaffolding and awareness:** Both in collaborative learning and work, there has been a lot of research about how to support them and whether this support needs strict guidance, optional scaffolds or just the possibility of mutual awareness for freely controlled coordination [6, 7].

The challenge addressed in this paper is how to implement these concepts to *integrate working and learning*, that is, how to embed learning processes meaningfully in the constraints imposed by workplaces and vice versa in order to make learning at work happen. We argue that this has to be done by combining organizational measures and technical means into socio-technical processes. This paper illustrates this argument by presenting a case from support of collaborative reflection as a learning mechanism at work taken from ongoing work in the MIRROR research project.

2 An Example Case: Supporting Collaborative Reflection at Work

Reflection can be understood as a process of informal learning at work [1]. It includes three steps: returning to experiences, re-evaluating them in the light of current knowledge and deriving insights for the future [8]. Although it is also investigated in educational settings, reflection can be considered a common and indispensable part of daily work [3, 9]. While individual reflection is a cognitive process, collaborative reflection combines cognitive and social processes, and needs support for articulating and exchanging experiences as well as various perspectives on the same case, and proposals for changes of work practices [10–12].

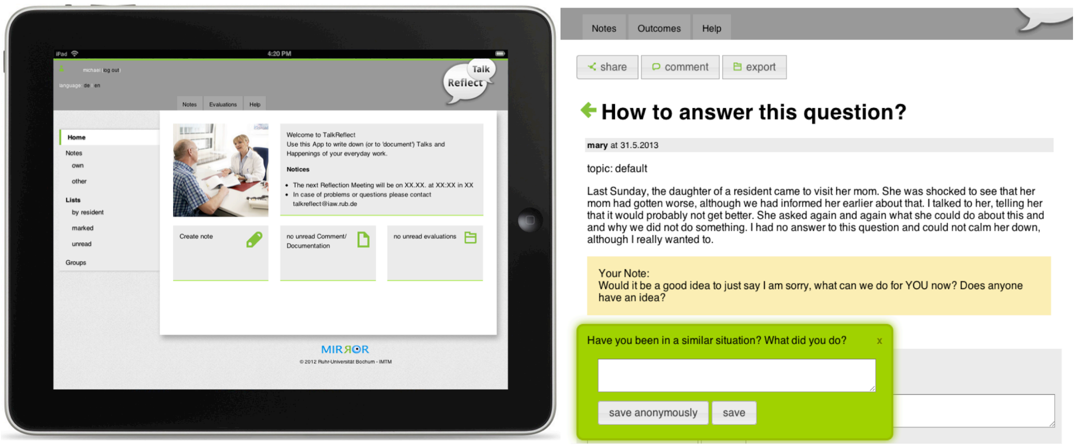

Fig. 1. The Talk Reflection App for collaborative reflection of conversations and interactions.

In our work, we have designed the "Talk Reflection App" [12] as a tool for the collaborative reflection of conversations and other social interaction taking place at work – such situations can be emotionally stressful if, for example, bad news have to be conveyed or conflicts cannot be solved. Dealing professionally with these stressing challenges needs experience with them, an understanding of these situations beyond what can be acquired from training and strategies to conduct them. With the Talk Reflection App, workers can document what has happened in such situations, assess their documented experiences with respect to feelings and other aspects, and they can share them with their colleagues (see **Fig. 1**). Subsequently, colleagues can make comments on each other's' documented experiences. For example, they can propose strategies of how to cope with a stressful conversation or similar situations as well as discuss and agree on certain changes to be made, which are documented in the tool (see Prilla et al. 2012 for more details on the app). This enables workers to reflect together on situations relevant in their work, and to redesign this work according to their needs [13].

3 Structuring Collaborative Learning at Work: Balancing between Scripting and Awareness

The Talk Reflection App pursues the implementation of processes of collaborative learning, which are intertwined with a direct feedback as it is provided by carrying out tasks during work. In particular people can directly realize the effect of changed work practices and make them again a subject of collaborative reflection. However, establishing the usage of the app has to overcome problems with the adoption of the tool and with realizing its potential benefits: In initial pilots, the app was predominantly used for documenting and sharing experiences, while features for collaboration such as comments to exchange understanding and perspectives related to shared experiences and the documentation of outcome to sustain and share results from reflection, were used much less [14]. We attribute this to two constraints of integrating learning and work:

1. Establishing *collaborative learning at work* requires the design and implementation of *socio-technical processes* in which technology can support an evolution of existing practices and communication structures but not replace them. A typical instance of this practices is that documenting experiences and sharing is employed by workers to remember cases and make others aware of them, while a large part of the reflective interaction will happen when people meet each other during work, e.g., in meetings or on the hallway.
2. Reflection is a kind of meta-cognition which is in many cases not initiated by the structure of the task itself, or by a teacher or facilitator. This a clear difference to learning at schools or universities where tasks and problems are designed or introduced to trigger reflection. Since using tools such as the Talk Reflection App is not initiated by the actual work task itself, diverging tendencies can be observed: On the level of their attitude, people generally agree that reflecting with others on past experiences can improve their work practice. However, during daily work routines they usually do not switch from their primary work task to the usage of tools with respect to collaborative reflection and learning. This is especially true for reflection on positive experiences, as such good practice does not produce the pressure for change that problems cause.

We could see these effects when we piloted the Talk Reflection App in practice. For the first constraint, usage data of the app showed a low degree of collaborative reflection on shared content in the app. When we observed meetings among staff and interviewed them, however, we were reported many situations in which they had used content in the app to start reflective conversations and also came up with ideas to change their work. In general, this means that the app already had an impact on reflective practice. However, comments and results are only known to people being physically present during these interactions.

For the second issue, people often reported they did not have the time to use the app or had not known what to write for example in comments. However, we also could observe that when people understood how the app could support their work, they started to use it more frequently. In one case, caregivers in a home for elderly people even used the app frequently for this reason although their manager had only allowed them to do so during their free time, e.g., in breaks and before their shift. The challenge therefore is to motivate people initially to use the app in order to enable them to perceive the value it can have for their work.

To deal with these constraints, we designed a concept of implementing a non-obtrusive guidance –as it is offered via scaffolding [15]– into the socio-technical support of collaborative reflection with the Talk Reflection App. The core mechanism of this scaffold is to display prompts from time to time (with a flexible yet fixed ratio) which actively request actions of the users (e.g., "Did you have a recent conversation? Would you like to document it?") or with questions to be answered (e.g., "Have you been in a similar situation? What did you do?"). The prompts are related to a model of possible processes which consist of core activities such as capturing data, articulation, or individual and collaborative reflection [14]. **Fig. 1** (right) shows a prompt asking for comparable situations if a user looks at an experience documented and shared by a colleague. The displaying of prompts can be adapted to the behavior of the users and to the course of adopting the reflection support: At the beginning, prompting can happen frequently to offer a relatively strict guidance; after a while it can fade out and the triggering of reflection relies on the users' awareness of others' documentation and articulation. Besides supporting reflection in a more contextual manner, this may also avoid people becoming annoyed by too many prompts. A central question in upcoming work on intertwining CSCW, CSCL and TEL will have to deal with scaffolds that (partly) replace teachers or facilitators and initiate reflection, giving learning results a sustaining impact on work practice by providing appropriate prompts.

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Mobile Support for Ad Hoc Learning Communities

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Abstract. The creation of user-generated content is an approach which is used to activate learners. This paper presents an approach supporting mobile collaborative use of user-generated e-flashcards within small ad-hoc learning communities. The application of this approach to support cooperative work and workplace learning is discussed too.

Keywords: mobile learning, collaborative learning, e-flashcards, learning communities, workplace learning

1 Introduction

The approach of e-flashcards is mainly related to work on active learning and feedback. Regarding the topic of active learning, such approaches are widely accepted that are based on constructivism and emphasize that active learning deals with own production and discussion of (learning) content [1]. The use of e-flashcards within large university courses was evaluated in [2, 3]. A study of use and acceptance of e-flashcards showed a high positive level of user acceptance according to the user feedback and active learning [3]. But this user acceptance was not reflected in the actual use of e-flashcards during the examination preparation phase. In this phase, learners meet other learners occasionally forming small ad hoc learning communities. Thus, the research question arises how to provide mobile support for small ad hoc learning communities during exam preparation. To gain additional benefit of the offline interaction in the learning process, a mobile learning application should support mobile collaborative learning, especially creation and ad hoc exchange of user-generated content. Therefore, this paper presents an approach to support mobile collaborative learning with e-flashcards within small ad hoc learning communities meeting these requirements.

2 E-Flashcards in University Settings

2.1 Pedagogical Scenario

The e-flashcard approach is based on small content snippets in the sense of Micro-learning (see [4]) and is suitable for learning of facts. Each e-flashcard consists of a question and the related answer page, which can be accessed by a web-based client or a mobile application, so that learning becomes possible anytime and anyplace. The mobile application for ad-hoc collaborative learning picks up the scenario of questioning each other using paper-based flashcards within the co-located ad hoc learning community. For this collaborative task, a Bluetooth-Connection between the mobile devices of the learners is established. One learner, the questioner, requests the answer to the question on his e-flashcard from the other learners. The questioner sees the answer side of the e-flashcard on the mobile device, whereas the question side of the same e-flashcard is presented to the other learners of the learning community (see figure 1). The answers of the other learners are compared with the answer on the flashcard and discussed between the learners. The questioner can send the solution or parts of it, for example a correct match in a fill-in-the-gap question, to the mobile devices of the other learners. If during this communication process new questions arise, a new e-flashcard will be created and sorted into the flashcard-deck. Furthermore, an ad-hoc exchange of e-flashcards between the mobile devices of the learners is possible by using the Bluetooth-Connection or utilizing NFC-tags.

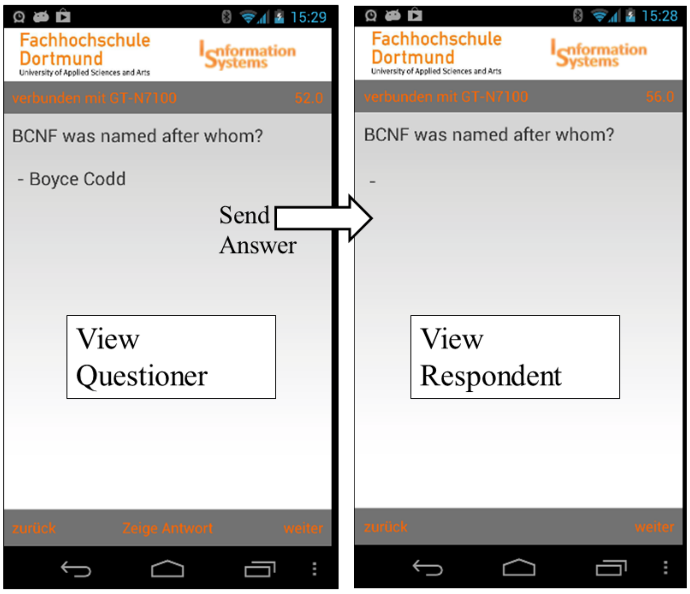

Fig. 1. Screenshot of the mobile application

2.2 System Architecture

Figure 2 shows the rough architecture of the e-flashcard system. The web server application supports the use and the creation of e-flashcards and maintains the e-flashcard pool. To enable a user-friendly, offline mobile learning with the e-flashcards, a native Android application was developed [5]. The learner subscribes lessons to determine the e-flashcards to be used on the mobile device. These subscribed e-flashcards are replicated in in a SQLite database [6] on the mobile device. To support additional ad-hoc collaborative learning with e-flashcards, this server-client architecture was enhanced with a P2P-network between the mobile clients.

Because an internet access of the mobile phones of the learners in ad-hoc collaboration settings could not be taken for granted, the Bluetooth protocol was used to establish the ad-hoc P2P-network. Zhang et al. [7] showed for example, that various mobile devices could be connected by Bluetooth to provide an ad-hoc 1:n communication channel between teacher and course members for feedback and learning progress monitoring.

To ease this connection process for the learners, NFC-capable devices are connected by touching the devices utilizing the NFC protocol (named Android "Beam" [5]) to transmit the Bluetooth-Connection data (port, MAC-address). This is applicable for the Android operating system 4.0 and above, whereas all other mobile devices still have to undergo the Bluetooth pairing process. On the mobile device ad-hoc created e-flashcards are stored in the SQLite database and can be stored on NFC tags additionally. When the connection to the e-flashcard server is (re)established, these ad-hoc created e-flashcards can be uploaded to the e-flashcard-pool.

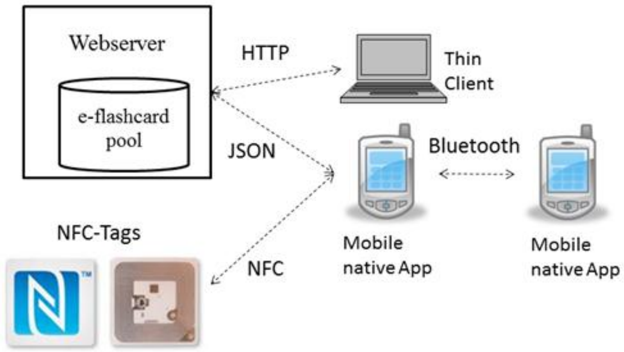

Fig 2. Architecture overview

2.3 First Experiences and future work

A case-study was carried out in a classroom setting at a vocational school for commerce in February 2013. The test group consisted of 16 students (14 male, 2 female), who were preparing for the A-level examination in the subject business economics. At first the test group created 44 e-flashcards and worked with the mobile cooperative

application in small peer groups of 2 or 3 learners. In the follow-up interview the learners indicated their acceptance to work together by means of the mobile application.
In order to increase motivation and fun of the users future work addresses the idea to add gamification-elements to e-flashcards platform (e.g. a competitive card game) to investigate whether this is a means to enhance the tool's use by the learners and to study cooperation within ad hoc learning communities.

3 Relevance for cooperative work and workplace learning

The approach of e-flashcards and its cooperative usage have the potential to support (collaborative) learning of facts even in companies. Therefore, various mobile e-flashcard applications are available, see for example [8, 9]. Due to the NFC and Bluetooth connection between the mobile devices the collaboration within these ad hoc learning communities collaboration is possible even if WiFi-connection is protected due to security reasons. From our point of view learning or internalization of facts is necessary even though knowledge platforms are widely used to store knowledge about facts. Internalized facts are especially necessary at workplaces handling time-critical situations, for example flight control, medical care or fire service. In these situations searching of facts in knowledge management situations is too time-intensive. As an example, Sonne et al. [10] reported on a question-based mobile learning application focusing privacy protection and data security developed for an airline.

E-flashcards could be used to enhance the internalization of facts and should be therefore integrated in work processes. Such opportunities occur whenever people come together to spend some time, have fun or meet for learning, for example during on-call duty or travel time. With this contribution we would like to brainstorm possible further tool's use cases and start a discussion about these and more potentials of the e-flashcards-approach for CSCW.

Acknowledgement

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Designing Learning Environments Based on Collaborative Content Creation

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Abstract. One of the approaches how to support collaboration during formal or informal learning is application of concepts which have been successfully verified in different domains. Especially various web-based knowledge sharing applications have been applied as a model for designing learning environments so far (e.g. social networking sites or forums). However, these applications miss important features which are essential for education, such as learning process management or learners' reflection and awareness. In this paper, we specifically investigate how concepts of content creation systems can be adapted to support effective learning. We describe implementation of a web-based system called PopCorm which is dedicated to learning by synchronous collaborative task solving. Stated design decisions are supposed to help in further research how to adapt concepts of various systems for purpose of learning.

Keywords: CSCL, Collaboration, Knowledge sharing

1 Introduction

Knowledge management always played an important role in various types of communities and organizations. Well-managed knowledge represents a critical factor in competitive advantage and thus the organizations are highly motivated to pay appropriate attention to its continuous creation, sharing and refinement. Especially knowledge sharing is considered as a crucial process in which knowledge is exchanged among members of particular organization or community. The process of collaborative knowledge sharing has recently significantly changed with the rapid expansion of various Web 2.0 applications and services [2].

Knowledge sharing applications based on Web 2.0 principles include wikis, forums, social networking sites, content creation tools (e.g. Google Docs) or community question answering systems (e.g. Yahoo! Answers). As the popularity of these applications was increasing, they became the subject of interest in educational domain, too. Especially wikis and forums are extensively used to support learners' collaboration. However, these applications were not designed and developed for purpose of effective formal nor informal learning. Therefore, it is difficult or sometimes even impossible to employ directly these systems to support learning [1]. There are many reasons for this discrepancy, such as instructors can lack the features for organization and management of learning process or for monitoring of current state of learners' collaboration. Moreover, learners can miss the appropriate awareness tools for their self-regulation and motivation. Some partial solutions have been proposed to address these problems so far (e.g. learning analytics). However, providing learners and instructors with full educational support requires more complex design solutions. Therefore, we investigate how to employ the concepts of popular web-based knowledge sharing applications to design effective learning environments, which are specifically aimed at collaborative learning. Our design is based on experiences gathered during developing and using a collaborative environment PopCorm for non-controlled learning as a supplement to the university course.

2 Related work

Learning systems should consist of tools dedicated to five categories of high-level functions [3]: (i) for dialogue and action; (ii) for workspace awareness; (iii) for supporting students' self-regulation or guidance; (iv) for teachers' assistance; and finally (v) for community level management. However, existing web-based systems for knowledge sharing provide none or only few of them. Therefore, specific studies are concerned how to connect principles of these systems with the appropriate functions for effective learning.

Authors in [1] investigated how to meet the needs of students and instructors while providing them with the possibilities of social networking sites. Learning environment *Classroom Salon* was proposed in which the collaboration takes place in small groups termed Salons. Each Salon can be open to the entire community or only to a particular subgroup. Students can use these Salons to post various documents, such as a piece of text, a program or a series of questions. Additionally, it is possible to annotate or vote on these documents. Another important feature is a dashboard which provides students with the statistics about created annotations.

Similarly, authors in [7] created a large-scale learning environment *OpenStudy* based on Web 2.0 technologies, such as online forums, real-time chat and social networking sites. Students are able to create a new topic of discussion, view existing topics or join the current discussion.

While solving some specific well-defined tasks, the main aim of collaboration is to create a valuable content rather than communicate or socialize (as a kind of collaboration which is supported by Classroom Salon or OpenStudy). In this case, it is essential to employ environments which support learning besides collaborative content creation. Therefore, we decided to design such environment and take into consideration concepts of popular content creation tools (e.g. Google Docs).

3 Learning Environment PopCorm – Design Trade-offs

We created the application named *PopCorm* (Popular Collaborative Platform) which is aimed to support formal as well as informal learning and simultaneously take advantage of popular concepts of content creation systems. PopCorm supports content in three different representations: free text, graphical diagrams and lists of items. Corresponding interaction tools were proposed to support each of these representations: a text editor, a graphical editor and a categorizer (see Figure 1). Another important element is a mean for learners' communication. Except collaborative content tools, we provide learners with a discussion which is a generic communication tool independent of a particular type of a task being solved. Learners can use this discussion anytime during task's solving to exchange messages related to the created content.

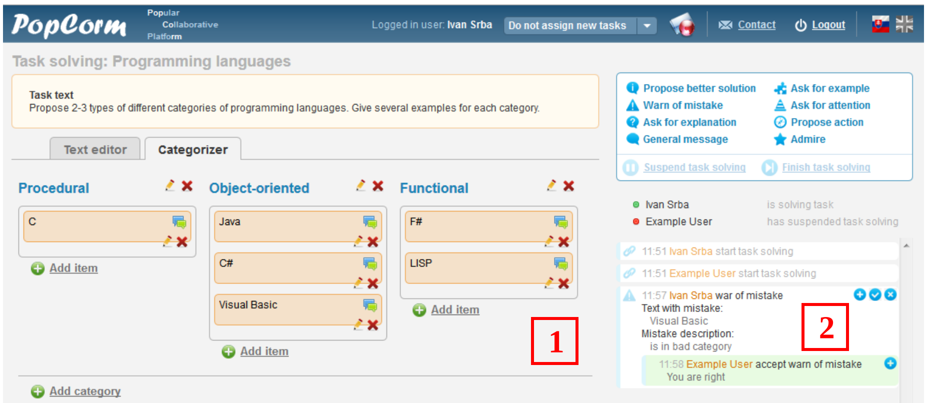

Fig. 1. Screenshot from the collaboration platform PopCorm; the categorizer tool (1) and semi-structured discussion (2) is displayed. The categorizer is a special tool developed for solving tasks the solution of which consists of one or more lists.

We describe PopCorm and our design decisions through trade-offs adopted from [3].

The Trade-off between Free and Structured Dialogue. Learners' communication in the discussion tool is partially structured by employing well-known approach of sentence openers. Groups, in which learners communicate via structured interface, show more intensive orientation on task solving in comparison with groups, in which members communicate via unstructured interface [4]. On the other hand, strictly structured communication interface can negatively influence collaboration [5]. Especially in the case that learners want to write a message which cannot be classified into any of predefined types of messages. Thus we decided to design a semi-structured interface which provides 18 different types of messages (e.g. propose a better solution or ask for an explanation) which include also general message type and comment which can be used to post any content. These special types of free messages solve the problem with the strictly structured communication interface.

The Trade-off between Parallel and Embedded Tools. We decided to embed the discussion directly to all interaction tools. Learners can take advantage of this integration and select particular text from editors and post a new message in the discussion with the connection on the selected text. This solution enables fast and effective referencing on the created content. Additionally, the communication about the content is still compactly recorded in the discussion and it is not split in the numerous annotations strewn all over the content. On the other hand, the implementation of embedded tools can be difficult depending on the purpose and the design of particular tools.

The Trade-off Related to the Coordination of Action and Dialogue. The design and implementation of PopCorm allows users to collaborate simultaneously without any restriction. All performed actions are synchronized among all group members in real-time and with resolution of possible conflicts. It means that learners can collaborate really effectively at the same piece of text or drawing at the same time similarly as it is possible in content creation systems. This scenario is quite uncommon in standard learning systems which usually support only asynchronous collaboration.

The Trade-off between Self-Regulation and Teacher Support. Introduction of the structured interface plays the important role in our design because different message types allow us to automatically identify student's activities. Afterwards, we are able to analyze and evaluate learners' interaction. As soon as the group finishes the task solution, learners are presented with the statistics about their collaboration. The automatically calculated evaluation is important not only for learners but also for instructors who can monitor learners' performance and take actions if necessary.

4 Supported Collaboration Scenarios

Design of PopCorm was proposed in the way which supports different kinds of collaboration scenarios in formal or informal learning settings. In formal learning settings, students can collaborate on short-term tasks which supplement learning materials provided by the particular course. These tasks can be prepared by a teacher who plays the role of the instructor. A teacher can monitor students' collaboration by the provided statistics and even by observing the currently created content in real-time.

In informal learning, members of different communities (e.g. workplace teams, communities of practice) can collaborate on tasks which support their involvement in their organizations. Examples are solving of problems learners run into during their work, human resources trainings or even team building activities. In this case, the role of the instructor can be represented by a manager, a supervisor or a team leader.

Evaluation. We evaluated PopCorm in formal learning settings as a part of the education process within the course Principles of Software Engineering at Faculty of Informatics and Information Technology, Slovak University of Technology in Bratislava. PopCorm was used as a supplement to learning management system ALEF [8]. Totally 106 students participated in the long-term experiment. Learners were repeatedly assigned to 254 dynamic short-term study groups by a method based on Group Technology approach [8]. Each group solved one of 69 short tasks prepared by a teacher. Totally 3,763 messages in the semi-structured discussion were recorded.

During the experiment, learners perceived collaborative learning in PopCorm as an interesting and unconventional way of education. Students expressed positive feedback to their movement from individual learning to collaborative one. In addition, they showed interest in the questions about how the proposed platform works. Last but not least, we received a lot of proposals how to enhance collaborative learning. The part of these improvements has been already implemented.

5 Conclusion and Future Work

Concepts of many popular Web 2.0 knowledge sharing applications have been applied in the educational domain so far, such as forums or social networking sites. While these concepts support mainly communication and socialization between learners, we focused specifically on adaptation of verified principles of content creation systems. Our web-based application PopCorm provides learners and instructors all features, which are necessary for effective and successful learning, while the main mean for learning is the content collaboratively created by learners. The evaluation of the proposed application design confirmed the success of this approach to creating innovative learning environments. In the future, we plan to investigate how concepts of recently very popular Community Question Answering systems (e.g. Yahoo! Answers or Stack Overflow) can be employed to support formal and informal learning.

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A Sensemaking Interface for Doctors' Learning at Work: A Co-Design Study Using a Paper Prototype

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Abstract. In the process of everyday work, medical doctors usually have no time for reflecting, organizing and making sense of information that reflects valuable informal learning experiences. In this paper we propose a prototype that supports retrieval from episodic memory of informal experiences and sensemaking in semantic memory. A paper prototype was used in several co-design sessions with healthcare professionals to validate the idea.

Keywords: Workplace Learning, Sensemaking, Health Care

1 Introduction

While the importance of learning at the workplace and the significance of informal learning in this process have been stressed by many, there exists a dilemma. Because of the ever increasing economic and time pressures that today's workforce is subjected to, there is less and less time to reflect and learn about experiences that have been made in the workplace. For example, as economic pressures on the Health Care System have proliferated, the workload of general practitioners (GP) in the UK has dramatically increased over the past years. Nowadays a doctor sees more than 30 patients (for 10 minute consultations) on a typical day as well as undertaking home visits. In addition, she is dealing with administrative issues, and has therefore only limited opportunity to reflect on and learn from the experiences encountered during the day.

On the other hand, there is a wealth of informal learning opportunity in this working day, such as experiencing "Patient Unmet Needs" that then lead to "Doctor's Educational Needs", or performing reviews of significant events. Significant amounts of informal discussions with colleagues about individual cases can also be observed. GPs can submit a record of their informal learning experience in the appraisal process, which is required for their re-validation. However, due to the aforementioned time pressures, there is a risk that a lot of the valuable experiences get lost, if they are not remembered or reflected upon.

We created a sensemaking interface to support retrieval from episodic memory of informal experiences and sensemaking in semantic memory. A paper prototype was created in an early design stage to test our assumptions with healthcare professionals.

2 Supporting Sensemaking in Informal Learning

We see the task of remembering and making use of informal learning experiences as a memory retrieval and sensemaking task. Informal learning is episodic in nature, meaning that episodes of learning experiences are distributed over working time, and stored in episodic memory. Making sense of these experiences then involves a process of mental categorization and connecting it to other experiences which happens in semantic memory [17].

Tools to support this task usually cover two main phases: *foraging* (information seeking, finding, and collecting), and *sensemaking* (building representations and interpreting information) [1]. In Healthcare, tools now emerge that help GPs during information foraging by keeping track of their informal experiences to facilitate showing evidence of learning for their appraisal process, such as Osmosis[1]. However, available tools lack the support for sensemaking. Sensemaking support, on the other hand, can be found in systems for information collecting and categorizing [2,3,4], systems for visual information seeking [5,6,7], information visualization [8,9,10], making sense of large networks [11,12,13], and collaborative sensemaking [14,15,16]. However, these do not focus on retrieving experiences from episodic memory.

3 A Design for Supporting Memory Retrieval and Sensemaking

To effectively support both foraging from individual experience and sensemaking, the main support mechanisms in the two memory systems, episodic and semantic, need to be considered. First, to access past episodes from memory, a retrieval process uses cues, such as the time or location of the episode. Hence, these contextual cues need to be represented in the interface. Second, categorization and enrichment then happen in semantic memory in which the episodes are connected to meaningful categories and other episodes. A support for this sensemaking process needs to provide flexible ways to group, categorize and enrich the episodes.

In Fig. 1, a general architecture of the design is presented. The system consists of two main canvases arranged vertically. The upper canvas is intended for representing collected informal experiences. These are represented by icons that symbolize information that was collected in a learning episode, such as a picture that was taken, a URL that was discovered, a textual or audio note that was taken or a conversation that was held with a colleague. The collected information does not capture the entire learning experience but rather provides cues that allow the person to retrieve the episode from episodic memory to make sense of it at a later stage.

The lower canvas is intended to support semantic memory, by means of sensemaking and organization of resources in some meaningful way. Icons can be dragged and dropped between both canvases, however a main moving direction is top-down. The lower part then gives different ways to physically manipulate the icons by sorting, organizing or grouping.

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[1] http://osmosis.me

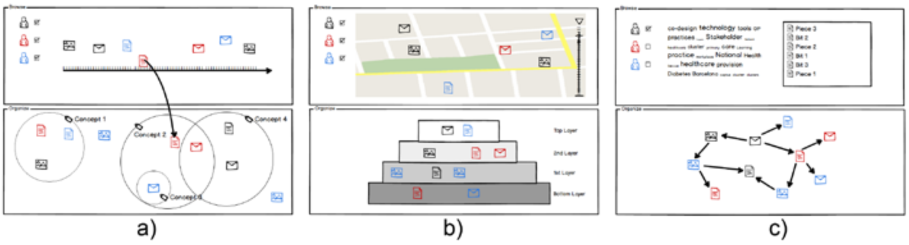

Fig. 1. The Browse (top) and Organize (bottom) canvas and alternative representations (a-c)

Both upper and lower canvases work as containers, which can be flexibly switched between different ways of visualizations (a-c in Fig. 1). The upper canvas (Browse) shows alternative cues that are important in memory retrieval, such as time, location, topic or person. In (a), users browse resources by the time when they were collected by shifting a timeline (*time*). In (b), users browse resources in a map that is arranged by the places where they were collected (*location).* Finally, (c) allows for accessing resources by using tags as filters (*topic*). Moreover, *persons* are included in each view by means of a checkboxes that allow the user to filter resources shared by other users.

In the lower canvas (Organize), users can arrange icons using round areas that represent specific categories (a). Placing a resource into a ring assigns a tag to this resource. By intersecting and placing rings inside each other, complex data structures can be built. In (b) a layered model is presented, which allows arranging resources according to different levels of abstraction. In the last example (c), information is organized into a concept map.

4 Participatory Co-design Using a Paper Prototype

Following a design research strategy, previously we have collected evidence through ethnographic studies, the use of personas etc. Here we particularly focus on testing assumptions on the general architecture of the design. Because physical manipulation is a key feature of the design, we employed a paper prototype (as shown in Fig 1) in which paper icons that represent collected information during learning episodes can be manipulated (moved, categorized etc.).

A series of co-design meetings have been held with clinical staff from two medical practices: 2 GPs and 2 Diabetic Specialist Nurses (DSN) and 2 Health Care Assistants (HCA). Participants were given an introduction to the tools and using the paper prototype, could then explore the idea imagining their own collected experiences within this interface. This allowed us to explore potential usage scenarios and questions regarding the users' perception and motivation to use the tools, perceived gaps and desirable additional functionality.

The paper prototype has been used in a series of co-design meetings over several months in order to generate and validate initial ideas and discuss their suitability for the professional's working context as well as obtaining user input into the ongoing designs and use cases.

Overall participants felt that the tool could work well for them, providing them with one place in which to record, develop and share both informal learning experiences (an individual focused use case) and important formal documents (an organizational focused use case).

Functionality that they considered to be particularly useful included the *timeline view*, the *collections visualization*, the *tag cloud* view and the *links* view. They saw the tool as offering support at both an *individual* and *organizational* level. So whilst it was important to them to be able to create their own collections, they also felt it would be useful to have standard collection labels (e.g. collections based on the revalidation/appraisal categories and/or collection sets agreed across their organisation). This was also important when considering the *tag clouds*, as they felt this view could help them identify common or important themes both within their own material and also across the organisation if the tag clouds were shared.

However, the participants thought there would be a risk that they would use the system to move and sort material but would not do anything else with the material. For this reason they suggested that one should be prompted to identify actions/tasks for themselves (and colleagues) related to the material/bits they are working with. Also related to prompting and showing development and progress, they thought they would like to use the links in the Links View to present their learning path and the actions they took during their sensemaking phase. Being able to export these learning paths and collections, so they could be included as evidence of learning in the appraisal process, was also important to them.

5 Conclusion

From the initial feedback, we conclude that the general architecture of the interface is perceived to be effective. During retrieval, Healthcare professionals rely on time and topic cues rather than location cues. Their suggestion for reminders also suggests that memory processes offer a suitable conceptualization for their informal learning needs.

Of course, the meetings were merely the first part of a much longer process and the practices who are involved in the co-design work will also be working with us to integrate the tools and pilot them.

We are starting to investigate the important collaborative aspects which have come out from the initial feedback, such as providing agreed categories and structures, visualizing tags others have used and sharing material and sensemaking tasks with colleagues. This can augment the development of meaningful representation of information [1], and we will particularly focus on how this collective knowledge influences individual sensemaking [18].

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