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Information Systems Design for Expansive Learning: A Novel Approach for Mobile Collaborative Problem Solving

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Introduction

The emergence of globally distributed teams allied to the evolution of mobile and ubiquitous technologies has allowed a considerable increase of mobile knowledge workers (MKWs). These professionals perform the majority of their working hours on the move (Bosch-Sijtsema et al. 2010) for knowledge intensive tasks (Davenport et al. 1996), leading to new skills and abilities, in particular problem-solving skills, increasingly in demand. The percentage of professionals working away from the office increased more than 60% between 2012 and 2015 (McDaniel et al. 2016). However, the mobile way of working restricts individual knowledge workers to interact with each other (Kietzmann et al. 2013). Since knowledge workers need to interact and collaborate with each other to solve complex knowledge intensive problems that cannot always be resolved alone (Davenport et al. 1996), the increase in work that requires mobility has constantly presented new challenges to MKWs in their work practices (Muukkonen et al. 2014). Thus, it is imperative to create an environment that can facilitate knowledge sharing and creation for collaborative problem solving, regardless of time and location. In this line, more studies on how problem solving with knowledge sharing and creation can occur in flexible work environments supported by mobile ICT are needed (Kietzmann et al. 2013).

In this study, the notion of problem solving with knowledge and sharing is based on the psychological literature, in which learning is considered as a collaborative social practice that expands the capabilities of an individual to comprise the capabilities of the group s/he is solving problems with (Engeström 2010). Therefore, to have opportunities to solve problems, and share and create knowledge in this expanded way, it is necessary for MKWs to participate in interaction and collaboration. Working across many locations, MKWs often have to use ICT for interactions and collaboration (Davis 2002). However, our literature review on MKWs suggests that the current studies do not focus on these issues, or solving them with IS design. Instead, the majority of the studies involving mobile workers focus on the acceptance and adoption of mobile technologies by MKWs. To the best of our knowledge, only two studies (Lundin and Magnusson, 2003; Kietzmann et al., 2013) address knowledge sharing and collaborative learning during mobile work, respectively. However, as highlighted by Kietzmann et al. (2013) and Lundin and Magnusson (2003), professionals require support to foster collaboration and learning in this new context of work. Furthermore, there is a need for developing new solutions for MKWs and knowledge of IS design in this context (Palomäki et al. 2014). Our work intends to bridge this gap by addressing the following research question (RQ), regarding both theoretical and practical aspects:

How to design IS for effective collaborative problem solving for mobile knowledge workers?

Theoretical Background

In this research, we use Expansive Learning theory as a theoretical background. This theory, originating from the psychology of human social behavior, explains how humans tend to solve problems and learn naturally, in collaboration with each other, thus expanding the capabilities of an individual to comprise the group s/he is interacting with. Expanded learning takes place in interaction, as a cycle (see Figure 1) and its typical sequence is as follows (Engeström and Sannino, 2010): (1) questioning the existing knowledge; (2) analyzing the situation; (3) modeling the newly found explanatory relationship in some publicly observable and transmittable medium; (4) examining and testing the model; (5) implementing the model; (6) reflecting on and evaluating the process; and (7) consolidating and generalizing the outcomes into a new stable form of practice.

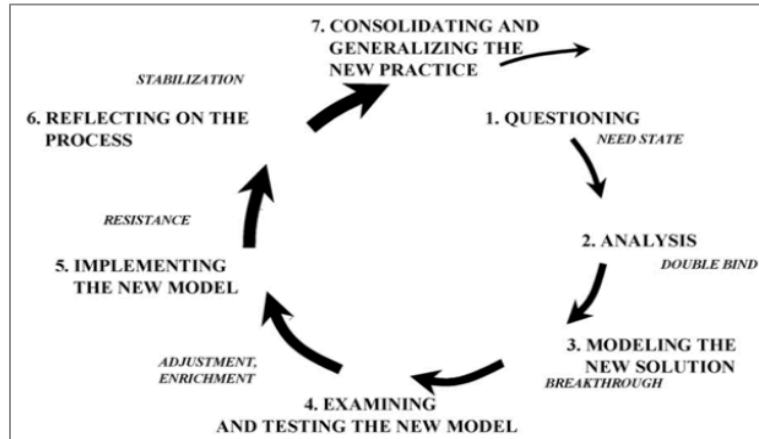


Figure 1. Expansive Learning Cycles (Engeström 2010)

Expansive Learning makes it possible for individuals to solve problems collaboratively, utilizing and building on the knowledge of each other (Engeström and Sannino 2010). Thus it offers a dynamic source of problem solving transcending the capabilities of the individuals taking part in it. This way, Expansive Learning can be highly beneficial for the organization development, improvement, and competitiveness. Both fixed and mobile workers benefit from the activities that promote it, as Expansive Learning facilitates the natural human tendency to solve problems and learn in collaboration with others. Therefore, we address how Expansive Learning can be facilitated with IS design, to benefit MKWs in their problem solving efforts.

Research Method

We adopted the three cycle view of Design Science Research (DSR) proposed by Hevner (2007) (Figure 2).

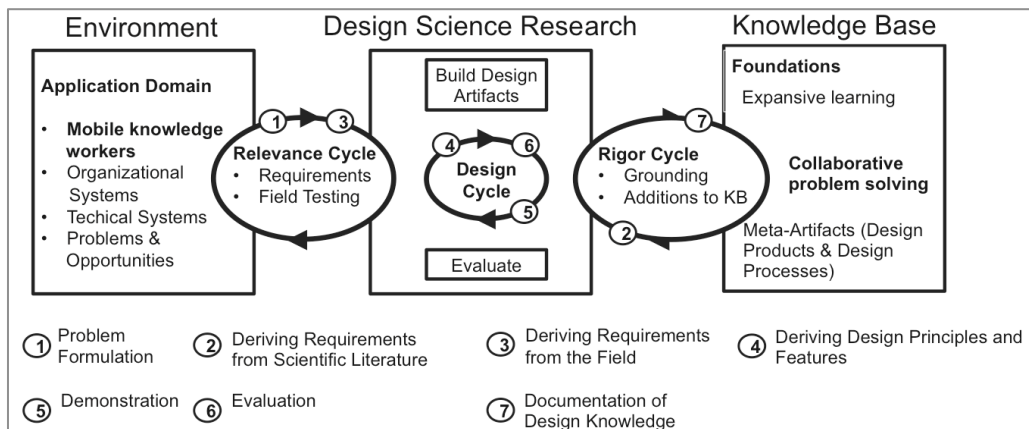


Figure 2. Research methodology adapted from Hevner (2007)

According to the author, DSR involves the construction and testing of a wide range of sociotechnical artifacts such as information systems (IS) applications, methods, strategies, and IS change interventions to generate solutions for practical problems and new knowledge. The created artifact, a re-usable and generalizable design overview, serves as a framework for developing real IS to support mobile collaborative problem solving. As shown in Figure 2, we implement seven steps in the three cycle DSR. The first step, Problem Formulation, is achieved and presented in the form of research question (RQ) formulated based on the problem described in the Introduction. Based on the problem formulation, requirements for artifact design are derived from the scientific literature (*step two*) and observations and interviews (*step three*). In the *step four*, design principles and features are then derived based on the requirements, followed by a demonstration of the designed artifact to the MKWs in the *step five*. During this step, the MKWs use the artifact to collaboratively solve one or more problems. In the *step six*, we observe how well the artifact supports the mobile collaborative problem solving. To refine and improve the artifact, six iterations of steps two-six are performed, before we document the design knowledge.

Data and Analysis

The participant observation was carried out in an IT Company that has been providing IT services outsourcing and consulting for more than 20 years already. The observation involved 39 MKWs at various positions like Relationship, Service, and Project Managers, who worked off-site most of their times. Through both face-to-face and virtual workspaces (Vartiainen 2008), observations were conducted from January 2013 to January 2015. We collected more than 1 GB of digital files, in total, 301 of these files were analyzed. The observation helped to understand the context of MKW and the challenges they have to solve complex problems. Also, to better understand the research problem, a literature review was conducted to define the guidelines for interviews performed with MKWs, either in-person or remotely, at a location chose by the participants. Interviews were timed between 30 minutes and 100 minutes, and were recorded and transcribed for analysis. Overall, 31 MKWs were interviewed. The distribution of the interviewees is as follows: 4 IT Relationship Managers, 6 IT Project/Services/Systems Managers, 8 Business Consultants, 5 Account executives, 1 Chief Marketing Officer, 5 Lecturers, and 2 Lawyers. Of these 31 participants, 25 were male and 6 were female; 7 were age between 20-30 years old, 19 were 30-40, 3 were 40-50 and 2 were over 50; 14 had the mobility alternating between two fixed locations and 17 were working at the three or more places and constantly moving. The analysis of these data was conducted using NVIVO software and the Expansive Learning cycles (Figure 1). The aim of this process of analysis was fundamental to define the goals of the artifact since the user stories from the field were elicited.

Design and Development of the Artifact

The IS artifact created is a re-usable and generalizable design overview that allows the design and implementation of real IS to support collaborative problem solving in the context of mobile workers. From the scientific literature and user stories elicited from the field we derived five (meta-) requirements for design. We then defined three design principles: Ensuring swift trust and intimacy with social media features (**DP1**); Enabling anytime, anywhere access with the mobile IT capabilities (**DP2**); and Stimulating both individual and collective reflection with visuals and knowledge bases (**DP3**). Then, we translated these into the design features of social media timeline (**DF1**), problem self-report (**DF2**), ideas report (**DF3**), interaction features (**DF4**) and analysis tools (**DF5**).

To test the design overview we developed a mobile app, called MobChangeLab. The app allows the creation of a community of MKWs that can also include "fixed" workers, clients or any participant that is relevant to their activities. The interactions inside the app take place on a "social media timeline" (see Figure 3a). Its aim is to create a mirror (an instrument of Expansive Learning) to stimulate MKWs to discuss and encounter solutions to a problem that needs to be solved. All the problems are self-reported by the users and presented to the community (Figure 3b). The app allows participants to discover if the problem reported was already solved by someone in the community and who is this person, and it also allows participants to comment about it and help each other in problem solving. Through this memory, it is possible to find out about the expertise of the participants and to identify who knows what within the group. Sessions of discussions and exchange of ideas on how to solve the problem can be registered in the app, following the steps of the Expansive Learning (Figure 3c). There are also tools for analyzing the data shared inside the app (Figure 3d), regarding the problems and the ideas/solutions reported, for future

analysis. Collaborative analysis of problems and development can be performed and can help to improve or to transform the work practices of MKW.

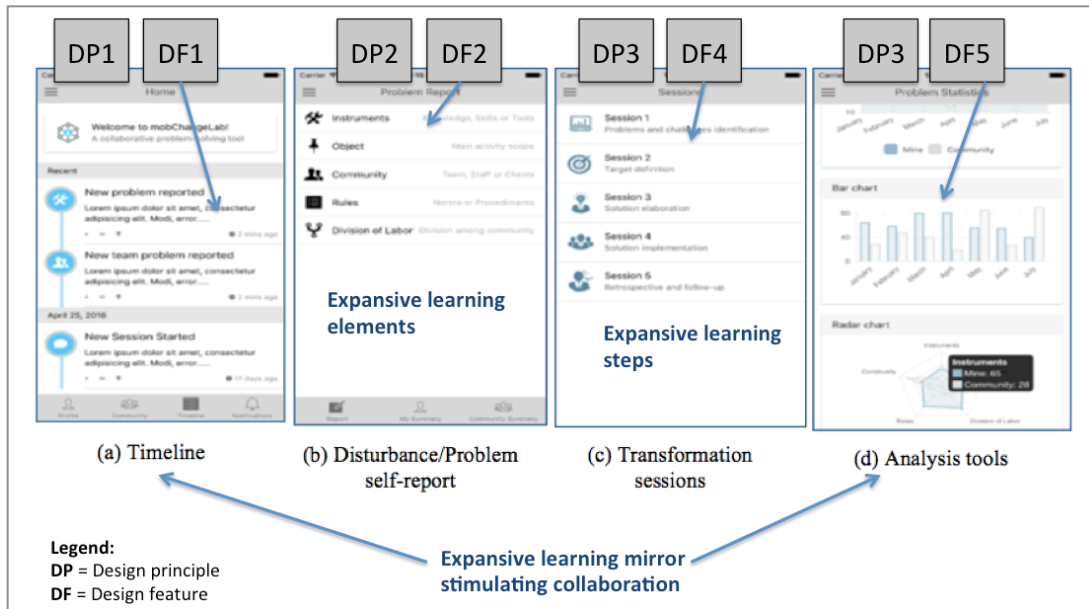


Figure 3. Main Features of the MobChangeLab App (screens)

Demonstration and Evaluation Results

The results of the use of the MobChangeLab, as presented in Figures 4a and 4b, show that more than 50% of the interactions within the app were related to the occurrence of problems already reported by another MKW. This result indicates that are frequently recurrent problems in the context of MKWs, and its problem solving can be supported by the MobChangeLab. Also the results demonstrate that the MKW can address the problems using the app, finding the individuals who can help them, with the app stimulating their collaborative problem solving through the features available in the app.

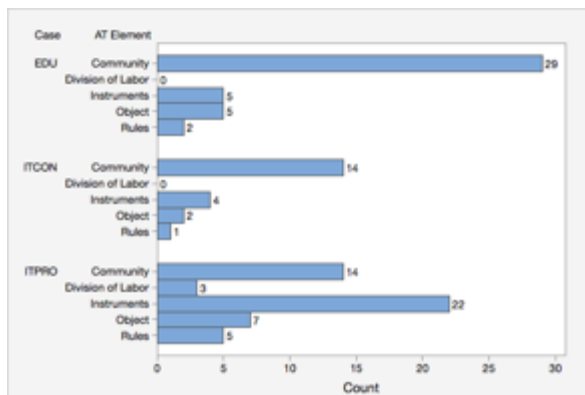


Figure 4a. Problems Reported

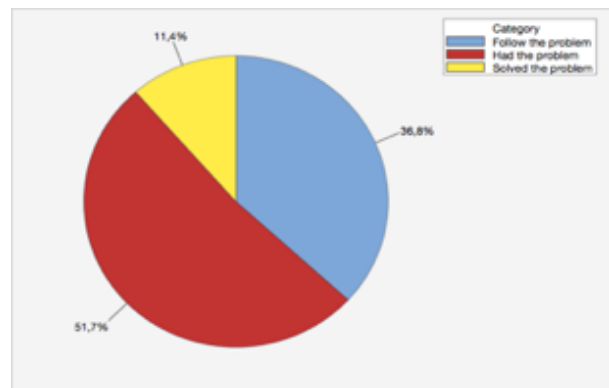


Figure 4b. Problem solving interactions

Discussion and Conclusion

With our results and design overview, we contribute not only to the practice, but also to the scientific literature in IS design. Our contribution aligns with the aim of DSR, which expects efforts in both theoretical aspect and practical aspect (Hevner 2007). Specifically, our contributions are as follows. First, our results indicate that MobChangeLab, the instantiation of the design artifact developed in this research, is useful for MKWs in their daily work. Based on the data obtained from interactions (Figures 4a

and 4b), MKWs used MobChangeLab for their collaborative problem solving. In general, the app elicited positive feedback from MKWs. Second, MKWs stated that MobChangeLab helped them not only to solve their individual problems on the move, but by helping others through its interface, they also gained useful knowledge they did not even anticipate that they needed. This kind of feedback demonstrates how MobChangeLab succeeded in facilitating the Expansive Learning: with the use of MobChangeLab, the knowledge created by MKWs through their collaborative problem solving, transcended the capabilities of the individual participants and led to unanticipated, positive outcomes beyond the problems currently being solved. The ability to such knowledge creation aligns with the Expansive Learning Theory (Engeström and Sannino 2010). In addition, through this way our results demonstrate that, by ingraining Expansive Learning Theory in IS design, we can facilitate MKWs natural tendencies for collaborative problem solving effectively, through which their knowledge can also be enhanced, in general. Third, our results also transcend beyond the context of MKWs. The principles of collaborative problem solving from Expansive Learning Theory we ingrained in our design artifact, apply to human learning in general, regardless of the context. Therefore, our design artifact has the generalizability to be reusable to other contexts where individuals need to solve complex problems on the move, collaboratively. In summary, the implementation of our IS design artifact as MobChangeLab app, has the expected effect in helping MKWs for collaborative problem solving. Therefore, the answer to our research question is that ingraining elements of Expansive Learning Theory in IS design, in the way we present in our design artifact (Figure 3), can facilitate MKWs problem solving on the move. The result highlights our contribution to the knowledge base of IS design by innovatively integrating the Expansive Learning Theory into the DSR, enriching the theory and design principles through implementation, evaluation and improvement.

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