Facilitating maturing of socio-technical patterns through social learning approaches

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ABSTRACT

Pattern-based approaches are becoming increasingly popular to capture design experiences for a wider audience. This rises to particular importance in participatory processes, such as user-driven design approaches. However, the creation process of such patterns is challenging, especially when it comes to motivational, affective and other soft factors. In this paper, we view the pattern development as a knowledge maturing process, i.e., a process of collective knowledge development. We describe the pattern development process, identify barriers in this process, and explain how various social learning approaches, such as peer coaching, social learning programmes (i.e., online courses with a collaborative focus), and reflective instruments in agile processes contribute to the key issue of decontextualizing and recontextualizing experiences in a continuous way.

CCS Concepts

Software Design Engineering, Software and its engineering → Design patterns, Software and its engineering → Software design engineering

Keywords

knowledge maturing process, social learning, design process, design patterns, socio-technical patterns, peer coaching, social learning

1. INTRODUCTION

With the advent of social media approaches and agile development methodologies, software design processes have become much more participatory or even user-driven. Increasingly, non-experts play an important role in these processes. While often neglected, learning from the experiences of similar design problems is the key for improving the quality of such processes. In an environment with fast-moving design and development paradigms, design patterns [1] have found to be a useful way of (i) capturing design experiences in a systematic way, (ii) making experiences accessible beyond the context they have been acquired in, and (iii) establishing a professional language and shared experience base. The key difficulties of pattern-based designs, however, remains the process in which they are created, which often takes long periods of time from a successful solution to an evidence-based pattern. This especially applies to the exchange and collaborative evolution of "good practices".

With the move towards social media in almost every domain, the effect of building more room for appropriation of individuals and for social negotiation processes into tools [2], there is an increasing need for capturing not only technical solutions, but also socio-technical solutions in which soft aspects play a much bigger role, such as motivational and affective aspects. State-of-the-art engineering methods are not geared towards these aspects, so that it has already been identified that this turns the engineering tasks into an art instead of into a predictable discipline that builds upon proven good and best practices [4]. While pattern-based approaches seem to be promising in that respect, too, it has also to be acknowledged that soft factors such as motivation and affective reactions are even more difficult to elicit. They are often "below the surface", individuals are not conscious about them and - particularly with emotions - there is a strong preconception in business environment against admitting (a wide range of) emotions. This shows that even before local good practices can evolve into general patterns, barriers hinder the sharing of and aggregation of individual experiences.

In this paper, we understand the process of developing socio-technical design patterns as a process of developing collective knowledge. We analyze the process with the help of the knowledge maturing model to discover characteristic phases and transition and related barriers (section 3). In a second part, we show how these barriers can be overcome using recently developed social learning tools, such as peer coaching, living documents, and social learning programmes (section 4). In section 5 we have a look at the implications on research project management before concluding in section 6.

2. BACKGROUND

2.1 Pattern and socio-technical patterns

Pioneering research on design patterns has been done in architecture by Christopher Alexander from work on design guidelines in architecture and it "describes a problem which

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occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice"[1]. These architectural design patterns provide a way of structured, abstract, but scalable collection of solutions to problems that may occur more often and support others in not starting from scratch with everything.

Since then, they have been applied in various disciplines, most notably in computer sciences with the groundbreaking book by [3]. They have found to be particularly useful in areas where problems are highly contextualized and solutions need to be adapted to those contextual factors. This implies that creating a "cookbook" would lead to many problem - solution pairs. There patterns help because their usefulness relies on similarity of the actual problem encountered with the generalized problem. In other words, the patterns provide decontextualized descriptions of problem-solution pairs with an explicit description of the traits of context found to be important. Applying such patterns requires to recontextualize the generalized problem and solution with the help of the explicit context of the pattern.

A major success factor for design patterns in the respective fields is the pattern language that describes the structure of patterns. While they do not differ fundamentally, they adapt with specific elements to the context patterns are created in (e.g. architecture with Alexandrian patterns or pedagogical patterns) [7]. The least common denominator of the language is:

- problem,
- solution, and
- evidence.

But usually, more complex forms include more elements, such as: (1) name (driver), (2) thumbnail/ picture, (3) category, (4) abstract, (5) problem, (6) context, (7) analysis, (8) solution(s), (9) diagrammatic representation of solution, (10) value of pattern (express educational values), (11) example, (12) related patterns, (13) references, (14) authors, (15) date and (16) acknowledgements [5].

Socio-technical patterns, e.g., in the technology-enhanced learning field ([6], [7]), are specific design patterns that not only target at technical problems (such as object-oriented design or architectural issues), but also encompass human and social aspects. Such patterns could cover introduction processes of developed solutions (e.g., suggesting participatory approaches), but also gamification approaches to influence motivation to contribute to a social media tool. The basic assumption behind socio-technical patterns is that the underlying problem and solution contains intertwined technical and human aspects. The design solution is a combination of technical functions and appropriation by the social system in which the technical tool is deployed. This encompasses, motivational, affective or social aspects, such as willingness to share and help others, basic needs such as experiencing competence, social relatedness and autonomy [8], or social pressure.

Socio-technical patterns have been found to be much harder to elicit and describe, but crucial for further advancing the engineering of socio-technical solutions [9]. Such aspects are often neglected or not explicitly addressed. Based on the conversations in the MATEL (Motivational and Affective Aspects in Technology-Enhanced Learning) workshop series, the main reasons for that include (i) very high contextual dependencies (both on the individual and the social system), (ii) lack of awareness about these aspects, and (iii) lack of a shared language for discussing about these aspects.

While a lot of contributions exist with respect to actual patterns, little research has been done on the systematic development of patterns from early experiences to well-developed pattern structures.

2.2 Knowledge Maturing

Developing socio-technical patterns is a collective learning process in which problem understanding, possible solutions and evidence for their usefulness are developed and collected by the various stakeholders in a design process.

In this process, based on individual experiences, a shared understanding is developed, and the individual experiences are

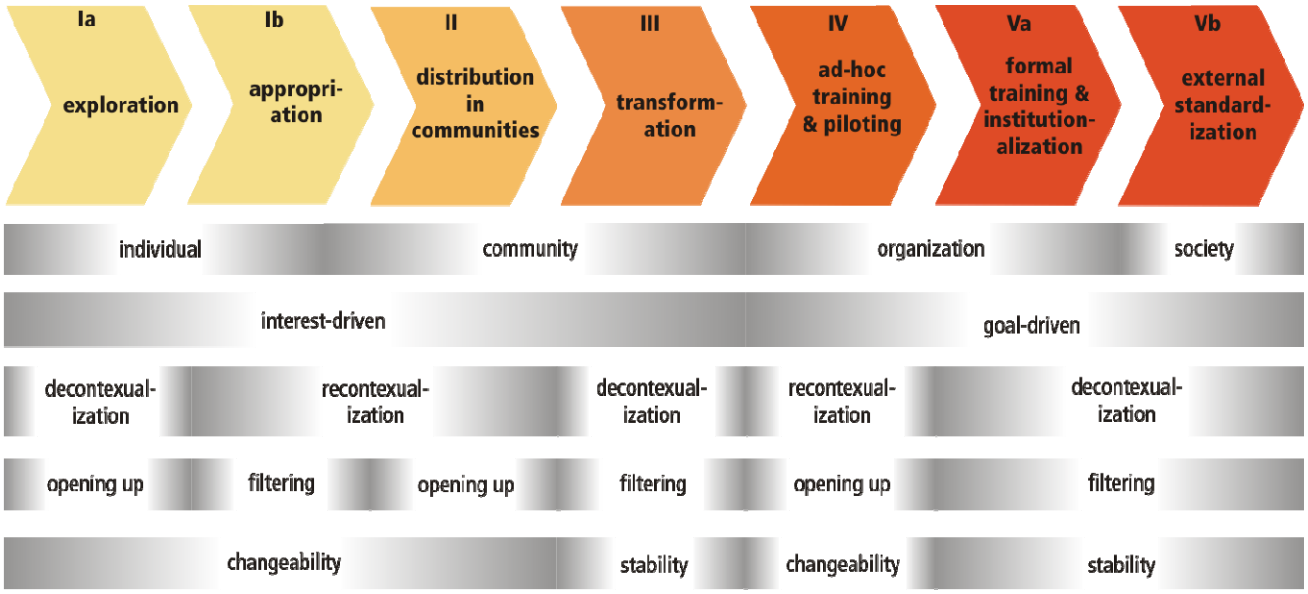

Fig. 1: Knowledge Maturing Process (from [10])

aggregated. This leads to a deepened understanding how problems and solutions options connect. For better understanding collective knowledge process, the knowledge maturing model [10] is used, which has been developed in several contexts and uncovered typical patterns in such a collective knowledge maturing process.

The knowledge maturing phase model (see fig. 1) describes the process of collective knowledge development along distinct phases, from individual-centered exploration and appropriation, via distribution in communities up to institutionalization and standardization. Within each of these phases, knowledge changes its characteristics that determines how to best support it. Examples are:

- The process advances through alternating primary activities that are concentrated on decontextualization (generalizing from a concrete context) or on recontextualizing (learning from applying the generalized form to other contexts).
- Some phases are focused on opening up towards new facts and experiences (such as Ia, II, IV); other phases concentrated on filtering out the relevant ones (such as Ib, III, V).
- Some phases are aimed at stabilizing what has been achieved (for wider dissemination) while others are designed to be open to change.
- Between the phases, characteristic barriers exist. The most prominent ones are between Ib and II (sharing by the individual), II and III (detaching from the originating community), or III and IV (management commitment in companies).

An important element of the knowledge maturing process model is that it distinguishes between artefacts (that represent knowledge) and knowledge. The formality and quality of artefacts and the maturity of knowledge does not necessarily correspond, which creates triggers for reflection [11].

3. ANALYSIS OF PATTERN DEVELOPMENT PROCESS

As outlined above, the development of patterns can be understood as a maturing process of collective knowledge on how to solve a generalized problem. Based on the knowledge maturing model, we analyzed the pattern development process. This was based on expert discussions during the MATEL workshop series [9], experiences with developing educational patterns such as [6], and – especially for the early phases – experiences in the large-scale European research projects EmployID and LAYERS in which design and evaluation activities have been geared towards producing (proto-)patterns. In both projects, a design-based research methodology is used [16], and patterns evolve from early-on problem analysis and interpretation, through various prototyping methods up to evaluation activities that accumulate evidence about the usefulness of solutions.

3.1 Phases of pattern development

From a knowledge maturing perspective, the pattern process can be described in the following phases:

Ia. Individual experiences are gathered, often not even consciously as part of design processes.

Ib. Individual generalizations. As soon as the individual becomes aware certain aspects of connections between problems and solutions (this could happen also through exchange with

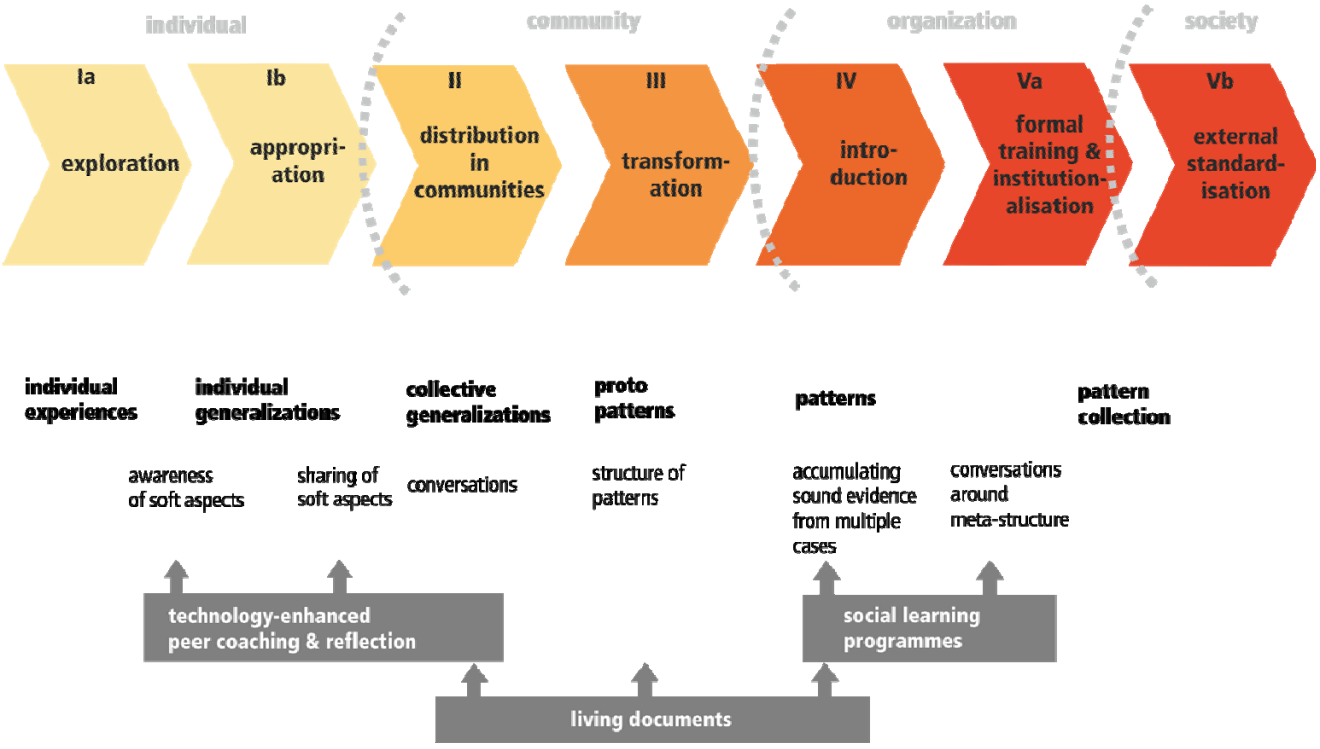

Fig. 2: Pattern development process as a knowledge maturing process

others), the individual starts extracting the relevant aspects and generalizing the problem-solution pair.

II. Collective generalizations. From combining with other experiences, possibly from other contexts, collective generalizations emerge. As part of the conversation, it becomes clearer what the problem was, what the solution was, and what the relevant context conditions were. This does not necessarily get documented, but could be.

III. Proto-patterns. In this phase, the generalizations are described in a structured way. First evidence is added that justify the proposed connection between problem and solution. The pattern language scaffolds this process. Apart from the more structured approach, this corresponds to good practices in knowledge management.

IV. Patterns. With widening the discussion, proto-patterns are further refined and often refactored to accumulate additional evidence from various other sources. The pattern labels provide the seed for a professional language to describe problems and solutions. From a knowledge management perspective, various good practices amalgamate into best practices, again with the difference of a more rigid structure.

V. Pattern collections. With a considerable amount of patterns developed, the conversation shifts towards structuring and better linking the patterns so that a pattern collection emerges that helps to navigate across a larger number of patterns to better find matching patterns for a user of the collection. Furthermore, the language is consolidated and refined. While in Va, such collections are restricted to an organizational context, they become part of curricula for the respective discipline in Vb.

In Fig. 2 the pattern development process is mapped and already related to the above described knowledge maturing model.

3.2 Barriers in the pattern development process

While in theory, the process looks smooth as a gradual refinement of abstractions of experiences, a closer look reveals that barriers hinder such development in many practical cases. These include:

Ia to Ib. A major issue with socio-technical patterns is that becoming aware of these aspects is a prerequisite for any pattern development. This is often not a natural process as motivational aspects are hard to discover: there are often discrepancies between what is given as reasons for not doing something (even in evaluations) and what is the actual root cause. The most striking examples are answers such as “lack of time”, which needs to be translated into “other things have higher priority”.

Ib to II. The sharing of individual generalizations is even harder for soft aspects than for other types of experiences. In many environments, discussing such aspects is not common, and it is not clear how others react to revealing such observations.

II. Conversations are essential to take the process further, but there are often neither organizational spaces nor technical tools to continue with such conversations over longer periods of time.

III. Even if generalized experiences are agreed upon collectively, there is often a lack of structure to do that consistently. It is key that the context is explicitly described and separated from problem and solution.

III to IV and IV. Emerging proto-patterns need to be spread for gathering wider evidence. There is often no forum to spread them and thus no opportunity to find similar findings. Furthermore, evidence is often collected not rigorously enough so that it remains unclear what the contextual dependency of the evidence might be.

IV to V. With an increasing number of patterns, the challenge of finding the right patterns in a large collection arises. To simplify that process, there needs to be a space for developing a meta-structure. This is usually an iterative process and cannot be purely driven by a group of pattern authors, but needs to incorporate experiences from applying the patterns.

3.3 Challenges

Based on this analysis of phases and barriers in the pattern development process, we have identified three major challenges for more effective pattern development:

- **How can we improve the activities of becoming aware of soft aspects and sharing them effectively**? Unless individuals involved in design processes become aware of soft aspects and there effects, we are missing out a crucial element of socio-technical design patterns. We believe that based on the fact that the respective individuals are immersed in the design process (and not just observers), we can make use of peer coaching and other structured methods for stimulating deeper investigation of affective factors. The solution-orientation of peer coaching furthermore helps to contribute not just problems, but problem-solution pairs.
- **How can we improve the creation of a structured**

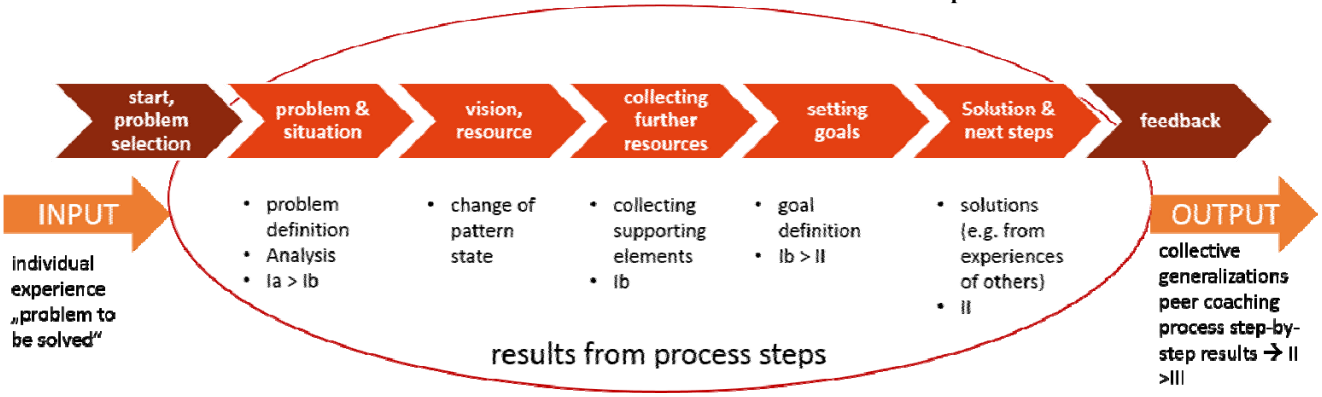

Fig. 3: EmployID peer coaching process with results, adapted from [13]

representations in a conversational space? As pattern development is a highly iterative and collaborative process, it is crucial that we have support for such conversational learning processes. We need to be aware that patterns are at different stages of maturity. Here Living Documents can provide an adequate support mechanism.

- **How can we improve spreading proto-patterns and invite others for larger-scale conversations?** Only in rare cases, pattern development expands beyond a rather local setting with limited evidence base. Spreading initial (proto-) patterns to an interested group is key to a wider reach and broader basis and stimulates conversations. Here, social learning programmes are a promising instrument.

Particularly in the context of research projects, we also need to consider how projects can contribute to the pattern development through their set up.

In the following section, we will present novel approaches to addressing these challenges.

4. SOCIAL LEARNING APPROACHES TO CREATE SOCIO-TECHNICAL PATTERNS

Social learning approaches as we understand them in this paper are technology-enhanced learning approaches that are based on an understanding of learning as an inherently social activity (see also Fig 2). These approaches also have in common that they have effects on both the individual level and the collective level, i.e., they facilitate individual learning and knowledge maturing.

4.1 Technology-enhanced Peer Coaching to facilitate proto-pattern elicitation

As already described earlier coaching could be a starting point for creating a socio-technical pattern. Coaching is a process-oriented method to support a person (a client) to solve his/her problem without being advised. The result of a coaching session would be a proto-pattern with need of bringing the sessions results into a pattern-like structure and revise the session results afterwards. In peer coaching this is even more effectively since there is a large collection of possible solutions after the session that needs to be tested out and evaluated to build a fully socio-technical pattern in the end. Peer coaching is the only form of coaching where a non-professional is doing the coaching and advices can be given by group members in that specific role to find as much as possible solutions for a named problem [12]. There are three roles in EmployID peer coaching: the peer coaching facilitator ("the coach") who moderates the process, the client who has a certain problem and searches for a solution and the other participants (advisors) who support with feedback, questions and advise.

To illustrate this more a recent held peer coaching session will be described in more detail:

As problem the client designated wish for empowered time management to gain time slots without distractions by meetings, phone calls or emails. After analyzing this and describing the whole situation (context) in detail the client is asked to pretend that the problem was already solved. This is also called "change of pattern state" and is main drive for awareness [13]. In our case the client said: "I would feel good, with a high self confidence.". Afterwards resources (strengths, supporting elements) are collected. A specific goal definition supports the solution finding process which emerges from other peer coaching participants' collection of possible solutions that may result from their own experiences. Afterwards the client is choosing for solutions and is planning his/her next steps. In the case of our example, possible solutions were among other things to list tasks of the week on the previous Sunday night before and block two time slots (morning or afternoon) during the week that are handled like fixed meeting appointments. Now the problem, the context and the solutions are clear, but there is no abstraction yet and no evidence for the found solutions. Even for solutions that come from other participants' experience the evidence might not be sufficient for creating a pattern.

Peer coaching is particularly useful for pattern development:

- While usually good practices are collected from debriefings or similar events, peer coaching does not only take place at the end of phases or projects, but when hot topics that are of personal relevance occur. These are typically particularly challenging situations that are relevant candidates for patterns.
- During the peer coaching session, the advisers not only accumulate advice in terms of possible solutions, they also become aware of similar problems in their own context (which they might not have recognized) and engaged in connecting problems with solutions. This is an important prerequisite for collective generalizations. Even more, if the advisers have already made experiences, this advances the generalization process, especially if this is supported by a summarizing documentation.
- The structured peer coaching process (as opposed to more free-form) promotes solution-orientation and ensures deeper investigation including affective aspects of the individual.
- As part of the peer coaching session, the client is facilitated to decontextualize his problem, the advisers suggest decontextualized solution opportunities, and within the session, this is recontextualized for a concrete solution plan. This promotes the advancement of along the knowledge maturing process.

Key to supporting a continuous maturing processing which individual experiences get transformed into reusable patterns is that we provide means of overcoming disruptions in the process. While peer coaching sessions can provide useful outcomes for the individual (even without technology support), it is crucial to support the transition to the collective level. Within EmployID, a peer coaching tool has been designed based on a series of experiments that consists of three conceptual elements: (i) an interactive chat for discussing among the participants, (ii) a summary document created during the session that form the basis for further elaboration of the topic after the peer coaching session (which is connected to the Living Documents system in the following section), and (iii) a structured process and related instructions and moderation tools.

4.2 Living Documents for facilitating collaborative documentation of patterns

Living Documents [16] is a web-based system for collaborative developing documents. It is especially geared towards facilitating (i) conversations around documents in a dynamic way and (ii) creation of stable documents that correspond to a knowledge

maturing process. It consists of a real-time editor, support for commenting and discussions, and cues for the maturity of the document. Particularly the latter make it an ideal conversational space in which early experiences (as part of conversations) and patterns can co-exist without blurring the distinction between different levels of support for a pattern.

In the context of this paper, the system promotes the transition from peer coaching session minutes into proto-patterns. This involves further conversations to continue with amalgamating experiences from others and the results of applying the plan from the peer coaching sessions. Furthermore, it has to be noted that as part of this transformation, the group needs to agree on how to deal with potentially confidential details.

4.3 Social Learning Programmes

With the hype of MOOCs, open spaces have become popular in which prepared instructional material is combined with spaces for social exchange among the participant that significantly contributes to the learning experience. As part of EmployID, it has been explored how such forms of learning contribute to collective learning processes (in the case: professional identity development). This can be transferred into pattern development.

Proto-patterns are presented to a forum, such as a community of interest, and others can join the conversation and contribute their experiences. The prepared proto-patterns act as a trigger and catalyst for sharing more experiences. The combination of the different experiences and integration with existing proto-patterns (and possible refactoring) can happen through the living documents system.

5. RESEARCH PROJECT MANAGEMENT AND PATTERN DEVELOPMENT

Apart from describing problem and solutions at an appropriate level of abstraction, most effort in the pattern development process is related to accumulating sound evidence about the pairing of problem and solutions in a specific context. While in practice, the overhead of sound evaluation is often neglected, research project provide an ideal environment as evaluation activities are an integral part of the planned work.

Furthermore, research projects need a vehicle for making their results transferrable. While this works well for theoretical and conceptual results, this is much harder for design results beyond the (ephemeral) actual tool implementations, which is a major obstacle for design-based research approaches such as [15]. Patterns provide an excellent way for that. However, the project activities needs to be geared towards producing these kind of results from an early project phase.

As part of EmployID, we have developed an approach that is – similar to patterns – based on narratives: learning scenarios [14]. In early phases of the project (such as the initial investigation phase), these narratives act as boundary objects between different perspectives in a collaborative research project (see Fig. 4): they describe the contextual need of users ("initial situation"), the interpretation of the situation through a theoretical lens ("learning challenges"), design options and ideas ("proposed solutions") and an anchor for evaluation ("evidence"). This already corresponds to the basic structure of a pattern: problem = initial situation and interpretation (which is a first decontextualization step), proposed solution, and evidence. Through iterative refinement their structure will evolve.

Peer coaching group activities and other instruments stimulating reflection have helped to create a deep understanding and a sense of ownership of the scenarios. Overall, learning scenarios have been used and found to be a very useful tool to improve the communication and understanding. They allow for both user-push and technology-push approaches to meet in a middle ground. They now evolve into a framework for evaluation where one of the major goals is to produce evidence for patterns, which are not just tools, but bundles of problems, interpretations and their socio-technical solution.

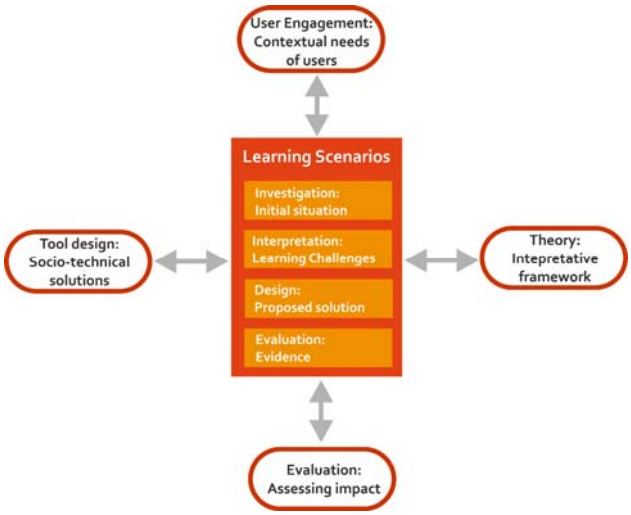

Fig 4. Learning scenarios as a boundary object for pattern-oriented collaborative research activities (from [14])

6. CONCLUSIONS AND OUTLOOK

The paper has presented an analysis of a pattern development process for socio-technical patterns through the lens of the knowledge maturing model, which has been developed as a tool for collective knowledge processes. This has uncovered the various stages of the process and highlighted the barriers in this process.

Based on this analysis, three novel approaches supporting social learning have been presented that address these barriers: technology-enhanced peer coaching, living documents, and social learning programmes. This is particularly suited to workplace learning where the more structured process of patterns can enhance best practice development.

Finally, it has been outlined how learning scenarios, as narrative boundary objects can help research projects to produce useful outcomes for enhancing socio-technical pattern development.

Overall, the developmental view appears to be a useful new perspective on the topic of design patterns instead of the predominant outcome-oriented perspective. It can help to development a better knowledge management for design processes.

Further discussions and developments based on these insights will be pursued - among other things - in MATEL workshop series (http://matel.professional-learning.eu) and within the further design activities of the EmployID project.

7. ACKNOWLEDGMENTS

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