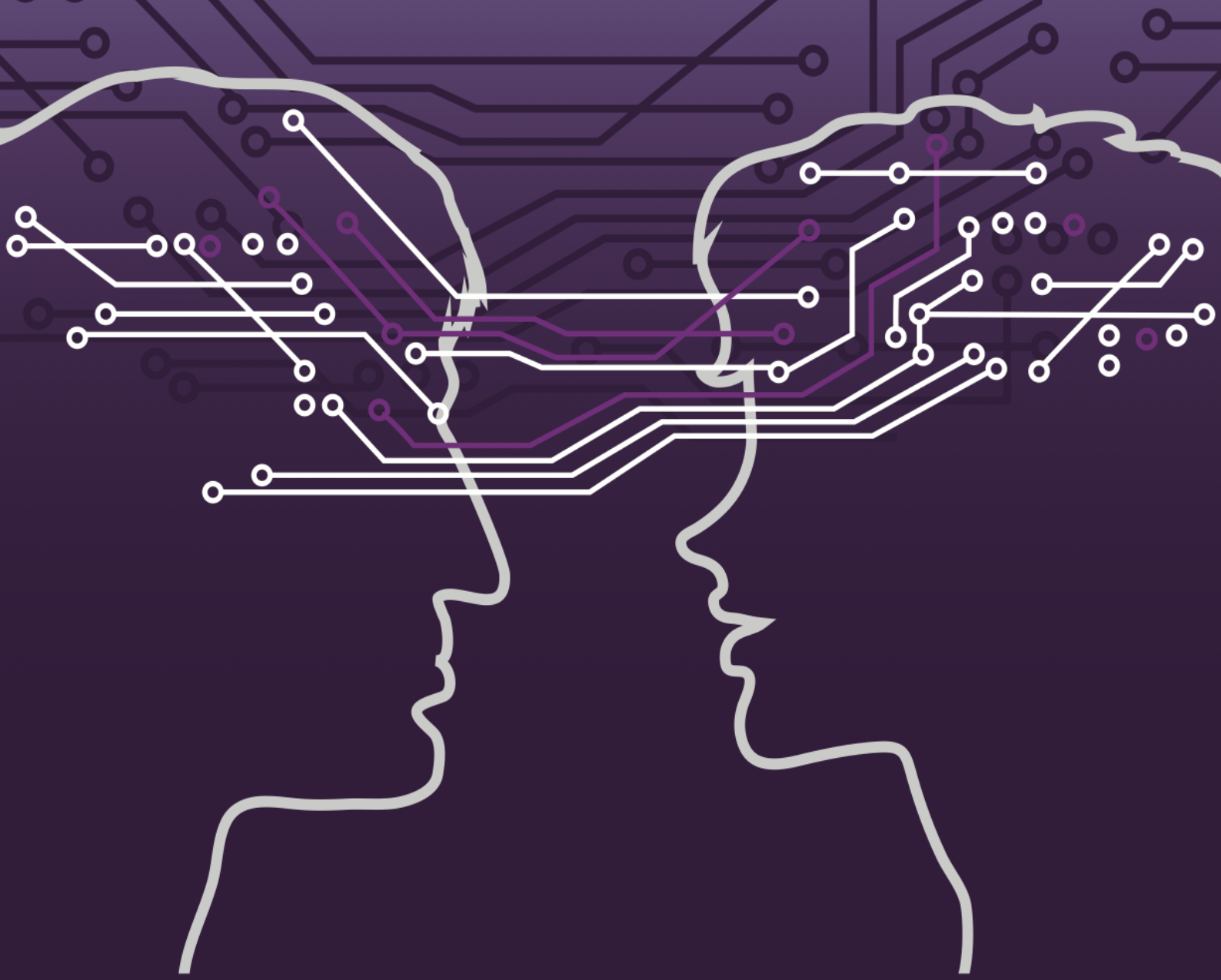

Proceedings of the 3rd Workshop on Awareness and Reflection in Technology-Enhanced Learning

In conjunction with the 8th European Conference on Technology-Enhanced Learning: Scaling up learning for sustained impact

Paphos, Cyprus, September 17, 2013

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Awareness and Reflection in Technology Enhanced Learning

Awareness and reflection are viewed differently across the disciplines informing Technology-Enhanced Learning (CSCW, psychology, educational sciences, computer science...). The ARTEL workshop series brings together researchers and professionals from different backgrounds to provide a forum for discussing the multi-faceted area of awareness and reflection.

The theme of the 2013 workshop was:

> How can awareness and reflection *support learning in different settings* (work, education, continuing professional development, lifelong learning, etc.). What are the *roles that technology can play to support awareness and reflection* in these contexts?

This theme was covered in several topics of the workshop. The main interests were about the theoretical discussion of awareness and reflection in TEL and related concepts (e.g., collaborative learning, creativity techniques, experiential learning, etc.). The methodologies to identify, study and analyse awareness and reflection in the context of (technology-enhanced) learning. Besides theory and methodology the workshop informed about empirical studies about technology support for awareness and reflection. A special aim was to showcase technology (design, application, evaluation) supporting awareness and reflection. Here, the central question was how awareness and reflection technologies can help to enhance the learning experience, by researching learner's awareness of social context, knowledge, artefacts and processes, and awareness and reflection in specific contexts, such as higher education, work-integrated learning, learning networks, etc.

The workshop included a paper session, demo and prototype slam as well as interactive sessions. The workshop provided a forum for presenting and discussing research on awareness and reflection in TEL, and created an interactive experience that connects participants' research, current tools or latest prototypes and models with real end users' learning experiences and requirements regarding reflection technology. Researchers and practitioners came together to work on the future agenda of ARTEL research and development (see the topic map below).

Papers and Demos on Awareness and Reflection

The workshop received 11 papers from which eight submissions were selected for the workshop after the review process. The submissions included in the proceedings are as follows:

The paper "Linking Reflective Learning and Knowledge Maturing in Organizations" by Krogstie, Schmidt, Kunzmann, Krogstie, and Mora links knowledge maturing and reflective learning in order to better understand support actions for reflection in the workplace. Guided by three propositions they illustrate the application of their theoretical framework with two empirical studies in the area of care homes. Based on this, they outline implica-

tions for the design of reflection tools.

Ullmann, Wild, and Scott present in their paper "Reflection - quantifying a rare good" an approach to determine how rare occurrence of reflections in writings are. Based on forum posts of online courses, a crowdsourcing approach was chosen to annotate sentences regarding several elements of reflections. These there then analysed to describe their frequency in texts. With this approach the intuition that reflections are rare in writings received empirical support.

The paper "Support for Collaborative Reflection in Healthcare: Comparing two Workplaces" by Prilla and Degeling describes the Talk Reflection App as socio-technical support for collaborative reflection. The paper makes the case for collaborative reflection and distinguishes between individual reflection and collaborative reflection (CR). Moreover, the authors present the evaluation of the Talk Reflection app in two medical cases and outline strengths and shortcomings of their approach.

Krogstie, Krogstie, and Prilla paper on "Modeling computer-supported reflective learning: Combining a high-level timeline view with reflection cycles and tool use" describes the current state of the Computer Supported Reflective Learning (CSRL) model developed in the MIRROR FP7 project. They introduce patterns to describe the reflective process. The evaluation of the model informs the refinements of the model, its notation, as well as usage instructions.

The paper of Charleer, Klerkx, Santos, and Duval "Improving awareness and reflection through collaborative, interactive visualizations of badges" describes the "Navi Badgeboard", a tool used on an interactive table to get an overview of the badges people have received during their learning. The tool aims at generating awareness of the goals and tasks required for a successful completion of a course.

The paper "Feeler: feel good and learn better. A tool for promoting reflection about learning and well-being" by Durall and Toikkanen describes a combination of visualisation of learning performance in relation to individual well being to achieve a better learning progress. Their goal is to develop a tool, which spans approaches of the the quantified self community and of the field of learning analytics aiming at technological support for individual and collective reflection-after-action processes.

"SpirOnto: Semantically Enhanced Patient Records for Reflective Learning on Spiritual Care in Palliative Care" by Kunzmann, Roser, Schmidt, and Stiehl describes an approach in creating, using, and extending an ontology to support (reflective) learning on spiritual care. Their idea is to enrich documentation of interaction with patients on e.g. palliative wards with concepts from an ontology including elements of spiritual care for different cultural and other backgrounds in order to help workers improve their caring skills.

"REFLECT: Community-Driven Scaffolding for Voice-enabled Reflection on the Go" by Schmidt, Kunzmann, Attwell, Chan, Heinemann-Grüder, Hughes, Lan, Vratny, and Heberle describes a mobile app called REFLECT, which aims at supporting GPs (General Practitioners) in their day-to-day reflection via voice-based questions.

Future Challenges of Awareness and Reflection

A central element of the workshop was to collaborate and to discuss the future challenges of awareness and reflection research for technology-enhanced learning. The outcome of this discussion is captured in the following mind map.

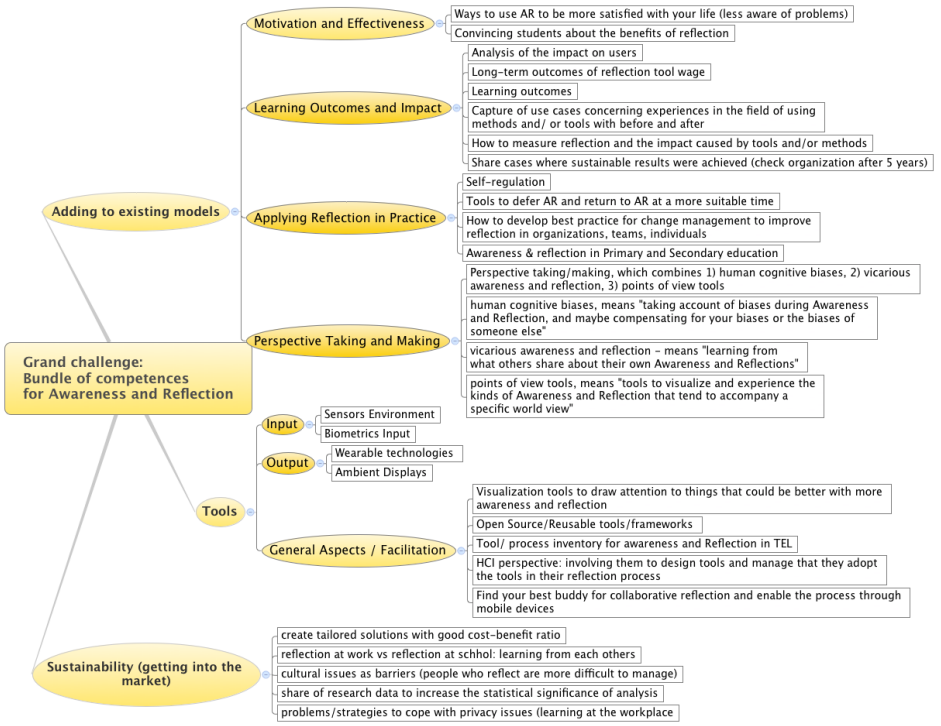

Figure 1: Future challenges of awareness and reflection

A version, which can be commented, can be found here: Future Challenge Map of Awareness and Reflection in Technology-Enhanced Learning.

Awareness and Reflection Workshop Series

The official workshop webpage can be found at `http://teleurope.eu/artel13`

The 3rd Workshop on Awareness and Reflection in Technology-Enhanced Learning (ARTEL 2013) is part of a successful series of previous workshops.

- 2nd Workshop on Awareness and Reflection in Technology-Enhanced Learning (AR-

TEL12). Workshop homepage: `http://www.teleurope.eu/artel12`. Proceedings: `http://ceur-ws.org/Vol-931/`.

- 1st European Workshop on Awareness and Reflection in Learning Networks (ARNets11). Workshop homepage: `http://teleurope.eu/arnets11`. Proceedings: `http://ceur-ws.org/Vol-790/`
- Augmenting the Learning Experience with Collaboratice Reflection (ALECR11). Workshop homepage: `http://www.i-maginary.it/ectel2011/index.html`
- 1st Workshop on Awareness and Reflection in Personal Learning Environments (ARPLE11). Workshop homepage: `http://teleurope.eu/arple11`. Proceedings: `http://journal.webscience.org/view/events/The_PLE_Conference_2011/paper.html#group_Proceedings_of_the_1st_Workshop_on_Awareness_and_Reflection_in_Personal_Learning_Environments`

As with the last year's workshops, Twitter was used as a back channel before, during and after the workshop. The vivid Twitter conversation around the hashtag #artel13 is summarised in the following wordcloud.

Figure 2: Twitter wordcloud of the ARTEL13 workshop

To stay updated about future events, to share your research, or simple to participate with other researchers, consider joining the Awareness and Reflection in Technology-Enhanced

Learning group.
`http://teleurope.eu/artel`

We want to use this opportunity to thank the authors for their contributions and the program committee for their support and reviewing activity.

November 2013

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http://wespot-project.eu

Contents

Linking Reflective Learning and Knowledge Maturing in Organizations

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Abstract: Reflection is a key activity for learning in organizations. While technology support for reflection on the individual and collaborative level is promising, it remains challenging to embed these learning activities into the organization. To better understand and support reflection in the workplace, it is important to see the mutual dependencies between reflective learning activities and knowledge maturing. In this paper, we seek to bridge the gap by presenting a conceptual model linking reflection and knowledge maturing. Based on the model we put forward three propositions: In reflective learning, expertise moderates knowledge maturing, discrepancies between knowledge elements trigger reflection, and the maturity of knowledge used in reflection influences the reflection process. We use findings from empirical studies in two care homes to support the propositions. We address implications for the design of technology enhanced reflection support by discussing a prototype reflection tool for care homes.

1 Introduction

Reflection is a key learning activity for organizations, but generally not very well performed or supported [1]. Reflection allows organizations to implement continuous improvement with double loop or deutero learning [2]. Critical and collaborative reflection is necessary because organizations have to operate in complex situations of change, with multiple stakeholders and interests [3]. Reflection is currently mostly approached from an individual or collaborative perspective, focusing on individual participants and the micro-level of learning. How reflection is embedded into the organization and contributes to the organization's goals remains rather challenging.

Knowledge maturing [4] describes knowledge development within and across organizations from a macro perspective. It concentrates on the evolution of knowledge from early ideas to standardization. The framework bridges bottom-up, individual and group driven knowledge processes with top-down organizational perspectives and is a good candidate for exploring the connections between reflection and organizational knowledge development.

The goal of this paper is linking the micro-perspective of reflective learning with a macro-perspective that embeds reflective learning processes into the organization. We

present an integrated model of reflective learning and knowledge maturing. We outline theoretical perspectives (section 2) and present a conceptual model and three propositions (section 3). We next present two cases (section 4) and use them to illustrate how our key propositions give insight about the cases (section 5) with implications for technology support (section 6). We conclude in section 7.

2 Background

In this section we provide a background for our research contribution, addressing existing work on reflective learning and knowledge development in organizations. We identify a gap in current research with regard to how these processes are connected and argue that research on knowledge maturing can be used to fill the gap.

Reflective learning can be considered as the *conscious reevaluation of experience for the purpose of guiding future behavior*, acknowledging the need to attend to feelings, ideas and behavior [5]. The essential role of experience and reflection in learning has long been recognized [6, 7]. In the workplace, work and reflection on work feed into each other in reflective learning [8, 9].

Reflection can be individual, but can also be a collective activity [10] involving the articulation and sharing of experiences, and collaborative knowledge construction (e.g. [11]), and also involves transitions between levels in the organization [12]. Reflection on work can be considered as interconnected learning cycles in which work experience is reconstructed and re-evaluated in reflection sessions (individual or collaborative) and the outcomes are fed back into work. Reflection cycles differ in their characteristics, with implications for what types of tool support may be adequate [13].

Whereas individuals and groups may reflect to reconstruct and elaborate experiences and thereby contribute to work-related problem-solving, an organizational perspective on reflection sees reflection as a way of addressing organizational matters and the implementation of structures and collective action: reflection is a collective capacity to question assumptions [10]. Key differences between the organizational, collective and individual perspectives on reflection include the type of reflection contents, access to the contents, and the language used [10]. These differences are related to the degree to which the knowledge involved is explicit, shared and formalized.

To understand reflection at work, it is necessary to see the bottom-up and the top-down perspectives in combination. The structures and collective actions implemented from an organizational perspective have to support reflective processes as seen from an individual and collaborative perspective [10]. Supporting reflection from the organizational perspective means creating the opportunities for employees to question current assumptions and knowledge. There is a trend for increasing decentralization of problem-solving in enterprises, which implies a need for active reflection processes challenging and confronting existing knowledge [3]. Whereas a standard process might be automated, more knowledge-intensive processes are hard to pre-define, and they emerge and change in unforeseen ways due to the knowledge developed throughout the process. Certain work-processes are in addition emotionally intensive, thus parts of the process needs to be adapted in the interaction between people there and then. Processes can 'move' through increased process maturity (as a process is better understood, and thus possible to formalize to a larger degree) or through break-

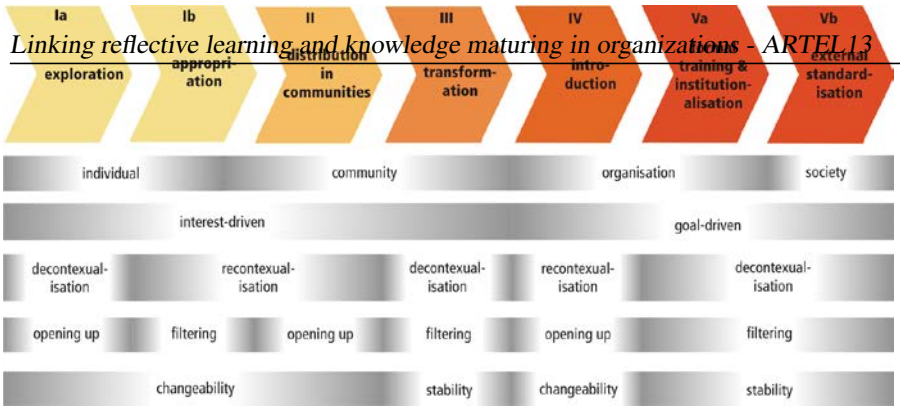
down in the underlying assumptions behind a formalized process, leading to a workaround. Workarounds can have positive effects (e.g. triggering reflection to instill improvement in the processes) or negative effects (on compliance, security and safety).

To understand and support reflection, then, taking into account the organizational perspective as well as that of individuals and groups, it would be helpful to explore in more detail the connection between reflection and knowledge in an organization. The reflection cycle model in [13] does not explicitly address the role of knowledge in the process. Research addressing the use and development of knowledge through individual and collaborative learning [11, 14] is not directed at reflection in the workplace. An adaptation of the model of Stahl has been developed [15] to show how reflection acts as a catalyst for organizational learning on a general level. What remain open are the more detailed connections between reflection and knowledge development, as well as implications for the design of technology support.

Nonaka and Takeuchi's theory on organisational knowledge creation [16] link knowledge to human activity. Central to their theory is that organisational knowledge is created through a continuous dialog between tacit and explicit knowledge performed by organisational "communities of interaction" that contribute to the amplification and development of new knowledge. They also identify four patterns of interaction between tacit and explicit knowledge commonly called *modes of knowledge conversion:* Socialisation (creating tacit knowledge from existing tacit knowledge through shared experience), Externalisation (conversion from tacit (or unstated explicit) to explicit knowledge), Combination (creation of new explicit knowledge from existing explicit knowledge), and Internalisation (conversion of explicit knowledge to tacit knowledge)

The internalisation mode of knowledge creation is closely related to "learning by doing"; hence the internalisation process is deeply related to action. When tacit and explicit knowledge interacts, innovation emerges. Nonaka proposes that the interaction is shaped by shifts between modes of knowledge conversion. Adding Nonaka and Takeuchi's ontological dimension of knowledge creation, we end up with the idealized *spiral of organisational knowledge creation*, which shows how the organisation can mobilise tacit knowledge created and accumulated at the individual level, organisationally amplified through the four modes of knowledge conversion and crystallised at higher ontological levels. Thus the authors propose that the interaction between tacit and explicit knowledge becomes larger in scale as the knowledge creation process proceeds up their ontological levels. The spiral process of knowledge creation starts at the individual level and potentially moves upwards through expanding interaction communities crossing sectional, departmental, divisional and possibly organisational boundaries. Note that it is not given that we want all knowledge to move to the organizational level

Knowledge maturing is a perspective on knowledge development that aims at bringing together the manifold forms of knowledge inside organizations. Following Nonaka's knowledge spiral [16] the knowledge maturing perspective describes knowledge development as a process that can be structured into discrete phases, each of which have different characteristics. Knowledge development starts with *exploration* (Ia) and *appropriation* (Ib) on an individual level, referring to the *emergence of new ideas*. After the *distribution in communities* (II), knowledge gets *transformed*



(III) for further outreach, and in phase IV, it enters the organization's scope with ad-hoc training (for a more instructional path) or piloting (for a more experimental path, e.g., for process knowledge). In phase V, knowledge first gets *institutionalized* within the company, and finally it moves to *external standardization*.

Fig. 1. Knowledge maturing phases and its characteristics (from [17])

Knowledge maturing connects the characteristics of each of the phases to forms of learning and to characteristics of design tools, and shows what has to be accomplished for a transition. This leads to the insight that learning in early phases is more appropriate for those who have high level of expertise in the relevant area, while mature knowledge allows interaction with those considered novices.

Knowledge maturing not only considers the knowledge level, but also the artifacts that represent knowledge, such as notes, and documents, but also process models, or tags or taxonomy terms. While similar development phases can be identified in artifacts, e.g., associated with their formality, the relationship between knowledge and artifacts is more complex: artifacts can use a level of formality that is not appropriate for the knowledge maturity it represents, which has been found to be a common problem in enterprise information and knowledge management.

Furthermore, knowledge maturing also identifies activities that contribute [1]. One of those activities is "reflect on and refine work practices". Looking at work process knowledge, one first attempt to analyze the connection between knowledge maturing and reflection has been made in [18] based on an empirical study in a hospital, and it was found that the maturity of process knowledge influence the quality of reflection.

Knowledge maturing is a promising perspective on knowledge development to better link reflection to organizational knowledge development. Particularly the identification of different characteristics of knowledge at different stages of maturity, based on [15, 18], are important starting points for a further integration. However, to provide guidance for design of reflection tools we need to look further at the interplay between the individual and the collective level, which we will address in the following section.

3 A Model Connecting Knowledge Maturing and Reflection

In the previous section, we have identified that knowledge maturing appears to be a promising perspective to linking reflection with organizational knowledge development. For informing technology design for supporting reflection, we need to have a closer look at how elements of a reflection process are influencing and are influenced

by knowledge maturing. We concentrate here on the interplay between the individual and the collective level. Towards that end, we have created a model by digesting the theoretical findings as outlined in the previous section and iteratively refining them with empirical findings that will be used in the following section.

As depicted in Figure 2, we have introduced the two main levels: the individual level and the level of collective knowledge. On the individual level, it is useful to distinguish between *experience*, *expertise*, and *background motivation*. An important basis for reflection is the set of individual experiences, an experience being "the total response of a person to a situation, including behavior, ideas and feelings" [5]; reflection addressing single experiences as well as conglomerates of experiences [19].

Individual *knowledge* develops from an aggregation of these experiences, but experiences clearly go beyond knowledge as they capture the context in which they have been made. Individual knowledge and experiences in turn, form part of *expertise*. This is in line with [20] who identifies *knowledge*, *experience* (as in how long / how many times one has been doing something), and *problem solving* as fundamental components [20]. *Background motivation* finally captures that reflection on the individual level is not only connected to expertise, but has an underlying complexity of goals/motives of the individual. This is particularly important as early phases of knowledge maturing are driven by individual motives [17].

On the collective side, knowledge maturing adopted a pragmatic view that collective knowledge is an abstraction of individual knowledge of the members of the collective [21].The relationship is not a simple sum. Individual knowledge can exist without turning into collective knowledge, if it does not become effective on the collective level (e.g., knowledge related to private activities). On the other hand, collective knowledge always depends on the learning of individuals.

Artifacts are manifestations, touchable or visible items, either in physical or electronic form [17]. They are important to communicate knowledge and to construct new knowledge. Their relationship to knowledge is not an easy one: they can represent knowledge (both on the individual and the collective level). But while the notion of knowledge maturing would suggest that artifacts that represent more mature knowledge is also more formalized, less mature knowledge can be over-formalized (e.g., formal process models of not well understood processes), while mature knowledge might lack an adequate representation.

To characterize reflection, the *reflection session* as a time-limited activity, planned or spontaneous, individual or collaborative has been introduced [13]. Reflection sessions are often connected to each other, which is in line with the basic assumption of interconnected learning activities in the knowledge maturing perspective. An important characteristic of a reflection session is the *object of reflection*, i.e. "what is the reflection about". This object can be on different levels of abstraction [22] and is usually connected to some knowledge element in focus. In the reflection session, individual work experiences, other relevant knowledge and artifacts, to which we refer as the *background* of reflection, are used to (re)construct and re-evaluate the object. The *Outcome* of reflection involves a change in individual and/or collective knowledge and artifacts. Not each advancement on the individual level leads to advancement on the collective level, and collaborative reflection may lead to differing outcomes for individual participants. *Triggering* of reflection happens when people

perceive a discrepancy [15]. In the workplace, these triggers may have various reasons, such as needs for sense making and problem solving related to work tasks [23].

Based on these basic conceptualizations, three main propositions have been derived based on a theory-driven analysis of real-world examples, which characterize the relationship between reflection and knowledge maturing:

Proposition 1) Expertise moderates knowledge maturing through reflection. Following the observation from knowledge maturing that expertise has a major influence on individuals' capabilities to interact with knowledge of different characteristics, we can also find different approaches to reflection between novices and experts in a field. Novices tend to take collective knowledge for granted, and reflect on their understanding and internalisation of the collective knowledge, while more experienced individuals also challenge existing collective knowledge. Particularly in collaborative reflection sessions, it is important to consider that novices will bring in unfiltered and less interpreted experiences, but will need more experienced individuals to actually bring about the development of collective knowledge.

Proposition 2) The maturity of knowledge used in reflection moderates the reflection process. Generalizing the findings from [18], the maturity of knowledge that is the object of reflection (and to a lesser degree also the maturity of background knowledge), influences the reflection process. On a general level, more mature knowledge appears to have more authority and legitimacy [4]; on a more specific level characteristics of maturity phases such as changeability vs. stability, opening up vs. filtering, or interest-driven vs. goal-driven influence how individual experiences are related to the knowledge, and how easy knowledge is further developed. The same experiences relating to immature knowledge may lead to advancing the knowledge, while they might get rejected if interpreted with respect to more mature knowledge.

Proposition 3) Discrepancies between knowledge elements trigger reflection and thereby affect knowledge maturing. As identified, discrepancies between the actual and the expected are a major trigger for reflection. Our integrated model provides more specific insights in how discrepancies between different *knowledge elements* (i.e., collective knowledge, artifacts, individual experiences, knowledge, or expertise) might be exploited to trigger reflection:

Discrepancy between collective and individual knowledge and/or experiences can lead to challenging the collective knowledge and thus developing it towards a higher degree of maturity. It can also lead to individual learning from collective knowledge, and to increased knowledge in appropriating collective knowledge.

Discrepancy between collective knowledge and artifacts include over-formalization, when artifacts are presented to be more mature than the knowledge they represent, particularly if associated with requirements for compliance. This can lead to challenging the knowledge/artifact, workarounds, and to re-developing the artifact. Discrepancy between collective knowledge and artifacts can also result from under-formalization, e.g. when information is not appropriately recorded. This can lead to re-development of the artifact. Also the characteristics of interaction can differ from the characteristics of knowledge, e.g., when knowledge is in a phase where

changeability and openness prevail, but the interaction possibilities restrict this, e.g., through access rights and lack of possibilities for contribution.

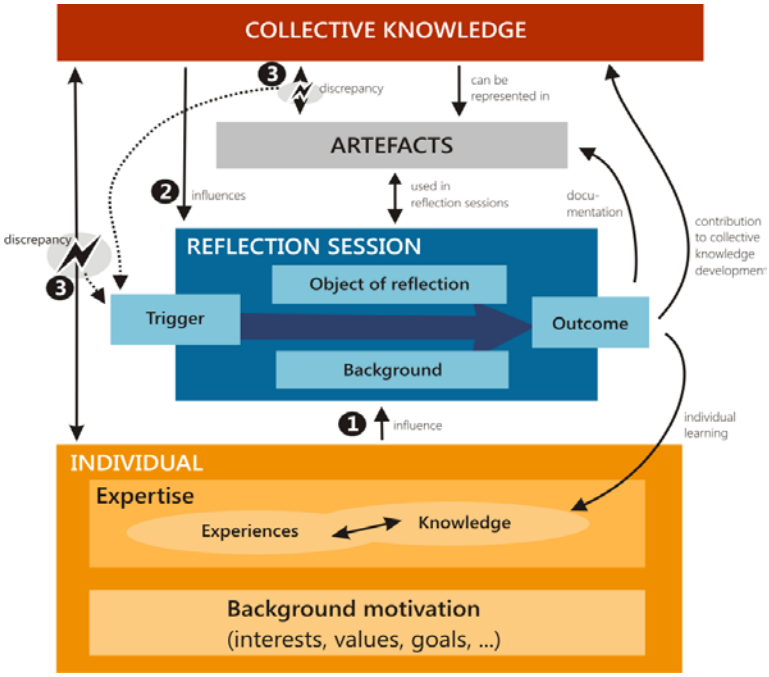


Fig. 2. A model connecting knowledge and reflection

In the next section we present two cases from care homes. This is a type of workplace in which reflective practice is relatively established and recognized as important, giving good opportunities to collect data on the interplay of reflection and knowledge maturing. In Section 5 we use the cases to illustrate the relevance of our three propositions.

4 Cases: Work and reflective learning in two care homes

In this section we present two cases from care homes: Case 1 (The Rose Garden) and Case 2 (The Community Care Home). The homes are located in different European countries. The residents of the homes are generally elderly people, many suffering from dementia. Our focus in both of the cases is the work of the carers. This section presents the research approach and gives some general context about the two cases.

4.1 The Rose Garden Care Home (Case 1)

We conducted an exploratory case study addressing work and reflection among carers at the Rose Garden, a small-sized, private residential care home. We observed over

two days, mainly in the lounges in which the residents spend most of their day receiving care from a team of carers. We conducted brief interviews and talked informally with different categories of staff (including owner, manager, and nurses) when possible. We collected data on the (at the time largely paper based) information infrastructure. Photography and note taking were restricted due to residents' privacy.

Three in-depth interviews (each 60-90 minutes) with carers (C1, C2 and C3) about their work and workplace learning are the main source of data from the case. C1, who had been working in the home for three months, is in her early 20s. C2, having worked in the Rose Garden for about a year, is in her mid 20s. She is a team leader in the home and an educated nurse from her home country, waiting for accreditation to be a nurse also in her current country. C3 is a senior carer in her mid 40s, with many years of experience from care work. The three carers were selected to cover different degrees of experience, and was the largest group that could be taken out of their daily work for interviews. The interviews took place in the lunchroom, largely undisturbed, and were audio recorded and fully transcribed.

A prior study exploring the data from the care home from a different research perspective indicated that the relationship between carers' reflection and the development of knowledge in the organization were important to the reflective learning. This along with the theoretical work presented in Section 3 guided a detailed data analysis of the carer interviews with a focus on key aspects from the model in **Fig. 2**. The analysis confirmed the relevance of the propositions presented in section 3; we selected an illustrative set of examples in section 5. In what follows we provide a brief description of relevant aspects of the work and learning practices at the Rose Garden, to give a context for the examples:

In the country of this study, there are no requirements for formal qualifications to start working as a carer. The majority of the care staff at the Rose Garden is young and inexperienced (e.g. C1), and the turnover is high.

Carers and residents spend much of their time in daily lounges. Medical supervision and administration of drugs are done by a nurse. Medical status information about residents is documented by the carers in various charts/reports. One of the carers on the team is team leader (e.g. C2) responsible for coordination and reporting. There is one senior carer (C3) in the home, acknowledged for her expertise. She is consulted by less experienced carers on care work, and by management to help e.g. in changing a care plan or take care of a difficult conversation with relatives of a resident.

The carers often have to handle challenging situations with residents. This requires knowledge about the resident (e.g. life history, prior interests) and general knowledge about care work. The Rose Garden follows a philosophy of person-centered care: Focus is the person with her life history, interests and integrity [24] To convey the care principles internally to staff and externally in marketing, a model of person-centered care is used. A diagram of the model is found on the wall in areas frequently visited by staff and visitors. The model includes a representation of the main psychological needs of people with dementia (see description in Section 6), connected to the process of care work, with *personhood* as a core element. The model is generally focused on care *principles*, not detailed procedures.

Doing care work in the lounge, the carers talk aloud. They explain to the residents what is happening and frequently ask their opinion or consent, in line with person-

centered care. The carers also update each other, explaining about episodes that they have experienced or been told about. The work in the lounge facilitates coordination that enables the carers to help each other out. The information sharing also helps the carers develop individual and shared knowledge of the residents.

Care work is mainly learnt by doing and from observing peers. The first week as a carer is spent following a more senior carer. After that the newbie starts doing care work. On-the-job training and reflective learning are strongly encouraged, the owner being actively involved in staff training. In the daily morning meeting with the care staff, the manager goes through the status of all residents, and then typically facilitates a general session on care work, linking recent events and current issues to the more general care principles pushing phase V knowledge (see fig. 1) to the attention and repeating key points from the bi-weekly lecture. The carers participate with answers, questions, and comments, e.g. on their individual experiences. The information shared in the morning meeting provides a rationale for action, e.g. for carers to handle immediate issues or for the manager to change care plans.

4.2 The community care home (Case 2)

Following the study in the Rose Garden care home, we have conducted an exploratory interview with a senior elderly care nurse in a community care home operated by a non-profit association. It houses about 75 residents. It is not specialized on any type of residents.

The researcher had prior contact to the care home so that the interview, which lasted for about one hour and was conducted outside the care home, could be focused on aspects of reflection and knowledge maturing. A second researcher took notes.

The care home is characterized by stability, both in terms of residents and staff. Some of the residents have stayed for about 20 years, and the last new full-time staff member started three years ago. Staff is composed of a mixture of certified elderly care nurses and care worker with little training in addition to on-the-job training.

However, the care home is currently undergoing a change of its processes, facilitated by an external consultant, to better accommodate to legal requirements, which favor a documentation-centric quality management for control. These changes particularly address an insufficient level of documentation of care activities and improvement processes, while care quality as such is not perceived as an issue.

5 Illustrating our Propositions with Findings from the Cases

In this section we illustrate the relevance of the propositions presented in Section 3 by referring to examples from Case 1 and Case 2. The examples originate in the interviews and observations. For the sake of illustrating our points we have occasionally combined elements into a more coherent narrative than what is found in the raw data.

5.1 Prop. 1: Expertise Moderates Knowledge Maturing Through Reflection

Case 1 illustrates how carers at different levels of expertise use organizational knowledge at a high level of maturity, e.g. the care principles outlined in the model of personalized care, in different ways when reflecting on experiences from care work.

The new carer C1 says: *"If we work every day and do not use [care model], we would be like a robot, not being happy about the job, not working from the heart."*One day when C1 interacts with a resident in the lounge she finds that he reacts unexpectedly. She tries to do the things that normally make him at ease. However, nothing works; the resident is obviously still in a distress. The carer is confused. (As she later explains in the interview: *"I know the resident, I know when something is not right.*"). She asks the other carers in the room, who explain about a change in the medical condition of the resident which might have had some effects on his behavior. One of the other carers explains about how she approached a similar situation with another resident the month before, and that it worked well. The explanation from her colleagues makes it easier for C1 to understand the behavior of the resident, and she starts approaching him in a different way. This works better. In the following morning meeting, the status of the resident is discussed. The manager explains about his condition. A carer illustrates the challenges with an episode from the day before. The manager suggests a couple of measures that should be taken in the interaction with the resident. Doing so she reminds about the importance of respecting his personhood and asking his consent, as described in the care model. The young carer C1 now feels she understands even better the residents' reactions the day before.

C1 is learning the care principles by heart and keeps them in a note in her pocket, to be able to prepare for possible questions from the manager or a care home inspector and demonstrate legitimacy as a carer. Key questions for her in the use of the principles include what principles to apply in a specific situation, and how. In specific situations, the general principles are clearly not sufficient, as seen in the example with the resident with the inexplicable behavior. When C1 acquired the resident-specific knowledge about the medical condition, she was able to re-apply the general principle of 'working from the heart' in her actions towards the resident, perhaps having slightly extended her individual knowledge of what it may mean.

C3, the senior carer, says about using the care model in practice: "*[it is] about the residents, how you treat them, their dignity, how you can give some activities for them, give them some choice. [] Respect, privacy, dignity for everything*."

C3 explains that she makes tradeoffs in her work, to "do the right thing" under resource constraints. C3 says that the management is aware that tradeoffs and minor workarounds have to be made in daily work. She thinks carers should learn from each other by "*[picking] the good things!*". Whether a particular action is good or bad is a result of considering several, possibly conflicting concerns. When the manager involves C3 in work to update care plans, C3 sometimes disagrees with the manager's suggestions, arguing about the resident's personhood: "*The person comes first*".

5.2 Prop. 2: The Maturity of Knowledge Used in Reflection Moderates the Reflection Process

In Case 2, it was recurring in the interview that the relevance of documentation to deliver good care and its role in everyday work is a frequent object of reflection. The documentation is largely prescribed by legal requirements. While employees are determined to deliver the best care possible within time and resource constraints, the artifacts they need to comply with are not perceived as best practice, even though they are presented as level V knowledge. This triggers reflection both on the individual and team levels. The reason why the knowledge is not recognized as best practice could be (i) that the artifact is unclear about the knowledge it contains, (ii) a mismatch between artifact and knowledge (i.e. exemplifying Proposition 3), or (iii) that the maturity of the knowledge is disputed, meaning that making it prescriptive and unchangeable creates conflict. The interview indicates a combination of (i) and (ii): the documentation serves two purposes - one is compliance, which requires much documentation, the other is improving care, for which meetings are more useful. The example shows that a high level of formality of artifacts can lead to recurring reflection sessions which center around the artifacts and their purpose *without* advancing the knowledge the artifacts should represent. Mixing maturity levels can turn reflection unproductive. It may be that the actual knowledge maturity phase indicates changeability (see **Fig. 1**) which is not allowed by the artifacts and their associated prescription. This can be linked to evidence from MATURE [1] that a high level of formality of artifacts (e.g. processes) constitutes a barrier to further development of knowledge.

A contrasting example, in which mature knowledge serves its purpose, can be found in Case 1, in which the care principles play a central role in work and reflection. Institutionalized throughout the Rose Garden, they serve multiple purposes: Providing practical guidance when a carer reflects on her daily work, principles (not procedures) giving some flexibility and encouraging the consideration of a situation from multiple angles. The principles can be connected to concrete examples and individual experiences. The examples, some of which are formalized, help carers understand the principles, and the principles are used to make sense of examples, especially the carers' own, individual experiences. Second, the care principles - used externally vs. authorities and being a clear example of phase V knowledge - legitimize decisions (e.g. to make a change to a care plan). Finally, the principles are used to strengthen the feeling of purpose, motivation and togetherness, e.g. giving meaning to work.

5.3 Prop. 3: Discrepancies Between Knowledge Elements Trigger Reflection and thereby Affect Knowledge Maturing

C3, being an expert, has a lot of individual knowledge enabling her to "read" challenging situations with residents. She is typically able to immediately see from a situation what are the essential elements that will affect how the situation evolves, and what tradeoffs will be involved. The discrepancies of knowledge elements may or may not lead her to reflect and develop her knowledge. It is however clear from the interview that to her, an additional concern is not only the residents, but the learning and well-being of her younger colleagues. The discrepancy between displayed indi-

vidual knowledge to handle certain situations and the collective knowledge needed to do so, is a trigger for her reflection on how to bring younger carers up to the desired level of competence. The learning resulting from C3's guidance of younger carers adds to the organization's ability to train its employees.

C3 furthermore contributes to the development of formalized knowledge in the organization through involvement in the updating of care plans (artifacts). The need for change in a plan is rooted in a discrepancy between the current state of a resident and the effects of continuing to implement the existing care plan. The representation of the state of the resident and the current care plan largely consist of collective knowledge, and often medical expertise plays a key role in the decisions. Still, expertise with care work helps combine and weigh the parts of the often complex picture of 'the whole person' in order to create a good plan.

C2 sees that there is often conflict between the ideals of the care model and resources, e.g. time. "*Yes, it is, it is there. The model is fine [] but if for example I have to ask people if they want a shower or not, some will not give consent even if they are really dirty or soaking wet*". Goal conflicts (e.g. what priorities have to be made) are often discussed in morning meetings."*We discuss solutions, alternatives to organize the work. Even <manager> says to keep up quality of work, if a person is not washed in the morning before breakfast we can do it after lunch*". C2 has individually over time been reflecting on the goal conflicts:"*We can ask [the residents] many times, offer a cup of tea and ask again later, but at the end of the day we have to force it. Being soaking wet on a chair, they will get a sore bottom []. But still, if we are forcing them, we are just considering that we are doing good for the residents. [] But always, when there are inspections [from the authorities] they will look if we are involving the residents in the care. "*. C2 reflects on this in our interview:"*If we just have to stick on to theory, the practice is definitely going to be poor. If we are just sticking on to the practical point of view, some or other day the theory is going to be…*" C2 has been talking to the owner about these issues on several occasions and thinks that management understands: "*They do understand []. I just told him, see: [] If somebody will not drink we have to send them to the hospital.*"

The difference between C2 and C3 is not just one of expertise in care work. C2, with her nursing background, has more vocabulary to discuss certain aspects of care with the owner, e.g. referring to medical issues and not just the care model. C2 both has the needs of a carer to handle discrepancies between knowledge elements (e.g. need to be on schedule; need to have the residents' consent) and the ability as a carer *and nurse* to confidently verbalize these concerns, both with management and for collaborative reflection e.g. in the morning meeting. Again we see a link between expertise and the way knowledge is questioned, shared and potentially developed. The case of C2 may illustrate the advantage for knowledge development as an employee can take different perspectives, e. g. by being assigned to two or more roles.

6 Implications for Design

In this section we use an existing tool prototype to illustrate how the insights from this paper can guide the direction of tool design. For that purpose, we use the Flower

Power (FP) app, which is a simple tool for note taking on work experiences in a care home applying the care principles presented in Case 1. The tool links note taking to the psychological needs of the resident (represented as a flower in the model) that must be met in the person-centered care. The app runs offline on an iPad intended to be available in the lounge in which the daily care work takes place. The carers can take reflection notes and examine existing notes whenever they have the time, and one device is to be shared among the carers in the lounge. Every user can read other users' notes. The manager can also read the notes, e.g. to prepare discussions.

The main screen in the FP app shows a key part of the care model – a flower with a petal for each key psychological need of a person [24]. Clicking the question mark on a petal opens a window with text explaining this aspect of care in the same way as in the book and consistently with how it is explained in lectures and morning meetings. If a user clicks anywhere else on a petal, the list of notes associated with that petal is shown. Existing notes may be opened, read, and commented. From the same screen, the user may also create a new note. The header of a note says what care principle is involved. When the user has written the note and saves it, the note will be added to the list of notes for that petal. On the main screen, the number of notes indicated in the respective petal will be incremented. A note can be associated with several petals, if the user thinks the respective care aspects are all relevant to the note.

Considering the three ways in which knowledge maturing impacts on reflection, as identified in this paper (see Section 3), we will briefly outline the directions that could be taken in further developing the FP app to take this into account.

We have seen that expertise moderates knowledge maturing through reflection (Proposition 1) in the care home. An improvement of the FP app based on this insight could go in the direction of allowing users to choose between two levels designed to differentiate the needs of carers at different levels of expertise in care work. One level, more intended for new carers, may be directed at supporting the learning of care principles and the linking of work experience to specific principles. The other level may support the linking of experiences to discrepancies between principles (i.e. mature knowledge in the organization) and experience, and/or between principles.

We have learnt that the maturity of knowledge used in reflection moderates the reflection process (Proposition 2) among carers. Accordingly the tool could support the promotion of notes to a higher level of maturity, e.g. by categorizing notes into two or more levels. A second level might reflect that the contents represent knowledge recognized on a community level. A possible third level could be notes taken into account in organizational development. Importantly, promotion to a higher level of maturity would not imply just sharing the note, but also transforming it through processes involving reflection, e.g. individually by the manager or collaboratively in a team meeting. In doing so, the origin could be preserved by keeping links to the original notes at a lower level of maturity to facilitate understanding of the rationale. Linking to the original experiences and ideas is simultaneously a way of acknowledging the role of contributors in the process, making the impact explicit. A promotion of knowledge to a higher level of maturity is likely to change the object of reflection towards the more abstract/general. However, the form of a note could still be a narrative of a single experience, if it is recognized as fit for conveying the message in an effective/interesting way, i.e. serving as a representative example.

Finally, in the care home, we found discrepancies between knowledge elements triggering reflection and thereby affecting knowledge maturing (Proposition 3). To support this in the tool, knowledge-related reflection triggers could be made explicit by supporting the linking of notes to artifacts, knowledge and experience perceived to be in conflict. The linking could help carers, as they write reflection notes, make sense of the discrepancies. Describing discrepancies in the shared, organization-wide language provided by the care principles may create greater awareness of discrepancies as the notes are read by colleagues and possibly trigger their reflection. Referring explicitly to discrepancies also supports the transformation to higher levels of maturity by linking work experiences to more general patterns (e.g. "a X vs. Y conflict") which might be used to structure the higher-level notes.

The discrepancies seen in Case 1 involve concerns that are not explicit in the flower model. This indicates a need for the app to support explicit referencing to other care principles applied in the carers' reflection on work, for instance *personhood*, which is also a key part of the model of personalized care applied in the home. The set of concepts to which examples and discrepancies can be linked must be large enough to capture conflicts between the ideals and the reality of care work, suggesting that concepts such as *time* and *consent* may be included.

7 Conclusion

In this paper, we have shown that knowledge maturing provides a useful framework to embed reflection models into the overall organizational knowledge development. The integrated model that has been developed in section 3 reveals important insights about how the organizational perspective and the individual perspective interact: (1) individual expertise moderating reflection and its contribution to knowledge maturing, (2) the maturity of collective knowledge involved in reflection sessions moderating the reflection process, and (3) discrepancies between individual knowledge, experiences, artifacts and collective knowledge being triggers for initiating reflection sessions. Qualitative empirical research in two care homes underpinned the relevance of the propositions in real work settings.

These insights are important foundations for designing reflection support in organizations, both from a technical design point of view, but also from an organizational point of view. Such reflection support has to be aware of (i) the expertise of the individuals involved, and of (ii) the maturity of knowledge that is reflected upon and developed further as part of reflection. Ignoring the different characteristics of reflection resulting from varying levels of expertise and knowledge maturity may result in barriers to productive reflection. Furthermore, the integrated model also provides hints how conflicts between collective and individual perspectives trigger reflection.

Future work will refine the model by applying it to other types of cases, with a focus on its descriptive power in analyzing reflective learning and knowledge development, and its utility in informing the development of technology for reflective learning. The findings in this paper may be used to enrich current models on reflective learning as well as models of knowledge development in organizations.

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Reflection - quantifying a rare good

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Abstract. Based on a literature review, reflections in written text are rare. The reported proportions of reflection are based on different baselines, making comparisons difficult. In contrast, this research reports on the proportion of occurrences of elements of reflection based on sentence level. This metric allows to compare proportions of elements of reflection. Previous studies are based on courses tailored to foster reflection. The reported proportions represent more the success of a specific instruction than informing about proportions of reflections occurring in student writings in general. This study is based on a large sample of course forum posts of a virtual learning environment. In total 1000 sentences were randomly selected and manually classified according to six elements of reflection. Five raters rated each sentence. Agreement was calculated based on a majority vote. The proportions of elements of reflection are reported and its potential application for course analytics demonstrated. The results indicate that reflections in text are indeed rare, and that there are differences within elements of reflection.

Keywords: quantification, reflection, reflective thinking, reflective writing, reflection detection, reflection analytics

1 Introduction

The phenomenon "reflection", a pivotal thinking skill, has a rich theoretical tradition. Several methods have been developed to measure reflection, especially in the area of reflective learning. Analytical models of reflection in writings can be distinguished by three types, covering the depth, the breadth, or the process of reflection (e.g. [2–4, 6, 7, 9, 10, 13–15]). These models decompose reflection into several elements characterising reflection.

Little is known about the quantities of these reflective elements in texts. Quantification is the mapping of phenomena into a set of numbers. It is core to scientific research, as it allows to investigate the properties of the phenomenon in their context, its relations, probabilities, and patterns, to test theoretical assumptions, in order to develop rules, laws, towards a general theory.

Regarding reflection, it is still a largely unmapped territory, when it comes to the quantification of properties of reflection in texts. This research tries to

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find answers to the question of what can be expected regarding the frequency of occurrences of reflection in texts. Intuitively reflection occurs rarely in writings. But, how rarely does reflection actually occur?

While there are attempts to quantify the proportions of elements of reflection in reflective text the reported results are hard to generalise. Guidelines to compare reflection studies do not exist yet. This research proposes a method based on a comparable unit of analysis, which allows to estimate frequencies of reflective elements in texts. It describes the method used to quantify reflection, and exemplifies the process on six elements of reflection. The study was conducted in the context of course forum posts of a virtual learning environment.

2 Proportions of reflection in texts

The following literature review outlines findings on three levels of reflection research, starting with a meta-analytical view, followed by research on the depth of reflection, and proportions of elements of reflection.

Dyment and O'Connell [1, p. 90-91] undertook a meta-review of the quality of reflection in student writings. They included 11 studies in their review. Amongst other criteria, they looked at the distribution regarding the depth of reflection. They classified the outcome of each study either as low, moderate, or high. A study classified as low for example had a high percentage of texts, which were mostly descriptive and less reflective. Five studies were categorised as low, four studies had a moderate level of reflection, and two had a high level of reflection. According to their review a relatively high proportion of studies report low to medium levels of reflection, while only two studies achieved high levels of reflection.

Although the categorisation into levels of reflection is informative, they warn that the categorisation is to a degree subjective as the used methods in each study vary making the comparison difficult.

The following section outlines results of individual studies describing proportions of elements of reflection, and their context. Some of the studies are already covered by Dyment and O'Connell [1]. Additional information was added to situate these studies in their context. In one case further reported results are presented. Studies not included in their review are marked with an asterisk.

*Wald et al. [13, p. 43] report on the distribution of reflective levels (depth of reflection) within a corpus of 93 reflective writings. The reflective writings stem from second-year students self-selected best reflective writing field notes. The reflective writings were selected from archived material and were not in connection with a instructional setup of the researchers. The levels started at level 1 with "nonreflective: habitual action" (0% of students), "nonreflective: thoughtful action" (18%), "reflective" (41%), "critically reflective" (30%), to level 5 "transformative learning" (11%).

Wong et al. [15, p. 53-54] conducted a content analysis (and interviews) of reflective writings in the context of an instructional design specifically targeting reflective writing. The writings were however not graded. The percentages of 45

students regarding the level of reflection were as follows: 13% non-reflectors, 76% reflectors, and 11% were critical reflectors.

Plack et al. [7, p. 204] analysed reflective writings of 43 journals of students participating in a course for clinical practice, which had an emphasis on reflective practice (instructions were given about reflection, journals were not used for grading). They report frequencies of elements and depth of reflection. Regarding the depth, 15% of the journals had no evidence of reflection, 43% showed evidence of reflection, and 42% evidence of critical reflection. The percentages for the elements of reflection were (percentage of journals containing an element): Reflection in action (23%), reflection on action (38%), reflection for action (28%), content (35%), process (38%), premise (18%), returns to experience (39%), attends to feelings (38%), and re-evaluation (32%). The most frequent element was return to experience, which is the category label for a description of an important experience. The premise element - critique of own assumptions - is the less frequent one (see Plack et al. [7, p. 206-7] for descriptions of the elements).

Hatton and Smith [3, p. 41] assessed the written work of 60 students in the context of a professional program, which used reflection-fostering instructions. They reported overall percentages of coded units. 60-70% were descriptive reflective, and more than 30% of dialogic reflection was found in essays after a special instruction. On average 19 reflective units were found in a writing of 8-12 pages.

*The analysis of Ross [8, p. 24-25] took into account 134 papers from 25 students (average 5.4 papers per student). The students took a course with a special focus on reflection. The article reported the following percentages of papers: 22% were highly reflective, 34% moderately reflective, and 44% low reflective.

Williams et al. [14, p. 7 and 12] report the highest achieved level of reflection of 56 students, who had to write a reflective journal during a course (the journal made up 10% of the grade, at least one journal had to be written per week). The percentages from the lowest level to the highest are: 0% describe learning, 2% analyse learning, 23% verify learning, 36% gain new understanding, and 39% indicate future behaviour.

The proportions of students or texts regarding level or elements of reflection have to be used with care. The mapping from the evidences of reflection to elements or levels depends largely on the interpretation of the researchers, and thus the percentages might be different if the mapping process would have been done differently. In addition, the reported percentages are on either a level of a person or journal. Thus, not much can be said about the distribution of reflective elements or levels in texts. Tentatively, the presented research results might indicate that most texts/students are written/write with a low or medium level of reflection. Highly reflective texts/students are rather rare. All presented studies describe that the course was especially designed to foster reflection, which compared to normal courses might result in higher proportions of reflection. The articles reporting on elements of reflection indicate that some elements occur more frequently than others. The work of Hatton and Smith [3] is insofar from special interest for this research as they provide percentages of units of reflection, which might give indications about the frequencies of reflective utterances

in text. However, they do not specify exactly their understanding of a unit, which makes estimates speculative. For example, if a unit is a sentence, then 19 reflective units in 8-12 pages would indicate that reflections are rare instances (about 1% of the text assuming 200 sentences for 10 pages). If a unit equals a paragraph and if we assume that a page consists of five paragraphs, then 38% of the units of a text would be reflective considering 10 pages.

3 Method

The chosen approach to quantify reflections follows seven points:

- Choose a text corpus and describe its domain and characteristics.
- Unitise the text corpus (in here the unit of analysis are sentences).
- Draw a random sample of units.
- Based on theory of reflection derive elements of reflections, which characterise it.
- Operationalise each element of reflection.
- Device a strategy to gain annotations for the units. In this paper the units are manually annotated.
- Calculate and report the proportions of the annotated elements of reflection (quantification).

It is worth to consider controlling the text length (amount of units of each text), especially for a smaller corpus. For example, if a corpus with a very long text and several very short texts is used, the randomly selected units will come mostly from the long text. If the long text is about describing a problem and the short texts are mostly acknowledging or short introductions of members of a forum, the uncontrolled corpus will be biased.

The theories on reflection vary regarding the elements which together model reflection. Furthermore, the elements of reflection are often high level descriptions, which may be too abstract to measure. For each element several subelements can be designed, with the aim to arrive at measurable elements. This list of subelements may be too large to be administered in a single experiment. A pre-test can help to find the optimal amount of items. A pre-test is also advisable to check the measurability of each item. Inhere six items were selected. For each element of reflection one or two items were selected. The rational is that the items are better distinguishable by human raters, instead of using several items from one element, which may be too similar.

4 Text corpus

The text corpus used for this research is based on forum data of the virtual learning environment[1] of the Open University, UK. It consists of two courses on eLearning, two courses about social work, and one course on science. The data was de-identified by the researcher.

[1] `https://github.com/moodleou/`

course	description	posts	unique sentences with personal pronoun	unique sentences without personal pronoun
eLearning 1	postgraduate course (30 credits)	410	3454	4639
eLearning 2	postgraduate course (30 credits); different semester than eLearning 1 course	274	2115	2480
social work	level 2 course (60 credits)	475	3787	3689
social work	level 3 course (60 credits)	103	903	872
science	postgraduate course (30 credits)	355	2170	3820

Table 1: Description of text corpus

The forums serve several purposes, for example to support the students, to have a platform for discussion, exchanging ideas, and to socialise. The forum posts therefore contain a wide spectrum of writings. The eLearning and social work courses explicitly stated that reflection is one of the learning goals. However, special assignments regarding reflection were in general[2] not conducted within the forums, but with forum external means, and thus may be only indirectly present in the forum corpus. The science course did not explicitly aim at reflection.

From all posts, posts of a character length between 1500 and 3500 characters were selected. On average the 1677 forum posts were 2121 characters long (sd=512).

Only course forums, which were core to the course and explicitly embedded in the activity of the course were kept. Forums for technical support, student talk, and general course-wide forums were excluded.

From all posts the ones made by the role "student" are kept, while the other roles like "tutor", "moderator", or "production staff" were filtered.

All texts were split into single sentences. These were then divided into sentences that contain a personal pronoun and sentences that did not contain a personal pronoun (using the reflection detection architecture of Ullmann [11] and its extension [12, p. 106f.]). 500 sentences from each set were randomly selected. They form the input of the corpus of sentences used for the annotation process.

[2] some courses had forums to discuss reflection assignments

5 Questionnaire

The questionnaire contained four sentences on each page to rate. A maximum of 30 sentences could be coded by a coder per batch. The instruction of the questionnaire explained the task. Each category was described with an example sentence and explanation. The workflow for the raters was: read a sentence, categorise it, and write a short explanation justifying your choice.

The raters could choose from one of the following seven categories. These categories follow the reflection model outlined in Ullmann et al. [12, p. 103f.]. Something could/should have been done differently, drawing a conclusion based on a premise (reasoning), taking another perspective (point of view), intention to do something, something was successfully learned (achieved), something is interpreted in a new way (new understanding), and none of these. The raters were prompted to choose the best category for each sentence. In addition, the instruction stated that the sentence had to speak for itself. The categories were presented for each sentence in random order. Pre-experiments showed a preferred answer bias for the first category. Shuffling the categories aimed at minimising this bias based on the sequence of the categories. After the rater selected their answer, they had to justify their choice with a short free text answer.

The categories can be seen as one of several variations to capture an element. This also means, that the questions do not exhaustively represent an element, but they cover to a certain extent the essence of it. The following table shows the mapping between the elements of reflection [12, p. 103f.] and the categories.

Elements of reflection	Categories
Description of an experience	Something could/should have been done differently
Critical analysis	Drawing a conclusion based on a premise (reasoning)
Taking other perspectives into account	Taking another perspective (point of view). Something is interpreted in a new way (new understanding)
Outcome	Intention to do something. Something was successfully learned (achieved). Something is interpreted in a new way (new understanding)

Table 2: Mapping of elements of reflection to the categories of the questionnaire.

The question "something is interpreted in a new way (new understanding)" can be seen as an outcome dimension of reflection, but also as another take/perspective on something.

6 Survey

The questionnaire was distributed via a crowdsourcing platform[3]. The participants had to fill out a minimum of four gold questions before they saw the first item of the survey. Gold questions are items with known answers used to stop those participants that fail to correctly answer a certain amount of gold questions from filling out the survey. Additionally, a set of own text validators was used to discourage participants filling out the questionnaire randomly.

10 batches of 100 sentences were administered. Participants from previous batches were allowed to rate a new batch. Each sentence was rated by at least five raters.

The 411 raters came from 17 countries. Most of them were from the USA (n = 202), GBR (n = 94), and IND (n = 45). The remaining 70 raters came from 14 other nations.

7 Results

The inter-rater agreement between the annotators was measured using Krippendorff's α [5] for nominal data. The α for the gold data is 0.43, for annotation and gold data combined it is 0.32, and for the annotation data only is 0.22.

The annotated sentences were then filtered. Only sentences where three or more raters agreed on (majority vote) remained in the data set. From the original 1000 sentences 623 remain. Krippendorff's α for this set is 0.36. The α values of the participants are relatively low, which means that by running the same experiment on the crowdsourcing platform again, some of the sentences will be classified differently. It has however the benefit that it does not rely on expert ratings, which also might be difficult to replicate by other researchers.

The following table shows sentences from the experiment and their classification.

Category	Example
Something could/should have been done differently	Victor and Morgan you are right that I should have applied better my own learning instead of using the Uni ones. [names were de-identified before the survey]
Drawing a conclusion based on a premise (reasoning)	I imagine this is probably in order to have a focus and provide enough detail rather than skim over the whole area.
Taking another perspective (point of view)	When I am doing FRT work, I often think about how the parents view me when they know I haven't got children!

[3] `http://crowdflower.com/`

Something is interpreted in a new way (new understanding)	After I saw how this lifted her mood and eased her anxiety, I will remember that what we can view sometimes to be small can actually make a significant difference.
Intention to do something	I would like to be involved in helping with the site too -although I'm a novice!
Something was successfully learned (achieved)	This has helped me reflect on my own life and experiences whilst allowing me to empathise with others in their own circumstances, I feel proud of what I have achieved so far as the work/life/study balance is always difficult to navigate but I'm lucky that I have a supportive family to help.
None of these	Bye the way, Audacity is also run under the CC Attribution licence.

Table 3: Example sentences for each category.

As we are interested in the proportions of reflective elements and not so much in the replication of every sentence's judgement, an analysis of the stability of the proportion over different points in time was conducted. The assumption is that similar proportions will arise, if the number of sentences is big enough and the sentences are randomly selected.

To test this assumption the 10 runs were split into 3 equally sized batches of 208 items. The following table shows the results.

	batch 1	batch 2	batch 3
none of them	109	102	121
intention to do something	32	30	18
reasoning	26	32	22
successfully learned	21	23	23
could have been done differently	12	7	10
interpreted in a new way	4	5	7
taking another perspective	4	9	6

Table 4: Stability over batches

The proportions of the categories do not vary much in each batch, which may indicate that although the inter-rater reliability is small since each time the experiment is replicated the sentences will receive different annotations, the proportion of elements will stay relatively steady. One exception (in batch 3 of the element intention) may indicate that there are some fluctuations, which should be considered in an experiment with a bigger sample size.

The next table reports on the proportions of reflective elements in the dataset. Based on the sentences, which received the majority vote, it shows for all ele-

ments its frequencies and its percentages. In addition, it shows the frequencies for personal and non personal sentences.

	all	%	personal	non personal
could have been done differently	29	4.65	18	11
reasoning	80	12.84	42	38
taking another perspective	19	3.05	13	6
interpreted in a new way	16	2.57	13	3
intention to do something	80	12.84	53	27
successfully learned	67	10.75	43	24
none of them	332	53.29	113	219

Table 5: Number of sentences in each category

Focusing on the six elements of reflection, the categories "reasoning", "intention to do something", and "successfully learned" are present in more than 10% of the sentences. Besides these relatively frequent, but still rare elements, "interpreting something in a new way", "taking another perspective", and the recognition that "something could have been done differently" occur in two to five percentage of the sentences. The category "none of them" has the highest percentage. "None" does not necessarily mean that this category represents a "not reflective" category. It might include sentences, which are reflective, but not captured in the six items representing reflective elements. The chosen six elements of reflection are not an exhaustive model of reflection capturing all possible ways of expressing reflection in texts.

In order to test the influence of personal pronouns in reflective sentences, the original sample contained the same amount of sentences with personal pronoun as those without. The table shows that personal sentences have higher category counts for all reflective elements than non personal sentences. This might indicate that sentences containing a personal pronoun are more likely to be annotated as one of the reflective elements.

Assuming that there are relatively constant proportions of reflective elements, one area of application might be the analysis of courses regarding the baseline proportions of reflective elements. Compared to this experiment however, more data from several domains should be taken into account in addition to a more fine grained model of elements of reflection.

The next table serves as an example for this possibility. It inspects the proportions of reflective elements over the five courses of the data set. The amounts of sampled sentences from each course vary. The number of sentences for the first eLearning course was 196, from the second eLearning course was 111, from the social work level 2 course was 146, level 3 course was 39, and from the science course 131. As the social work level 3 course has a much lower sentence count than the other courses, it was excluded from the results. The courses were balanced according to their number of sentences. The following table shows the balanced percentages of elements of reflection for each course.

	%el1	%el2	%swl2	%sci	%all
could have been done differently	3.1	5.4	4.8	6.9	4.7
reasoning	13.3	9.9	17.8	9.9	12.8
taking another perspective	2.6	2.7	4.8	2.3	3.0
interpreted in a new way	3.6	1.8	2.1	2.3	2.6
intention to do something	12.2	10.8	14.4	10.7	12.8
successfully learned	11.2	12.6	8.2	10.7	10.8
none of them	54.1	56.8	47.9	57.3	53.3

Table 6: Percentage of balanced sentences for elements of reflection per course. el1 and el2: elarning courses; swl2 and swl3 is the social work course level 2 and level 3; sci: science course

The last column contains the previously reported percentages of the whole corpus. The courses with more sentences will have more influence on the overall percentages. Notable is the 9.4% difference between the social work level 2 course and the science course on the element "none". This means that the former course has nearly for each 10 sentences an additional reflective sentence.

8 Discussion

Based on the intuition that reflection is a rare good (valuable but does not occur frequently), this research provides evidence about the proportions of reflective elements in texts. Based on the literature review, research indicates that the proportions vary on the study level, level of reflection, and elements of reflection. This research presents the proportions of reflection, based on the unit of sentences, from six elements of reflection. It concludes that these elements of reflection are indeed rare, and that some of the elements, for example the element "change of perspective", or "something was interpreted in a new way", are especially rare. In addition, sentences that contain a personal pronoun, are rated as having higher frequencies of reflection. This may indicate that sentences, in which the writer expresses a personal view, are more likely to be rated as reflective.

In addition, the number of sentences of reflective elements varies between courses. While these results are interesting for the comparison of courses, the results have to be taken cautiously, as a bigger sample size would be necessary to carry out a thorough analysis of the elements of reflection. This would be needed to balance the cells containing a small number of sentences.

Compared to the research outlined in the theory part, this research shows proportion of reflective elements from course forum posts, that did not focus on developing reflective writing skills. This may help as a reference to other courses that are especially designed to enhance reflective writing.

This research used sentences as the unit of analysis. While this decision helps to calculate percentages of elements of reflection based on the total sentence count of a text, it bears its own problem. Certain elements may not be able to

be captured in one sentence, and thus the raters might have annotated it as none, although from the wider context it would belong to an element of reflection.

As stated, the studied elements of reflection were not exhaustive to describe all forms of reflection. Further research with other elements, and other operationalisations of the elements would help to extend this research. Furthermore, it may be fruitful to study text corpora with different contexts. This could help to determine, which context factors stimulate reflection or hinder it.

The used approach however allows to quantify the proportions of reflective elements, and it indicates that reflection is a rare good.

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Support for Collaborative Reflection in Healthcare: Comparing two Workplaces

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Abstract. Reflection is a frequent and integral part of daily work, and often it is done by multiple actors in meetings or during joint work. Its support, however, has mainly been investigated with respect to educational settings or individual reflection processes. This paper describes a framework for the support of collaborative reflection at work and a study on its implementation at two workplaces in healthcare. Results of the study show which means of supporting collaborative reflection can be beneficial in practice and that we need to understand this support as a socio-technical task.

1 Introduction: Collaborative Reflection at Work

Reflection is a frequent and integral part of daily work (Boud 1985; Kolb and Fry 1975). Typical examples are thinking about whether certain decisions were right and groups considering whether their cooperation is effective. Reflection processes contain three steps: Going back to experiences, re-evaluating them and drawing conclusions for future work from this (Prilla et al. 2012a). While this has been investigated for *individuals* reflecting, *collaborative reflection* is done by a *group of people* sharing their experiences and jointly developing changes for future work from that (Daudelin 1996; Dyke 2006). The result of such collaborative processes can be relevant for individual work, but also on group and organisational levels. By this, collaborative reflection complements education and vocational training at work with a process of bottom-up understanding and evaluating work and helps people to learn from experiences in a self-directed, collective manner (Daudelin 1996; Hoyrup 2004). However, there are hardly any insights on the design of tools for collaborative reflection.

This papers aims to bridge the resulting gap and describes a study in which support for collaborative reflection was trialled in two healthcare workplaces. From this, the paper shows how collaborative reflection can be supported, that we have to understand this support as a socio-technical task and that there is a need for further work on exploring such support.

In what follows, we describe existing work and insights into collaborative reflection as well as the "Talk Reflection App" as a means to support such reflection (section 2). After that, we present the study conducted in the healthcare workplaces (section 3), its results (section 4) and a discussion on conclusions to take from our work, including impacts on the design of collaborative reflection tools (section 5).

2 Computer Supported Collaborative Reflection

2.1 A Framework for Supporting Collaborative Reflection

Tools for the support of reflection have been discussed mainly in educational settings or with respect to individual reflection. Authors have proposed journals or portfolios or series of pictures to help users to reconstruct and reflect experiences (Fleck and Fitzpatrick 2009; Scott 2010). With the exception of support for specific situations such as post-mortem project reflection meetings (Kerth 2001) and generic tools such as shared whiteboards (Lin et al. 1999) there is hardly any support for collaborative reflection available.

Differences between individual and collaborative reflection can foremost be seen in support for communication among participants and sustaining results – to reflect together, participants need to exchange experiences, different individual perspectives and understandings need to be discussed and solutions need to be agreed on. To operationalize the respective steps of collaborative reflection and the corresponding needs, we created a cyclic blueprint for collaborative reflection tools based on insights from earlier user studies on collaborative reflection (Prilla et al., 2012a; **Fig. 1**).

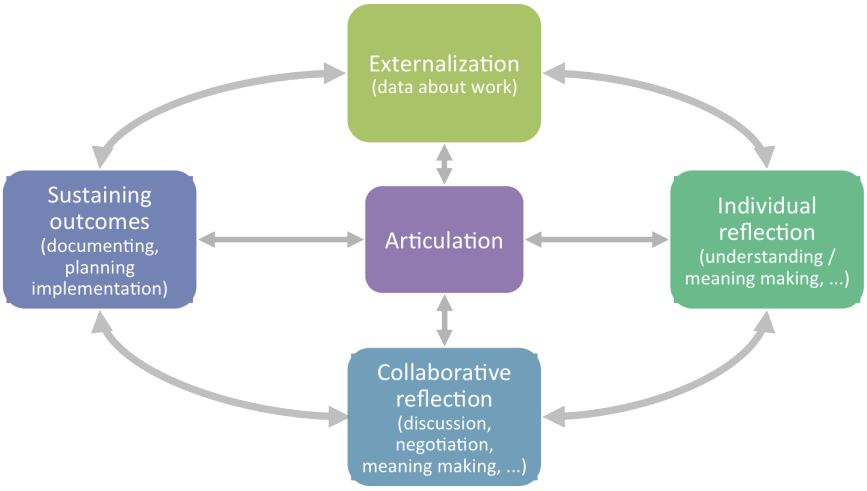

Fig. 1. Cyclic blueprint of collaborative reflection, based on (Prilla et al. 2012a).

The blueprint shows how collaborative reflection is tightly coupled to phases of individual reflection and that these phases constantly switch, e.g. if a topic is discussed in a group, then reflected by individuals with respect to own experiences and later on again reflected within a group. Such reflection needs a sustainable documentation of experiences to share them with others and to sustain all relevant aspects – usually, after a certain time details may be forgotten and emotions may fade, which affects the reflection processes afterwards. Moreover, reflection should end up in sustainable and shareable results if it is to lead to changes in work – otherwise, only the group reflecting knows about proposed changes ad their origin (Prilla et al. 2012b). A central requirement for al steps is support for articulation of experiences, ideas,

solution proposal and results and to be able to share these articulations. **Table 1** summarizes the resulting requirements (cf. Prilla et al. 2012a).

Table 1. Requirements for the support of articulation in collaborative reflection.

Articulation	**Requirement**
Experiences	Documenting experiences for later use
Individual Reflection	Documenting and sharing insights (e.g., in comments)
Collaborative Reflection	Sharing similar experiences and ideas for solutions (e.g., in comments)
Results	Documentation and sharing of results

2.2 Supporting Collaborative Reflection of Conversations: The TalkReflection App

The „Talk Reflection App“ (**Fig. 2**) was developed to support the phases of the collaborative reflection blueprint shown in **Fig. 1** and to implement the requirements documented in **Table 1**. The app supports reflection on conversations with patients in hospitals, residents in care homes, relatives of patients and third parties such as social workers, as our studies in healthcare workplaces revealed that this is a relevant and reflection intensive topic (see Prilla et al. 2012a). Therefore the app supports articulation to explicate experiences from conversations as described in **Table 1**. It also supports sharing these documentations and the articulation of outcomes from collaborative reflection. The usage of the app is explained in the following scenario.

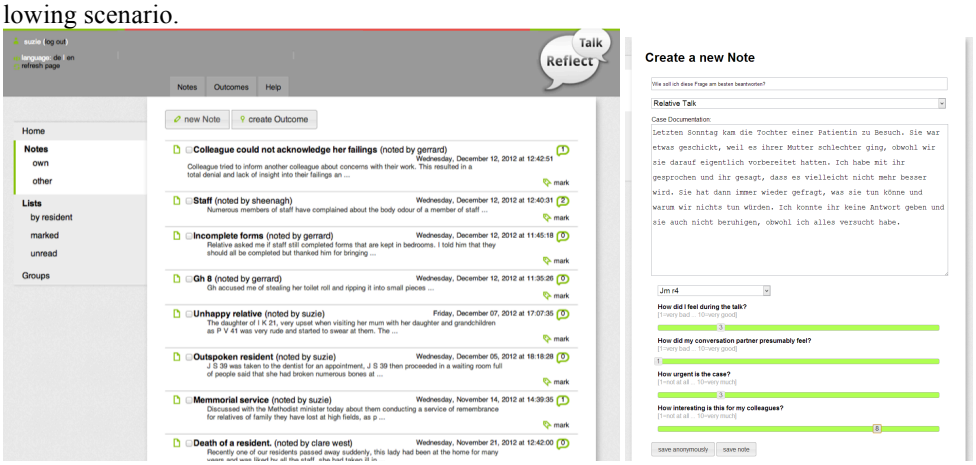

Fig. 2. The Talk Reflection App. Left: Overview of accessible, articulated experiences (documentations); Right: Form for documenting a conversation.

The caregiver Anna has had a difficult conversation with relatives of a resident in the care home she is working hat. Afterwards she *documents* (articulates) the content and topic of the conversation together with her feelings during the conversation in the app. She describes her insecurity when telling the son of an older lady that the lady’s medical conditions are getting worse dramatically, and she might die soon. She uses the content fields to describe this and

the self-assessment sliders below it to document her feelings about the situations (see **Fig. 2**, right).

Her colleague Bernd notices that Anna has shared her note with him (**Fig. 2**, left). When he reads it, he remembers a similar situation he has been in and comments on Anna's documentation, suggesting to refocus the conversation on the relative and to offer him support – in other words, he reflects on his own experience and makes a suggestions for coping with a comparable situation in the future. Since the topic is of interest for the rest of the ward, too, Anna's case is also discussed in a meeting with all caregivers of the ward and together they discuss strategies how to support and teach new caregivers in similar situations. They agree on three things to include in this process and document this outcome of their collaborative reflection in the Talk Reflection App, connecting it to the cases it is related to. They shared it with all colleagues on the ward in order to enable them to reconstruct the suggested solution based on the cases linked to it.

3 Supporting Collaborative Reflection with the Talk Reflection App: A Study at two Workplaces

The Talk Reflection App was trialled for four weeks in a German hospital specialized in care for neurological diseases (case 1) and for five weeks in a British care home for people suffering from dementia (case 2).

In case 1, reflection was focused on conversations between physicians and relatives of patients, as physicians felt they needed to systematically use experiences from such conversations to learn how to act professionally if the conversations get emotionally stressful. They stated that their prior education had not covered this topic and that they would be willing to form a group helping each other in it by using the Talk Reflection App. The study was conducted with five participants, including inexperienced assistant physicians, who had just started work at the hospital and more experienced senior physicians (see **Table 2**).

Table 2. Overview of study participants and tools used to gather data

	Participants	**Data from studies**
Case 1 (Hospital)	5 physicians (2 experienced, 3 less experienced)	Questionnaires (Pre/Post), interviews, observations (meetings), log files
Case 2 (Care home)	5 caregivers (3 to 20 years of experience), (1 manager)	

In case 2, the caregivers wanted to reflect on conversations and interactions with others related to such conversations, including encounters with residents, their relatives and third parties such as social workers. Care for people suffering from dementia is especially demanding for caregivers, as these people might (re)act strangely or even become aggressive. Being able to talk to them, their relatives and third parties in a professional way not only diminishes the personal stress level resulting from that, but also improves the reputation of a care home. The study was conducted with five caregivers, who used the Talk Reflection App to learn about

these situations, and the manager, who wanted to be informed about it, but did not actively use the app.

In both cases, the app was introduced to the five participants in a common workshop in order to enable them to work with it in a self-directed manner. Before the workshop, they were asked to fill out a short (pre-) questionnaire (10 items) to create a baseline on their current reflection practice and need for learning about the respective topics. In the middle of the trial period and at its end, we conducted reflection workshops with the participants, in which they were asked to skim through experiences documented in the app and choose some for reflection in the workshop. During the meetings a researcher was present to observe and document reflection among the participants and to get feedback on the app.

Table 3. Meetings during the trial periods in both cases.

Time	**Meeting and Tools for data gathering**	Observation
Begin of trial period	Introduction and training, pre-questionnaire	
Middle of trial period	Initial reflection meeting on cases in the app	
End of trial period	Final reflection meeting, post-questionnaire, short interviews	

At the end of the trial period, in addition to the final reflection meeting the participants were asked to fill out a post-questionnaire (30 items), which included the same items used to create the baseline and an additional set of items on aspects such as acceptance, value and impact of using the app, which were aligned to the levels of evaluation on the model of Kirkpatrick (1975) – typical questions can be found in section 4. Moreover, the participants were interviewed briefly on their experiences in using the app. **Table 3** summarizes the course of the studies and the tools used for gathering data. This data was complemented by the log data captured throughout the usage of the app.

4 Results

In both cases, the participants used the Talk Reflection App for the documentation of critical conversations and (in case 2) interactions in order to reflection on them later. In case 1, for example, an assistant physician documented a conversation with relatives, which she perceived to be very demanding (see **Table 4**). She created a comment to document this perception. In a later meeting with the other participants, she used this documentation as a memory aid to present this case to her colleagues in a very detailed manner. This caused immediate reactions by her colleagues and in the resulting reflection session of this case, colleagues reported similar cases and proposed different ideas how to better deal with such situations. In the end, they agreed that in these situations, inexperienced physicians should always ask a senior physicians to join until they were confident to deal with such situations alone.

In case 2, caregivers reflected about the death of a resident, who has been admitted to hospital against her advice to the relatives and social workers. One of the caregivers had documented the interaction with the relatives that led to the admittance (see **Table 4**), and

afterwards used this documentation to reflect on this it with her colleagues and the home manager. Some senior staff members reported on similar situations in the past and that a conversation how to deal with the emotional affection directly after the situation had helped them to overcome their grief. Although some had stated initially that such situations can happen in a care home and that the group should not take any particular measures, after the reflection session they agreed that there would be a possibility to have such group conversations after very demanding situations in the future, which would be led by the manager.

Table 4. Sample Documentation, Comments and Outcomes of using the Talk Reflection App in both cases.

Articulation	**Hospital (Case 1)**	**Care home (Case 2)**
Talk / Interaction	"[Patient's] therapy finished. Again relapse, palliative therapy. Prepared [relatives] for begin of home care, asked to seek professional support for care. Talk was very difficult, parts were not received or blocked out."	„The resident passed away suddenly, had been here long, was liked by all staff. Was ill in the morning and her guardian admitted her to hospital, Unfortunately she passed away [there]. This was very distressing to the staff as they felt it would have been more dignified for the client to be in familiar surrounding."
Comment	"[Relative] conveys the feeling it is our fault. (…) Hears for the first time that [patient] is going to die"	- (verbal statements)
Outcome	"Problem: Conversation held alone. It should be known that a senior physician can be asked for support"	„After discussing with the homes manager about the staff being upset, it was decided that staff who were most affected get together and discuss thoughts and feelings."

The examples shown in **Table 4** illustrate that besides documenting experiences and making them accessible later, using the Talk Reflection App also had an impact on the reflection of each individual: In the articulation work (cf. Suchman 1996) of documenting their experiences, the participants had also documented insights from reflection. In case 1, the physician mentioned that she perceived that the relative had blocked out certain information given to her, and in case 2, the caregiver (verbally, not in the app) stated that the grief of staff was mainly caused by the manager, relatives and social workers not listening to their advice. This shows how documenting the cases already triggered reflection.

Looking at the usage of the app in both cases (see **Table 5**), we can see that is was predominately used for the documentation of cases. Given that a critical situation does not appear every day, we consider the creation of 7 documentations in 12[1] days (case 1) and 18

[1] Due to technical problems, there is only solid data for the last 12 days of the trial period, although the participants stated to have used the app before as well. In addition, some physicians created docu-

documentations in 33 days (case 2) to be sufficient for an initial test, in which in both cases the users needed some time to adopt the application and integrate it into their work tasks. All documented experiences were shared with all other participants in both cases.

Despite the sufficient amount of documentations, other features such as commenting and creating outcomes were used below our expectations (see **Table 5**): Compared to the amount of documentations, the number of outcomes (three in case 1, two in case 2) and the number of comments (nine in case 1 and 14 in case 2) are not sufficient and, especially in the case of comments, cannot lead to fruitful exchange of experience as it is necessary collaborative reflection. In addition, some of the created outcomes in the app are a result of reminding the participants during reflection meetings to also write down their outcomes.

Table 5. Number of Documents, Outcomes and Comments created in the Talk Reflection App in both cases.

Type of articulation	**Case 1**	**Case 2**
Documentation of critical conversations / interactions	7	18
Documentation of outcomes from reflection	3	2
Comments on (own / others') documentations	9 (4/5)	14 (11/3)

Despite the numbers shown in **Table 5**, an analysis of statements and feedback given by the participants of both studies during the meetings and in the final interviews shows that they perceived using the app to be valuable for exchanging experiences, reflection on them in the group and deriving outcomes for future work. In meetings, we could observe participants vividly discussing during reflection how certain situations needed to be understood or could be tackled better in the future. In interviews, participants could easily describe comments they had made verbally on others' documents and also some agreements the participants had come up with to solve certain issues expressed in the documentation. The participants reported that all of these articulations and communications had happened outside the app in face to face interactions as they happen daily in hospitals and care homes when people meet each other during work, in meetings or between shifts. These casual interactions were perceived to cause less effort and led to features such as commenting being used less. This effect could also be seen in meetings, in which participants used documented experiences from the app to describe a certain situation to their colleagues and to reflect on it verbally afterwards.

Data from the questionnaires used in the study underpins that there was value from using the Talk Reflection App in both cases, as it indicates that participants perceived it to have a positive impact on constructively thinking about conversations (that is, individual reflecting on them) and discussing conversations with colleagues (part of collaboratively reflecting them, see **Fig. 3**). The data also indicates a light effect on the perception of how situations reflected on could be improved during the trials, which was slightly stronger for case 2. Given that the trials only lasted four and five weeks, this goes beyond our expectations as we had expected changes in behaviour to take longer than this period to be implemented. However, long-term evaluations need to approve this finding.

mentations offline and wanted to save them to the app, although they had no connection to the Internet. This resulted in lost cases.

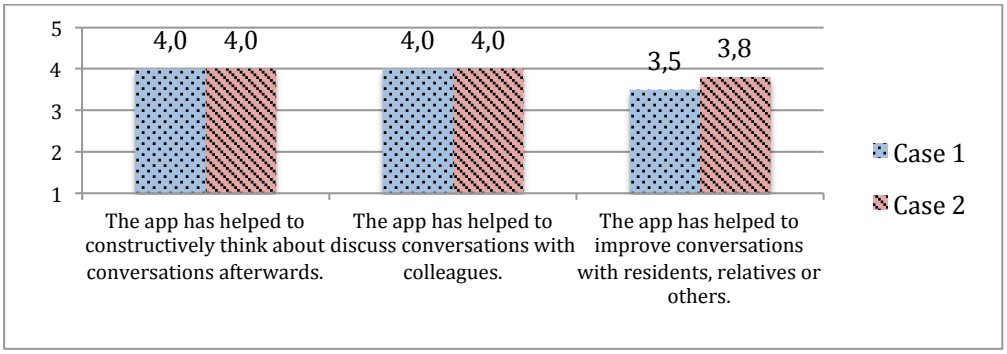

Fig. 3. Perceived value of using the Talk Reflection App in both cases, n=5 for both cases.

The participants were also asked to clarify which factors had influenced their reflection practice. Answers to this show that being aware of reflection as an important topic and organisationally anchoring it in regular meetings was perceived at least to be as important as using the app (see **Fig. 4**). For case 1, the answers even indicate that the participants perceived the app to be less valuable for reflection that the other factors. These surprising results can be attributed to the fact that the studies lasted for only four and five weeks and that in this short period time, the effect of the intervention to more systematically reflect superseded the positive effect caused by the app. This might have been amplified by the time to adopt the app in each of the cases as reported above. On the other hand it shows that the sheer process of introducing the app acted as a reification of reflection, increasing awareness for it – this provides a good basis for long-term success of the app.

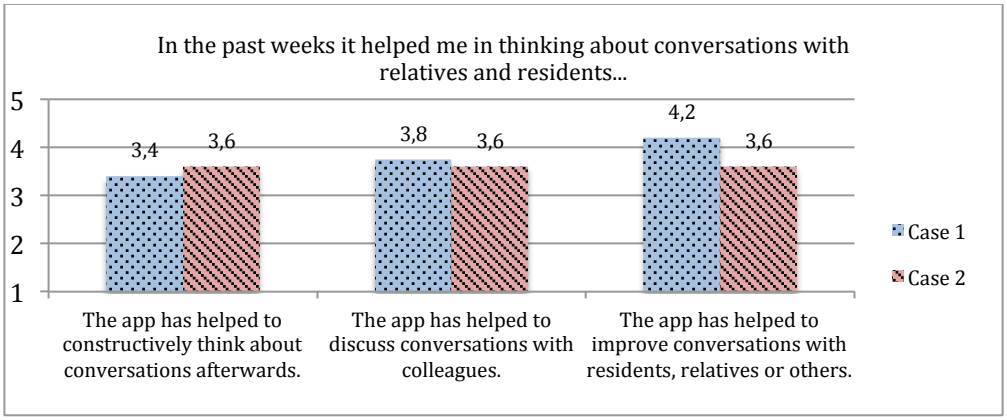

Fig. 4. Factors impacting the reflection practice of participants in both trials.

Although our observations and insights cannot be generalized, as the data from the trials was collected with low participants numbers, they point to the value potentially created by tools such as the Talk Reflection App that support the collaborative reflection blueprint

shown in **Fig. 1**. Further work will have to show whether these positive pointers also show in other cases with more users and a longer period of usage.

5 Discussion: Reflection as a Socio-Technical Task

Results of the study show different perceived value and adoption of articulation support for conversation and interaction experiences, comments and outcomes as described in the framework in section 2.1: While the documentation of experiences and the possibilities to share them with others was used quite frequently, the discussion of experiences and creation of outcomes was observed to take place outside the app (but, sometimes, by using it to refer to its content). This is also indicated by the questionnaire about reflection support (**Fig. 4**). The results thus suggest that, with regard to support collaborative reflection, the Talk Reflection app was mostly used as a tool to *prepare* (by documenting and sharing cases), to *mediate* (initial reflection within the documentations) and to *trigger* (discussion within the group) reflection. To support communication and articulation about experiences and the documentation of outcomes from reflection, further work needs to be done. From these findings, we derived a classification of reflection support as primary and secondary effects happening in technical and social processes (**Table 6**).

Table 6. Primary and secondary support of collaborative reflection steps. Insights derived from the studies and separated by technical (T) and social (S) parts of socio-technical support.

Purpose of Articulation	**Primary Support**	**Secondary Support**
Documentation of experiences	Documentation in app (T)	Verbal explanation (S)
Individual reflection	Reflective parts in documentation (S and T)	
Collaborative reflection	Direct communication (S)	Comments in app (T)
Sustaining outcomes	Direct Communication (S)	Documented results (T)

Our observations indicate that supporting collaborative reflection is a **socio-technical design task**: In both cases positive effects on the reflection process where the result of a combination of social processes with technological components. This explicitly includes that technical support for reflection needs to be complemented by establishing organizational processes.

Although collaborative reflection was conducted successfully in direct communication between participants, there are also trade-offs to be considered: It is necessary to leave and share traces of experience exchange and reflection outcomes for those that did not participate in the reflection process personally. However, during the study participants needed to be reminded to create comments in the app or to document an outcome. The sufficient number of documentations also shows that this problem is not caused by the effort it takes to document a difficult conversation. On the contrary, we conclude that users have to be triggered to also use the app for other kinds of communication. “Prompting“ (e.g., Lin & Lehman 1999), that remembers users of other content and features of a tool, may be helpful for that (e.g. by

showing questions like "Have you been in a similar situation?"). This has to be analyzed in future studies with the Talk Reflection app.

One limiting factor of the study is that the tests were conducted in participant groups working closely together. Physicians in case 1 and caregivers in case 2 communicate regularly as they mostly work on the same wards and floors. Therefore using the comments within the app to exchange experiences may be less beneficial and more time-consuming for them than just talking about it on the hallway during daily work. Future studies have to shed light on the question whether groups that do not work together so closely (e.g. different wards of the same care home or hospital) would use those functions more often.

6 Conclusion and Outlook

This paper describes a study about support for collaborative reflection at two healthcare workplaces. For the study the "Talk Reflection App" was used that was developed based on empirical results and a model of collaborative reflection. Analyzing the results of the study, we suggest that this support has to be understood and implemented as a socio-technical system rather than a development challenge. We found that in the studies the documentation and sharing of situations to reflect about turned out to be a crucial preparation task and trigger for reflection, while comments as part of collaborative reflection and development of outcomes where observed to take place mostly in direct communication between participants.

Future studies have to show whether and how these later phases of collaborative reflection can also be supported. Prompting mechanisms as described above and other concepts are currently tested and evaluated.

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Modeling computer-supported reflective learning: Combining a high-level timeline view with reflection cycles and tool use

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Abstract. To help conceptualize technology enhanced reflective learning in the workplace and guide the development of reflection tools, the Computer Supported Reflective Learning (CSRL) model has been developed in the MIRROR FP7 EU project. This paper presents the CSRL model in its version 1.2.1, which compared to previous versions has a stronger focus on the triggering of reflection, on changes to work resulting from reflection, and on how reflective learning processes involves transitions between levels in the organization. As part of addressing these concerns, the model now includes a separate timeline view explicitly showing levels in the organization. The paper describes how the CSRL model was evaluated in April-May 2013. Main findings from the evaluation are outlined, and implications for further refinement of the model and associated guidelines for its use are discussed.

1 Introduction

In developing technology to support reflective learning in the workplace, there are multiple challenges. One challenge has been the lack of a conceptual model to represent the essential aspects of reflective learning in the workplace in a way that informs the design of reflection tools. This challenge is being addressed in MIRROR, an integrated research project funded under the 7th FP.

One of the tasks in the MIRROR project is to develop a Model of Computer Supported Reflective Learning (CSRL) [1]. In its final version (2.0) the CSRL model is intended as a tool for the design of technology in the domain of computer supported reflective learning in the workplace beyond the MIRROR project, offering a set of model views and guidelines for their use. The rationale and use of the CSRL model can be briefly explained as follows:

*A group of stakeholders in an organization (managers, employees, and developers) want to better understand and support reflective learning in the organization. They sit down together and create a high-level model of the relevant reflection process(es) with the **CSRL timeline view**. They also identify cycles of reflective learning connecting work and reflection on work along the timeline. For each cycle they use the **CSRL***

cycle view *to add more detail on activities and the use of tools.* ***To consider the potential of specific tools to support the reflection, they use the CSRL tool use view*** *to see what purposes the tools might serve. Thus the group agrees on a shared model of the reflective learning process(es) in the organization, informing later design decisions.*

This paper addresses the MIRROR CSRL model in its version 1.2.1. Our focus is the combined use of model views at different levels of abstraction. We present the views and their rationale and report on an evaluation of the views in spring 2013.

The paper is structured as follows: In Section 2 we provide a brief theoretical background. Section 3 presents the current version of the CSRL model with three model views. In section 4 we describe the evaluation of the model. In section 5 we discuss the findings, considering strengths and weaknesses of the proposed approach. Section 6 concludes the paper, proposing further work to be done.

2 Background

Reflection is critical to workplace learning, enabling employees to make sense of complex and dynamic situations [2, 3]. Boud et al. [4] (p. 19) define learning through reflection as "those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations". In the MIRROR project we consider reflective learning to be the *conscious re-evaluation of experience for the purpose of guiding future behavior*, acknowledging the need to attend to feelings, ideas as well as behavior associated with work experience. In the workplace, work and reflection are closely connected, feeding into each other [2, 3]. Reflection on work experiences can happen close to work or with more distance, and it can be based on human memory alone or also on the use of data collected from the work process. Reflection is done individually or collaboratively [5, 6]. Through reflection, an improved understanding of the experience is created, and implications, conclusions, or lessons learned can be derived and applied to work. Cycles of reflection and learning (e.g. [7-10]) transform work experience into knowledge applicable to the challenges of daily work. Informal learning through reflection in the workplace can benefit from the use of technology [11-16].

Models like the CSRL model are developed over time, in collaborative sessions but also individually and asynchronously. The CSRL model, now in its version 1.2.1, is a result of emerging, bottom-up model development [17]. The model captures shared insights about the domain (computer-supported reflective learning in the workplace) among project stakeholders (scientists and representatives of user organizations) with varying perspectives and interests. The insights come from conceptual work, user studies, requirements elicitation, prototype development and evaluations in the project test bed organizations. The representation of the insights in the CSRL model is based on an iterative process of discussion, negotiation, systematic collection of input and hands-on evaluations of the model within the project, and feedback from external stakeholders, e.g. project reviewers. Through this process, the model aids conceptual alignment in the project. As there are different perspectives of reflection being researched in MIRROR there are also several conceptual models that are aligned with the CSRL model in the sense that they extend it by refining aspects of reflective learning.

The CSRL model is intended as a tool to aid the design of technology for reflective learning in the workplace. As such it provides a semi-formal description of the conceptual architecture within which reflection tools should be produced and includes a number of high-level constraints (i.e. business requirements) for more detailed technical requirements and design choices for apps. The guidelines for use of the CSRL model are at this stage rudimentary and mainly consist of the course of actions described in section 4. What is established is that the model is intended for collaborative modeling of scenarios, involving developers as well as (representatives of) users. Particularly in enterprise and organizational modeling, collaborative techniques have been used for developing a joint high-level model of an area through a facilitated process [18-20]. There are similarities between this type of modeling and the one used for parts of the modeling tasks in the evaluation of the CSRL model (section 3).

The CSRL model has a role in identifying/specifying user requirements for reflection tools and guide the process towards the design of the tools. The model can also be used to consider the roles of existing tools in a reflective learning scenario, and help identify roles for which there is currently little support. Before describing how we evaluated the use of the CSRL model, we outline the model with three views.

3 The MIRROR model CSRL

The version 1.2.1 of the CSRL model was developed to address certain aspects of reflective learning in the workplace that were not sufficiently addressed in the previous version of the model. Compared to previous versions the current reflection cycle has a stronger focus on the *triggering* of individual and collaborative reflection, on *changes* to the work process resulting from the application of reflection outcomes, and on transitions between reflection cycles across *levels in the organization* [21]. The model has also been complemented by additional views, that is, model elements and syntax for certain purposes and phases of using the model. For example, a timeline view (section 3.3) has been introduced to allow explicit representation of the levels of the organization involved in the reflective learning processes.

The combination of views in the CSRL is intended to help users of the model meet simultaneous requirements for model quality: *Pragmatic quality* in the sense of supporting communication about scenarios by keeping things simple, and *semantic quality* in the sense of including enough detail to support the design of tools [22]. The main views of the model are summarized in Table 1 and described in what follows.

Table 1: CSRL model views and their purposes

Model view	Purpose
Reflection cycle view	Modeling the reflective learning process, focusing activities involved, transitions between stages, resulting changes to work, and the triggering of new reflection cycles
Timeline view	High-level model of reflective learning stories, e.g. representing user requirements. Providing a structure for modeling reflective learning cycles. These can be seen as an instantiation of the more abstract reflection cycle, making it more understandable and acting as a bridge to the more detailed design information provided in the tool use view

Model view	Purpose
Tool use view	Showing how reflection tools support activity in the reflection cycle, linking tool use to each of the stages

3.1 The reflection cycle view

The reflection cycle view of the CSRL model generically describes the learning cycle in which reflection on work experience leads to outcomes that feed into changes to work and/or into further reflection [21]. The main elements in the reflection cycle view – see Figure 2 - are *stages* (rounded boxes), *activities* within the stages (text items below the name of the stage), *transitions between stages* in the cycle (closed arrows), and *transitions to new reflection cycles because of a trigger* (dashed arrows).

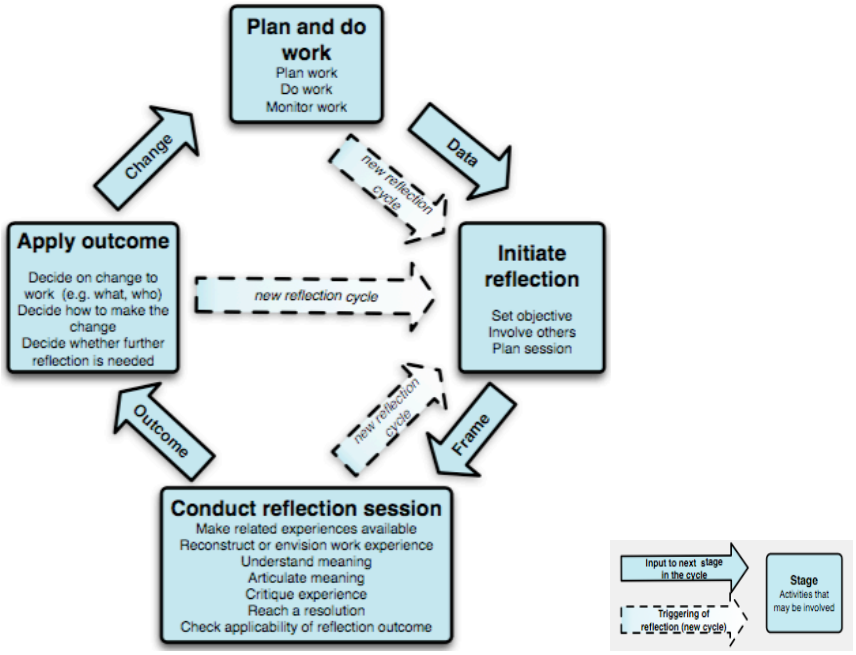

Figure 1: CSRL model v1.2.1 Reflection cycle diagram

In the current version of the CSRL model, increased attention has been given to the *transitions* between stages. There are different criteria for when it is appropriate to make a transition, e.g. when the Data (from work), Frame (for reflection), Outcome (of reflection) or Change (to work) resulting from the activities in the stage meets certain requirements [23]. The initiation of a transition to a new reflection cycle happens when there is a reflection *trigger*: a discrepancy leading to a state of discomfort that the individual wants to overcome [24] or to other motivation to change work in some way. Also, the individual may, for various reasons, involve others in collaborative reflection [25]. Triggering can be external, when some event outside the individual (e.g. a prompt from a tool) creates awareness of the discrepancy. Note that initia-

tion of a new reflection cycle can start within an existing cycle, e.g. originating in the Conduct reflection session or Apply outcome stages.

3.2 The tool use view

Tools can support the activities in each stage of the reflection cycle in various ways. They can help the user by *capturing data, providing data, scaffolding* the process, and *simulating work* [1]. Also there can be *tool support for involving others (for work or reflection)* and for *determining whether to proceed to the next stage* in the cycle. More information on this view is found in [21].

3.3 The timeline view

A CSRL timeline model (see Figure 2) consists of an upper part representing activity on the work arena (e.g. doing work and planning work), and a lower part (below the thick line) for reflection on work experience. Time runs from left to right in the diagram. A model consists of a sequence of steps along the timeline. There are four types of steps: work (yellow box, vertical lines), reflection triggering (pink arrow, checkered), reflection (blue box, horizontal lines), and change to work (green arrow, diagonal lines). The horizontal/vertical/diagonal lines and checkering have been added for the purpose of this paper, to make the elements distinguishable in black-and-white. Work activities may be categorized as individual, team or organization wide, as shown in the layers above the thick line. Reflection may be individual or collaborative, as indicated in the layers below the line.

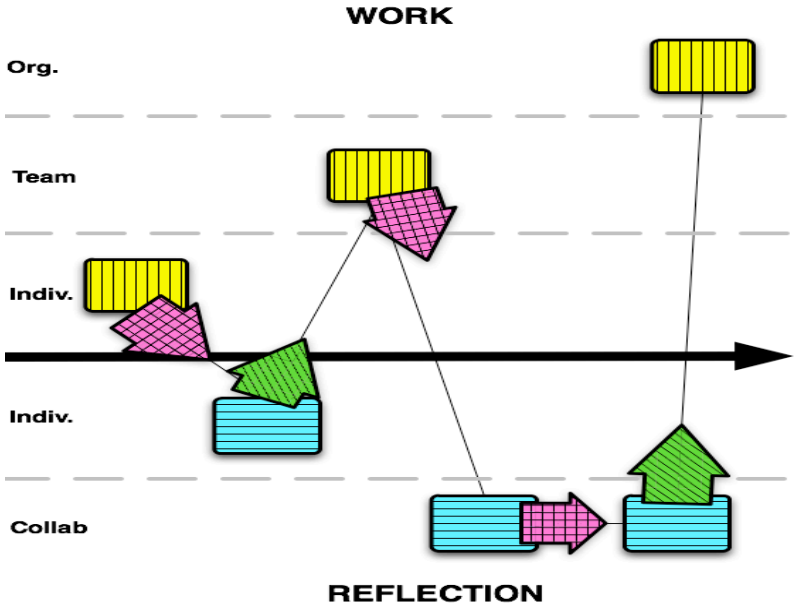

Figure 2: A model in the CSRL timeline view

For each of the boxes and arrows, some information is to be specified, see Figure 3.

Model element	Symbol	Information specified for the element
Work		**Who** is doing the work? **What** is being done?
Trigger		**Why** is reflection triggered? What is the **objective** of the initiated reflection?
Reflection		**Who** is reflecting? **How** does it happen? i.e., if desired, name/describe the approach.
Change		**What change** is made? **Who** is affected? (i.e. individual, team, the entire organization)

Figure 3: Information specified for the elements in the timeline view

4 Evaluating the CSRL model v1.2.1

The CSRL model v1.2.1 was evaluated in April-May 2013 within the MIRROR project. There were two main parts of this evaluation:

- First, the CSRL reflection cycle (in an interactive, "clickable" html version) and the types of tool use (formulated as checklist questions: "How does your app help the user…") were applied to the MIRROR apps. The purpose here was to check whether and how the apps supported the various steps of reflection.
- Next, the CSRL timeline view in combination with the reflection cycle view was evaluated in a collaborative modeling exercise.

Below we report on how the evaluation was conducted and present key findings.

4.1 Evaluation of the (clickable) CSRL reflection cycle and types of tool use

The CSRL reflection cycle and the tool checklists were evaluated in May 2013 by 8 MIRROR developers and four representatives of user organizations. They individually applied the checklists to the MIRROR apps they were involved with. All apps were in this way addressed. The participants were already familiar with the previous version of the CSRL reflection cycle with associated types of tool use. The checklists were used to describe existing apps that have not yet been extensively evaluated, the answers reflecting how the developers and test beds intend or expect the apps to be used. After the exercise, the participants filled in a questionnaire, focusing on the usability and relevance of the clickable model and the tool checklist items.

Findings from the evaluation show that the list of tool use types (cf. section 3.2) can be used to describe the role of apps for different reflective learning settings and types of reflection tools. By systematically addressing the questions in the checklists most of the developers were able to comprehensively describe the intended types of use of their apps. Answers to the follow-up questionnaire showed that some of the types of tool use were perceived as less clear, for instance *monitoring work* or *providing scaffolding*. The clarity of some items in the tool checklists should be refined in

the next version. Also there are some aspects of reflection and tool support that are not explicitly addressed in any of the current items that maybe should be captured in new items in the list. Especially, "providing scaffolding" seems to be too wide as a category in light of current focus in the project on guidance and prompting. 6 out of the 8 developers reported that the exercise of applying the tool checklists to their apps lead to *new ideas about app functionality or use*. This means the model served its intended role as a design tool by helping developers iteratively improve existing apps.

4.2 Evaluation of the CSRL timeline view

An evaluation of the CSRL timeline view was conducted in May 2013 by participants from the MIRROR project. In the evaluation, 26 participants distributed over five groups, each including at least one developer and at least one representative from an organization using or aiming to use MIRROR tools. In the groups they created models in the CSRL timeline view (see examples in Figure 4 and Figure 5) based on textual scenarios/stories of reflective learning, which were taken from empirical work in the test beds, for example a scenario of behavior in a medical emergency. Each group worked on a scenario that had been created in advance by 1-2 group members familiar with the app(s). The scenarios were to be of relevance to the partners and include one or more MIRROR apps. The groups had no permanent facilitation support, but a researcher circulated through the groups to answer questions on the modeling work.

Three of the scenarios prepared for the evaluation included the combined use of two or more apps. Below is shown the result of two groups modeling their scenarios.

Figure 4: Example 1: CSRL timeline model (scenario including use of two reflection apps)

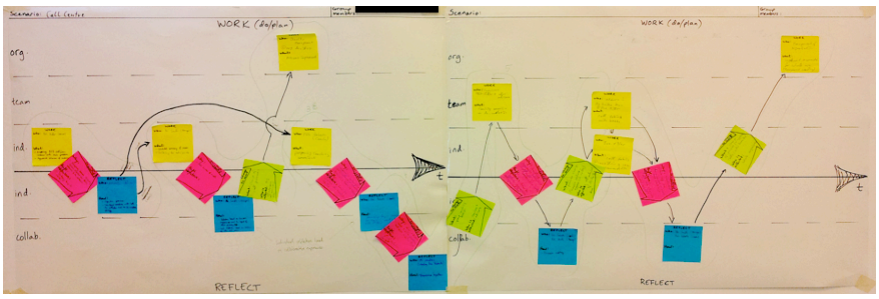

Figure 5: Example 2: Scenario including use of three reflection apps

It should be noted that all the stories modeled in the evaluation were designed to have a "happy ending" in the form of change to work at the organizational level. The modeling ensured a clear focus on this level (and how to get there) through the visualization of the different levels.

After the timeline diagrams had been created, the CSRL reflection cycle model was used as a template for specifying more detail about each cycle (one diagram per cycle), in particular the use of reflection tools. Figure 6 shows one of the cycles in the timeline in Figure 4. It can be seen that the tool "TalkReflect" is being used in the *Plan and do work* stage of the cycle, whereas the tool "DocTrain" is used in the *Conduct reflection session* stage. It can also be seen that the reflection session can end in a new reflection cycle being triggered, or in a change to work. Figure 6 also shows that the participants understood that an outcome of reflection might also be how to improve learning (in this case by "collection more data") instead of direct changes to work procedures.

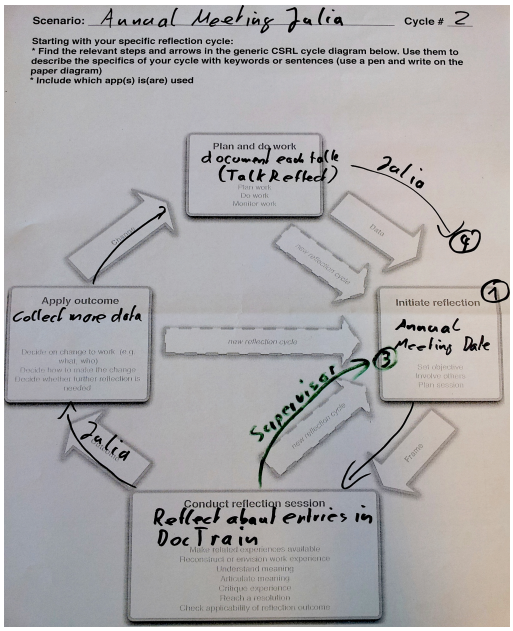

Figure 6: Reflection cycle detailing a single cycle from the timeline in Figure 4

After the collaborative modeling exercises the participants individually filled in a questionnaire to provide feedback on the modeling. We will briefly describe key results from analyzing the data (diagrams and answers to the questionnaires).

Modeling with the CSRL timeline view was perceived as useful by the participants. To the question "**What do you think about collaboratively working on a scenario model in this way?"**, 25 out of 26 participants used positive terms, the last pointing to a challenge without being negative.

Two questions addressed the usefulness of the timeline view and the cycle view, respectively, for design. The question about the timeline view was: **"Imagine you were involved in a process of designing another reflective learning tool, either**

from scratch or to iteratively improve an existing tool. Would you consider creating high-level models of scenarios in a way similar to what you did in this exercise? Please briefly explain." Answers were generally positive: 23 of 26 answered yes (many with additional remarks about the purposes for which they would use it and/or conditions that need to be in place, especially real data from the workplace and participation of users), two answered no (saying respectively that they would prefer to use only personas and not scenarios, and that they thought the modeling might not be beneficial for technical development because the cycles would change due to the tools), and one can be considered neutral (arguing that s/he would not know because s/he is not a developer). It is interesting to note that the two respondents (both experts in software development) who explicitly say they would not use the model for *design* were both positive about using the timeline in an early phase of a project to support communication with users. Follow-up interviews would be interesting in these cases.

Another question addressed the use of the cycle view to aid design: **"Imagine you were involved in a process of designing another reflective learning tool, either from scratch or to iteratively improve an existing tool. If you were to use the CSRL cycle model to aid the design process, how would you use it?"** The answers were generally positive, but referred to many different reasons for conducting this step, only some related to reflection tools. For instance, it was mentioned to use the cycle model to create a scenario, to understand the problem better and identify people involved, to ensure completeness of the scenario, to detect flaws in the combination of tools, to check if all aspects are supported, to better understand how an app can be useful. A couple of participants did not see the benefit of the detailing after working on the timeline diagram. Answers to this question and other questions showed that many participants would like to have more guidelines e.g. on how to proceed from the timeline to the detailing of the reflection cycles.

One group, which dealt with applying certain tools in a healthcare scenario, was observed permanently during the exercise (Figure 4 and Figure 6 show models created by this group). The group was composed of three representatives from a German hospital that had tested some tools mentioned in the scenario and wanted to integrate them into their practice, and three tool designers. Besides one designer who had used the timeline view earlier, none of the participants knew more about it than what they had been told in the briefing before the exercise. In the beginning of the group work, the participants focused their discussion on the scenario and had difficulties translating their utterances into elements of the model. The more experienced designer took the lead in this and proposed how it could be done. Over time, other participants took over this task, which shows that they got accommodated to the way of modeling. Participants also made free use of the model elements and sometimes extended them by writing additional text on them such as which tool could be used in certain situations. From working on the model, they sometimes switched back to talking about the scenario and made slight changes, e.g. when they realized that it could be made more efficient in some aspects. Sometimes they forgot to document decisions made during these discussions and had to be reminded by other group members (predominantly the designer who was more familiar with the approach). When they switched to describing the individual cycles taken from the timeline view, negotiation processes between the tool designers and the hospital representatives started, e.g. when they were discussing to which extent the tool "DocTrain" can support discussions as indicated at

the bottom of Figure 6. Finally, as can be seen from Figure 4, the group created a fairly detailed timeline model, which also contained parallel actions. The resulting model was not as detailed as one would have expected from a professionally run modeling workshop (Figure 6 exemplifies this well, as it outlines the process of reflection but does not provide enough details for third parties such as designers to understand the process fully) but was sufficiently complete for the group to agree in the end that they had made significant steps ahead in both creating common understanding of how the tools could be used to produce value in the hospital and improve the envisioned scenario. They reported that they had had a productive workshop that advanced their idea of implementing reflection support.

From temporary observations (stepping from group to group during the exercise) and feedback of other groups and their members, we also learned that the transition into modeling reflection cycles with the CSRL reflection cycle diagram generally worked, but identifying the cycles was sometimes challenging. Also the *rationale for* this step was a bit unclear in the exercise, which may be due to the fact that discussing tool features was not a main focus of the exercise (and also there was little time for it). However, the modeling approach did enforce consideration of, and being explicit about, what are actual triggers of reflection and the resulting changes to work (or resulting initiation of more reflection) in the scenarios.

From the resulting timeline diagrams it can be observed that three of the groups decided to model branching processes, which is an adaptation of the approach. The need to model branching was commented also in the questionnaire. The diagrams also show some other deviations from the original modeling language, e.g. positioning of elements between two levels to express uncertainty about where an element belonged.

4.3 Strengths and limitations to the evaluation

In interpreting the findings, it is important to take several factors into account. The participants in the evaluation were generally familiar with the model, most of them having participated in earlier iterations of evaluating and refining the cycle model (with associated types of tool use). All participants were aware that they were participating in a process of evaluating the CSRL model in order to improve it, with the added benefit of getting more insight about the scenarios being modeled. This provided the participants with background knowledge on reflection cycles and made it possible to present the timeline view as a high-level view of a reflective learning process consisting of several reflection cycles. Also the participants were familiar with the need for the CSRL model to offer ways of representing levels in the organization, and to be able to model scenarios involving more than one reflection tool. Prior to the evaluation of the timeline view, the developers and some of the test bed representatives had been participating in the evaluation of the clickable version of the reflection cycle, applying the associated checklists to their specific apps. All this prior knowledge of the CSRL model means that we cannot deduce from the evaluation results how the model would be perceived and used by someone who does not already know it. It is however likely that whatever is unclear to those familiar with the model, is likely to be *more* unclear to somebody who is new to it. Furthermore, the findings should be understood in light of the stage of development of the reflection tools in the modeled scenarios, and the status of the scenarios. The tools (MIRROR apps) in ques-

tion are existing tool prototypes, most of which are currently undergoing formative evaluation. The scenarios were developed before the exercise and did not represent new learning needs or tool usage. The most novel element, relevant for three of the groups, was the *combined* use of tools. It was in the interest of the participants (in light of their various objectives for their work in the MIRROR project) to develop a shared understanding of how tools can be combined to support reflective learning in the organizations in question. The evaluation showed that all groups considered it useful to improve their shared understanding of their scenarios

The fact that the evaluation consisted in two separate exercises means that we lack results on the coherent, stepwise application of the cycle, timeline *and* tool views to a scenario. The evaluation was done in a project that the researcher responsible for the model was part of. This might have lead to socially wanted answers, i.e. regarding what the participants thought about collaboratively modeling the scenarios. Also, it is a limitation that we do not have observational data from all the collaborative modeling groups, which could have been used to get insight about the stepwise development of the models, including the rationale for each step

It can be considered a strong aspect of the evaluation that the constellation of stakeholders in each group included app designers and representatives of the user organization or the project partner representing the type of user organization in question. Also in most groups there were other participants that could offer additional viewpoints. This can be considered a strong aspect of our evaluation, allowing us to derive insights on the usefulness of the model for creating shared understanding among stakeholders with different perspectives and interests.

5 Implications for further development of the CSRL model

Based on the evaluation of the CSRL model and the objective for the model to support the design of technology for reflective learning in the workplace we have identified main considerations for further development of the model and its guidelines: Use of the CSRL model for communication among stakeholders, switching between levels of abstraction, flexibility (vs. rigidity), and the need for guidelines/facilitation.

5.1 Use of the CSRL model for communication among stakeholders

The use of the timeline can be considered as an instantiation of the generic CSRL cycle view, showing how different cycles can be connected in a reflective learning process in a specific case. The evaluation showed that modeling reflection as in our approach can help stakeholders improve their shared understanding of a scenario of computer-supported reflective learning, as it was obvious in the group observed more intensively. This came at the cost of losing accuracy and details in the model compared to other ways of modeling (e.g., together with a modeling expert). The drawback was however outweighed by the quality of the resulting models and the effect on collaboratively understanding and designing reflection processes and tools usage in them. Of particular importance here was the interplay of talking about the model and the process it represented. Instantiation of an overall model is a traditional technique

for improving understanding among stakeholders of the overall model (improving pragmatic quality). Our evaluation results indicate that the use of the CSRL timeline helped participants improve their understanding of how the CSRL cycle model can used to model different specific cycles. This also made the participants recognize aspects of this model that were difficult or unclear. The timeline view furthermore made it possible to add detail to the CSRL cycle view by bringing in the individual/organizational interplay, something that was commented as a lack of semantic quality (completeness) of an earlier version of the model [17]. Finally, the notation in the timeline view with the bright colored elements worked well for hands-on collaborative modeling. The notation is adapted to collaborative modeling sessions without tools, for which a clear differentiation of elements (e.g. through color) is important.

5.2 Switching between different levels of abstraction

It can be considered essential to the effectiveness of modeling that the model supports shifts between different levels of abstraction. Having different models that represent aspects on different abstraction levels is good for comprehension of the individual models, but it is challenging to keep the different models consistent. In this regard there are some challenges to the current version of the CSRL model.

There is a mismatch in notation that results in some confusion. The notation in the timeline view (Figure 2) was created with the purpose of highlighting specific aspects and thereby shifting focus a bit as compared to the cycle view (Figure 1). The result can however be perceived as inconsistencies between the views, which was commented by some in the evaluation. The main inconsistencies relate to the representation of triggering and change to work: triggering (initiation of a new reflection cycle) is represented with a dashed arrow in the cycle view and with a closed arrow in the timeline view. Change to work is a transition (not a stage) in the cycle view, but one of the four main elements in the timeline view. This means that the color-coding of the four elements in the timeline view cannot be transferred to the four stages in the cycle view. In the guidelines for using the model, this will have to be well explained. Better matching between the visual format of the model elements, e.g. in the use of colors, should be discussed as a possible improvement of the notation in order to better support switching between different levels of abstraction. Another way to deal with this is simplifying the model elements even more (see also section 5.3), no more differentiating e.g. between triggers and transitions on an element level, but using textboxes to describe both arrows. However, the differentiation of triggers and transitions might not be decisive during the collaborative modeling of stakeholders, but be best done by experts from the group post-processing the models (see section 5.4).

The timeline view turned out to be helpful to users who had not been trained to abstract from concrete situations in order to model reflection formally. Compared to the reflection cycle view, the timeline view is much closer to the understanding these participants have of how reflection takes place in practice. The quality of the resulting models shows that this helped people create an initial set of specifications of how a certain set of tools can be used to support reflection in their organizations. The models provide a starting point for further work and might not have been created in such quality if the participants had used the more abstract main view of the CSRL model.

Considerations about consistency between levels can also be made with respect to the connection between the activities in the steps of the reflection cycle and the types of tool support outlined in the tool use view. This is not a question of notation but of clarifying the actual mapping between activities and use of tools, which is not 1-1.

As part of the work on the next version of the model one should look more at the cognitive integration [26, 27] between the different sub-languages, aligning notation and color usage.

5.3 Flexibility (vs. rigidity) in the modeling

The need to model branching processes was seen in participants' questionnaire answers, in three of the five timeline diagrams (e.g. Figure 4 and Figure 5) and in the group we intensively observed. The latter used branching processes to depict that the same trigger might cause reflection on different levels or with different participants, and to show that there can be outcomes from reflection that affect different levels of work and thus continue the reflection process on different levels.

In collaborative modeling it is generally important to keep the modeling notation used simple [18, 20]. The process-oriented notation used in the timeline view is no exception to this. On the other hand the need for simple control structures (e.g. parallel tasks, alternative tasks) is found in all standard process modeling notations (BPMN, UML Activity diagrams, EPC etc.), and also in all but the simplest process patterns [28]. Thus, the need for representing branching in processes of reflective learning in the workplace should not come as a surprise. Simple branching should be considered for the next version of the CSRL model. We should however avoid trying to formalize the control-flow modeling mechanisms too much, as it will make the language harder to use. Thus considerations for achieving semantic and pragmatic quality must be balanced.

5.4 The need for guidelines, facilitation and experts present

In collaborative enterprise modeling [18, 19, 29] facilitation of the modeling process is regarded as important. However, there are also approaches showing that using the right metaphors and interaction designs, users might create certain models on their own, without the help of an expert [30, 31]. In the evaluation we saw participants act on their own with the modeling elements and others who needed support by more knowledgeable members of the group. In addition, the challenges described in section 5.2 might have been diminished by some expert support. In the case of modeling reflection, facilitation and guidance then need to be available in different ways. For facilitation, knowledgeable participants might be able to take the role as champions in the model processes, as it was the case for the designer in the group we intensively observed. Such people are much more likely to be present when modeling takes place, e.g. in staff meetings and the like. Guidance then may be given by these users, but can also be available from written documentation – the need to have an expert onsite would severely slow down the process. Therefore, as argued above, keeping the complexity of modeling low and providing such documentation might be most suitable in order to keep the flexibility of modeling high enough to engage end users into it.

Expert support, however, is necessary in the post-processing and follow-up phases of modeling reflection: If we use the user-driven model phase to gather initial models and build common understanding of reflection processes and tool usage in them, there is a need to clean up the models afterwards in order to make them readable and to refine them to a level of detail and quality sufficient for implementing processes. These steps might not be feasible without an expert, who knows about the levels of detail and may also detect flaws and contradictions. Further research will thus also include finding a away to let stakeholders model as much as possible on their own, while using expert support for tasks stakeholders cannot do well on their own.

6 Conclusion

Based on results from the evaluation of the MIRROR CSRL model we have argued that the CSRL model has pragmatic quality supporting communication about reflective learning scenarios among different stakeholders. The model also has a semantic quality that allows the representation of more detail to aid the design of computer support for the scenarios.

To aid the development of the next version of the CSRL model, evaluation of the stepwise application of all views of the model should be conducted. It would be particularly useful to do this with subjects who are not already familiar with the model. This will also address the question whether the model and its views are equally usable for different stakeholders such as experts, users or developers.

One question that needs to be addressed in the work on the next version of the CSRL model with associated guidelines is how far into the process of developing CSRL tools the model should be used. Currently we do not see CSRL model as a tool for supporting design in the steps immediately preceding coding, but as a conceptual tool to help identify and agree on user requirements and build an understanding of how reflection tools could meet these requirements. The guidelines for use of the CSRL model needs to be clear about the role of the different model views with respect to different phases in a process of developing CSRL solutions.

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Improving awareness and reflection through collaborative, interactive visualizations of badges

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Abstract. This paper introduces novel ways of improving awareness and reflection through visualizations of badges as an abstraction of learning analytics data. We report initial findings with both a personal dashboard approach, Navi Badgeboard, that provides details on student and class progress, and a collaborative, interactive tabletop visualization, Navi Surface, to promote group reflection. We evaluate both approaches to find improvements among students regarding awareness and reflection on course activities. Our results indicate that Navi Badgeboard helps with awareness of personal activity while Navi Surface improves collaboration resulting in better reflection.

Keywords: learning analytics, learning dashboards, collaboration, reflection, awareness, visualization, badges

1 Introduction

Feedback and collaborative discourse, between student and teacher, among students and even with external parties, leads to significant gains in learning [2]. Traditional tools for this are exams, class discussions, self-assessment and peer evaluations, but also (micro-)blogging (Twitter, Wordpress, Facebook) can help students share and reflect on their work, collaborate, discuss and learn from class mates [10]. These processes leave behind a multitude of learner traces that reflect activity and progress of students [17]. We strongly believe that visualizations of these traces in so-called learning dashboards can assist in creating a feedback loop of awareness, reflection, sense-making and impact [17] and improve motivation [13].

In previous work, we have developed visualizations of learning traces through tools such as StepUp![14], SAM[6] and TinyARM[13]. While these traces provide a broad insight on student activities, the abundance of information can be overwhelming for both student and teacher, even when presented through bar charts, line charts and parallel coordinates.

This paper focusses on our attempts to visualize an abstraction of trace data. We limit the data to the essential course goal settings. The goal is to assist in informing the students individually about their progress and to enable discussion in class. This abstraction can be achieved by defining badges for activities.

We visualize the data through two applications that we have developed in an attempt to improve awareness and reflection: a personal learning dashboard to support individual awareness and reflection and an interactive visualization on a multitouch tabletop to support collaborative awareness and reflection.

In section 2, we will discuss more examples of learning dashboards, collaborative visualizations and the use of badges in learning. Section 3 explains the setting of the course we use to evaluate our tools and explains the badge system in more detail. Section 4 elaborates on 2 approaches: the personal dashboard and the collaborative visualizations. Section 5 details the evaluation of the tools, followed by some ideas for future development and conclusions in section 6.

2 Related Work

The Quantified Self (QS)[1] movement, which focusses on collecting user traces and using data for self-improvement, is spreading across multiple domains but is probably best known for its application in personal health [16]. Through mobile phone apps and an increase in cheap tracking devices (e.g. Fitbit[2], Nike+[3]), people can become more aware of their health and modify their behavior by tracking activities such as walking, sleeping, running, etc. A similar change in behavior can be achieved with students by applying QS to learning, tracking the traces students leave behind through e.g. blogging, time tracking etc. [4]

These learning traces can help students become more aware of their activities. By visualizing these traces through interactive dashboards, students and teachers are provided with better ways of exploring and understanding this abundance of data [14][6]. Personal dashboards can also be populated with grade and badge data [8].

Badges, which are essentially another form of abstraction of the tracked data, bring with them many benefits and uses: The creation process of the badges can influence the design of the course [7] and hence create clearer goals for both student and teacher. Badges can be used as feedback and are proven to directly impact behavior and motivate students in off- and online courses [11][13][7]. Skill recognition can be brought outside the classroom to support life long learning by using badges as certifications in e.g. Massive Open Online Courses [7][5].

As collaboration can have a serious impact on learning [2] and the possibilities of collaborative visualizations are yet to be explored more fully [9], this paper does not only look at personal learning dashboards but also at ways of combining interactive discourse with learning traces and more specifically badges. Our research focusses on awareness and reflection through tabletop displays: as a collaborative tool in a formal setting, they cause students working in small groups to articulate and reflect on their insights more than while using more conventional displays [15] or paper [12]. They can also be used in more informal settings, a public place like a university hall where collaboration between

[1] `http://quantifiedself.com`
[2] `http://www.fitbit.com`
[3] `http://nikeplus.nike.com`

strangers helps increase awareness and reflection regarding a specific topic [1]. We focus on how to improve awareness and create a better insight of the learning process.

3 Learning Analytics Data

3.1 Course Setting

We evaluated our tools in a class of 26 engineering students between the ages of 20 and 25 following a course on Human-Computer Interaction (HCI). This year, the course focusses on the design, development and evaluation (usability, usefulness) of a recommendation application. Students work in groups of 3 and improve their application through iterative development. The course, while it includes face-to-face studio sessions on the Science Campus of KU Leuven, is open to everyone. All data including presentations, course material and reports is publicly accessible online, through Slideshare[4], the course wiki[5] and the group blogs which students are required to update regularly. They use Twitter with a course specific hashtag (#chikul13 [6]). Discourse happens through class discussions and comments on each other's blogs and tweets.

3.2 Learning Traces

The student generates data by blogging, commenting and tweeting. These activities leave behind traces that can be used by learning dashboards to visualize activity and progress. Both individual and group activity can be visualized, but also data on interaction between students, groups and even interaction with external people is available. Visualizations can help students become aware of their activities and compare their performance to evaluate their progress in class.

Automated trackers hook up to the RSS feeds of the blogs and connect to the Twitter API. They gather student generated data, store it in a database and make it accessible to other applications through a REST service. On these services, learning dashboards can be developed visualizing the data. This framework is explained more in detail in [13].

3.3 Badges

In previous attempts, we have focussed on showing all the collected data. While these dashboards provide an abundance of information, it is interesting to limit the feedback to the essentials (e.g. in the HCI course: regular blog activity, commenting activity). Badges help abstract the data and create a more generalized overview of the traces. This can provide a better understanding of the goals settings and the required activity.

A badge is set up as follows:

[4] `http://slideshare.net`

[5] `http://ariadne.cs.kuleuven.be/wiki/index.php/Chi_2013`

[6] `https://twitter.com/search/realtime?q=chikul13&src=typd`

- a badge icon with an easily identifiable image related to the semantics of the badge (see Fig. 1).
- a color coding for categorizing the badge by type (positive, negative, neutral).
- a bronze/silver/gold medal for badges indicates different levels of achievements.
- a textual description on how the badge can be achieved.

To define what badges we use in our HCI course, we looked at the activities that are important. Blogging and Twitter play a big role in the course as they are indicators of commitment and collaboration, so we want to award this behavior. For example, badges are awarded for a specific number of tweets, posts, comments. High comment activity on a post is usually triggered by the content of that post. Therefore badges can also indicate quality of the content of a blog post which can be derived from the number of comments it receives, by internals (students, teachers) and externals (visitors). Inactivity is a behavior students should attempt to avoid and can be detected through lack of digital traces, that we translate into a negative badge. In total we defined 51 badges of which 42 were awarded repeatedly bi-weekly. The full list of 51 badges can be found at `http://navi-hci.appspot.com`.

Badges are automatically assigned. Certain activity in the tracked data will trigger an event when requirements are met and a mail is sent to the student with information on the awarded badge. This badge data is also stored and can be accessed through a REST service, creating an open data framework on which other visualizations can easily be developed.

We follow the Mozilla OpenBadge Standard[7], so that students can choose to publish their awards on social networks.

In the next section, we will discuss how these badges are shared among students, in an individual and collaborative way.

4 Personal and Collaborative Interactive Visualizations

4.1 Two Approaches

Badges can assist in informing students individually about their progress but can also play the role of a catalyst for discussion. We present two methods that attempt to increase awareness and reflection in quite different ways.

The first approach relies on personal dashboards. Navi Badgeboard provides an overview of achievements and progress. Students can also compare progress with that of the class. This tool is used in a personal way, usually outside of class on a desktop computer or mobile device. The data is open and public and therefore not only students can access each others' dashboard, but also teachers and externals.

While the first approach gives students the opportunity to check their progress on their own time, the second approach is more controlled and direct by facing

[7] `http://openbadges.org`

students with their achievements (or lack thereof) in a public setting. One way to achieve this is by projecting Navi Badgeboard in class while the teacher moderates a discussion around specific badges. As only the teacher is in control of this projection, students play a more passive role in this discussion. To create a more active discussion where all parties have equal power in steering the conversation, a more interactive visualization is necessary with support for multiple users. Therefore we take our second approach to tabletop displays, creating Navi Surface which allows students and teacher, or groups of students, to create and moderate a more open and deeper reflection discourse.

4.2 Navi Badgeboard

Through Navi Badgeboard, the user can discover the badges and therefore the intended course learning outcomes of the HCI course and find more detailed information on how these badges can be achieved. It also presents the user with a list of all students participating in the course. From this list, each student's Personal Badge Dashboard can be accessed.

Personal Badge Dashboards contain a list of badges per bi-weekly period (see Fig. 1): greyed-out badges have not yet been acquired by the student, colored badges have. The user can cycle through the bi-weekly periods.

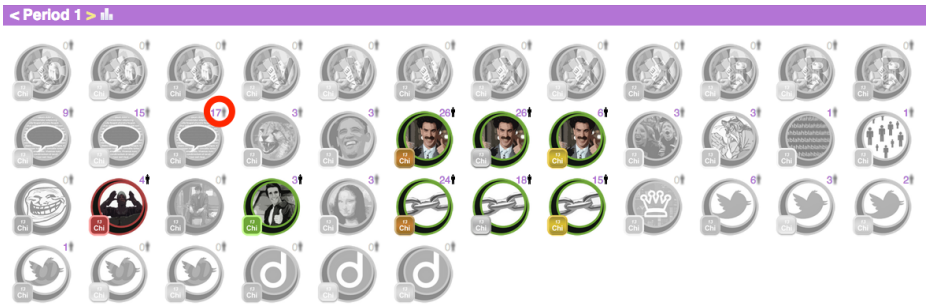

Fig. 1. Navi Badgeboard - Personal Badge Overview: A student's badge overview for a given period. Colored badges have been achieved, greyed-out ones have not. The number next to the badge (e.g. the number highlighted by the red circle) indicates how many students in class have been awarded this badge.

The number next to the badge indicates the total times the badge has been awarded to the class in the selected period. A high number next to a grey icon indicates the student is one of the few students without the badge. A low number next to a colored icon indicates the student is one of the few to have earned this badge. Depending on the badge, either situation can be a good or a bad thing.

From the Personal Badge Overview, the user can drill down to a Class Progression View, a visualization of the class's badge progression over time. An example is shown in figure 2 where the X-axis represents time and the Y-axis

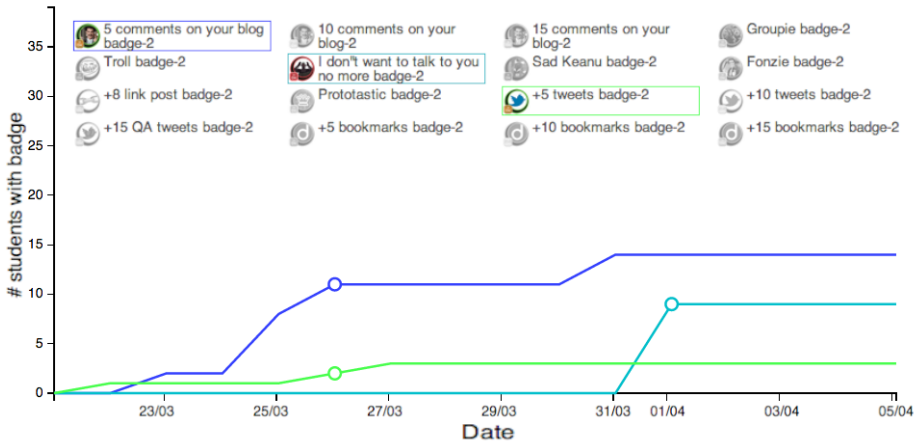

Fig. 2. Navi Badgeboard - Class Progression: Every line represents a badge. Circles represent the moment in time the student has been awarded the respective badge. The user can choose which badges to visualize through the filter options.

the number of students that have been awarded a specific badge. Every colored line represents the progression of a badge for the class. The circle indicates when a particular student was awarded this badge. The Class Progression View gives the user an immediate idea of how early or late the student is at achieving a specific badge compared to the rest of the class.

Students can also share their badges as a way of skill recognition to external parties. Through a 'send to backpack' button, students with Mozilla Open Badges[8] accounts can send these badges to their Mozilla Open Badges Backpack and publish them on social network sites.

Navi Badgeboard is developed using HTML5, Javascript, D3.js[9] and Java deployed on the Google App Engine[10]. This application can be accessed from mobile devices and desktop browsers and is publicly available [11].

4.3 Navi Surface

An interactive visualization can help students get a better understanding of the course activity data. Adding collaboration to the process creates opportunities for a more active discourse around the data. To enable such collaboration, we developed Navi Surface, a first prototype of a multi-user multi-touch tabletop display application developed using HTML5, Javascript and Paper.js[12].

[8] `http://openbadges.org`
[9] `http://d3js.org`
[10] `https://appengine.google.com`
[11] `http://navi-hci.appspot.com`
[12] `http://paperjs.org`

Navi Surface presents the users with a list of students and badges available in the course. The badges are displayed per bi-weekly period and the user can cycle through these periods. This information is located at the bottom of the display and is interactive: each student name and badge can be touched and dragged.

The remainder of the screen is called the Playfield. All interactive items can be dragged onto the Playfield. The badges in the Playfield light up the names of students that have been awarded these badges. Student names light up the badges that have been awarded to the respective students. Dropping badges onto the Playfield also displays their detailed information.

Touching and holding an item will activate the relationship visualization: lines will connect the item to all its related items on the Playfield e.g. a student name will be connected to all its awarded badges. As the application supports multi-touch, multiple items can be moved and touched simultaneously, creating more interesting visual relationships (see Fig. 4) and enabling collaborative interaction with the data.

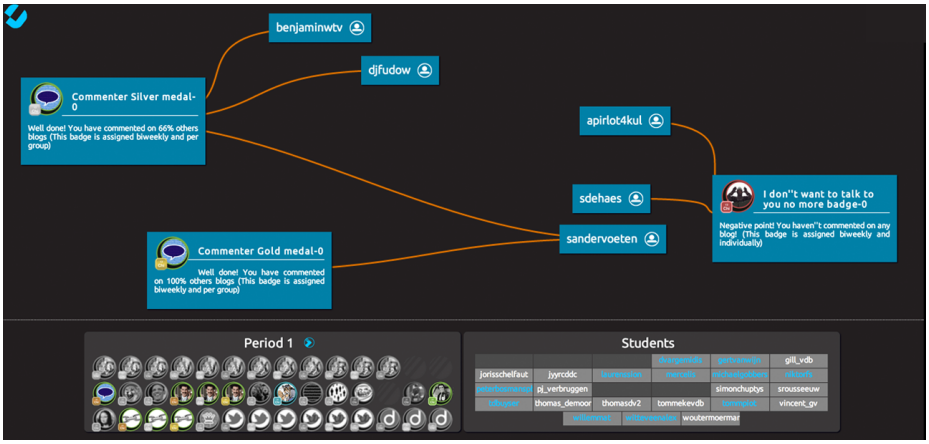

Fig. 3. Navi Surface: The bottom left shows the list of badges of a specific period. The bottom right contains the students' names. The items in the Playfield (top) are touched and held to display the relationships between them.

The tabletop display can be placed in the classroom. As the CHI course format is a studio session, students can freely get up and walk to the tabletop to access their own and class mates' information. The teacher can also invite students to the tabletop display. In our CHI course, as students work in groups of 3, the teacher can invite a group to discuss their progress. While the teacher can guide the process by dragging items onto the Playfield, students can also interact and steer the conversation. This engagement causes a personal but also collaborative interaction and evaluation.

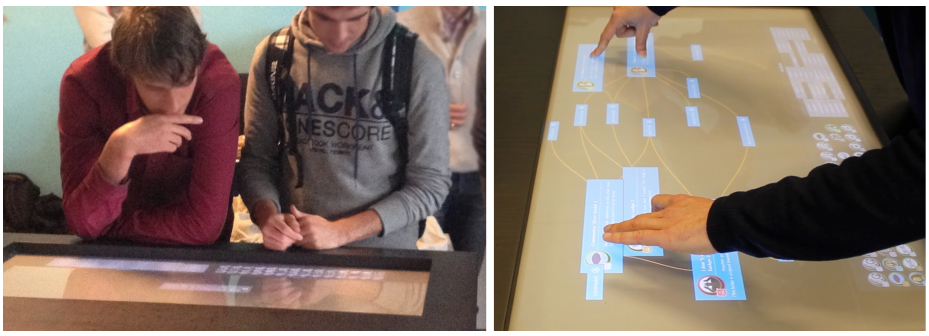

Fig. 4. Navi Surface: Students actively using the tabletop display application during our evaluation session.

5 Evaluation

5.1 Navi Badgeboard

22 of the 26 students between the ages of 20 and 25 participated in the evaluation of Navi Badgeboard. First we evaluated the usability of Navi Badgeboard using the System Usability Scale (SUS)[3]. It scored 65 which means it scored below average. We also asked students to fill in an online survey that goes more into detail on the different functionalities and visualizations which revealed additional interesting information.

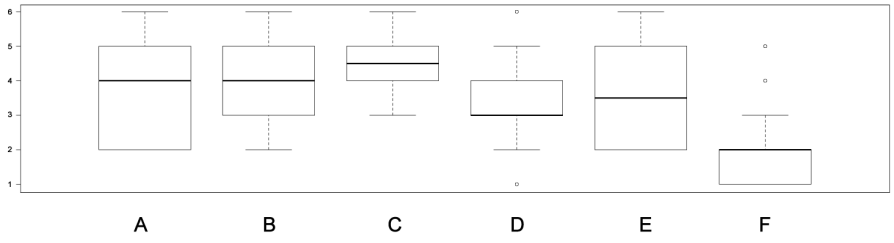

Fig. 5. Navi Badgeboard Functionality Importance Questionnaire: A) Overview of other students' badges B) Overview of number of badges achieved by the entire class C) Overview of all badges and descriptions D) Filter options for the Class Progression graph E) Class Statistic graph per badge F) Add to OpenBadge backpack

Figure 5 shows how important students consider the different functionalities using a 5-level Likert item (2 - Not at all important, 6 - Extremely important) with one extra option (1 - Did not know the feature existed). Students mostly agreed the dashboard gives an accurate representation of the activity of the

class. The overview of the badges which shows the students what badges are achievable in class was rated important. The global overview of the class's progression however was deemed less important. As students also seemed to have less preference for class mates' personal dashboards, we can assume that they were more interested in gaining awareness of their own goals and tasks than awareness of others. This is also confirmed by the lack of interest for the Class Progression View. These views were very valuable to the teacher and teacher assistant however.

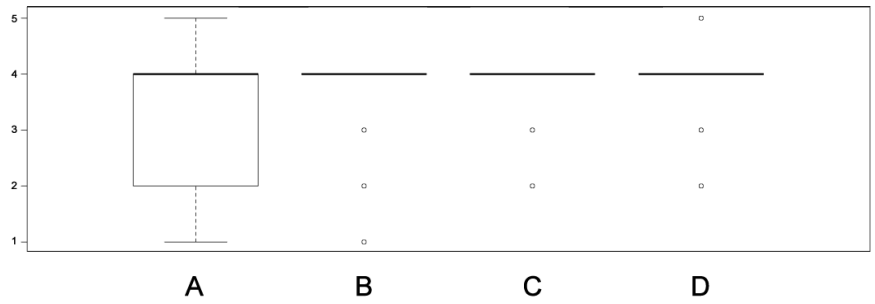

Fig. 6. Navi Badgeboard questionnaire: A) The system increases my motivation B) The system promotes commenting on blogs of other students. C) The system promotes reading blogs of other students. D) The system promotes Twitter participation.

Figure 6 shows the results of 4 5-scale (1- Strongly disagree, 5 - Strongly agree) Likert questions. Students believed motivation was improved through the Navi Badgeboard. They were under the impression it promotes commenting, reading blogs and Twitter, activities these badges were designed to impact. While this was the case for Navi Badgeboard, our dashboards showing raw activity data through lists, tables and charts had a lesser impact on motivation [13].

The Google Analytics data showed that most activity happened around the CHI course's studio sessions. It can be assumed that students check up on their badges before a session starts. Students are also notified by email when awarded a badge. Two students mentioned that they would only visit Navi Badgeboard at such occasions.

While we have included Open Badges support, almost no students were interested in or even aware of this functionality. While we could improve the usage of this feature by making it more prominent, most badges might have been too specific to the course process, giving the students no incentive to share them externally.

We can conclude that Navi Badgeboard does improve awareness of the goals and tasks required to successfully complete the course through the Badge Overview page. Students also regularly check up on their own progress, usually before a

class session begins. We can assume students wish to reflect on their progress through these regular visits. However, they seem less interested in other students' achievements.

5.2 Navi Surface

While we will evaluate further prototypes of Navi Surface during course sessions, this initial evaluation of the tabletop display application took place during a poster session just before the end of the CHI course. This gave us the opportunity to not only evaluate the tool with CHI students but also outsiders. 14 students walked up to the tabletop to test the application using the think-aloud protocol. Students were left to experiment alone or in group and hints were only given when the participant(s) got stuck. Student actions were recorded on video and they were given a questionnaire afterwards. 10 students approached and tested the tabletop in groups: 2 groups of 2 students and 2 groups of 3. Not all students were part of the CHI course.

The application received a SUS score of 71 which is just above average. However, only taking into account the CHI course students, the application received a score of 77. We assume that due to the abstract nature of the data, in its current form, Navi Surface does not give enough insight on the course content which makes it harder to use for outsiders. We will discuss how we can improve this further in section 6.

The goal of Navi Surface is to provide better understanding of the data and thus also increase awareness through collaborative interaction. This collaborative interaction should also ignite further discussions to create a deeper reflection.

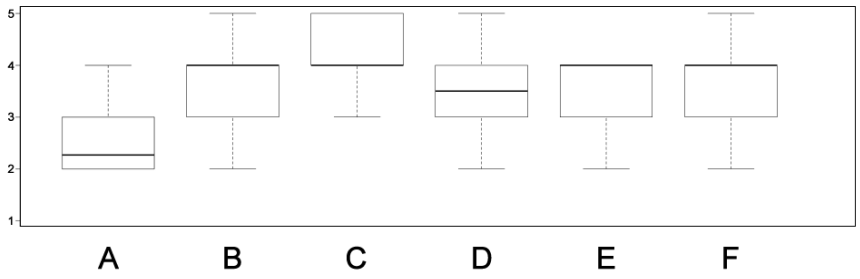

Fig. 7. Navi Surface questionnaire: A) The visualization improves my awareness of the class's general progress B) The visualization helps me understand the meaning of the badges C) The visualization helps me see what badges someone earned in a given period D) The visualization helps me compare badges of students E) I would like to use this tool together with the teacher to evaluate my progress F) I would like to use this tool together with other students to compare our progress

Figure 7 contains box plots of the results of the 5-scale Likert questionnaire (1 - Strongly disagree, 2 - Strongly agree). Students do not believe their awareness of class progression was in any way improved. This result was expected as the first prototype only shows badges for the students dragged into the Playfield area. Only after dragging all names onto the tabletop would the user get a better idea of class status regarding the awards. As badges are only shown per period, an overview of the entire course length is also not available.

Navi Surface was built with multi-user collaboration in mind and while a single user experience is possible, it was not the goal of the application. This matches our finding in the questionnaire: there was a preference of using the tool in group. There was also an interest in using the tool together with a teacher.

Observation of the students while using the tool also confirmed that collaboration improved the reflection process as students understood the tool and the data much quicker. After getting a good grasp of what Navi Surface provided, they spontaneously started discussing their progress based on the badges. They reflected on why and how certain badges were achieved and others were not. They also experienced this collaboration to be more fun.

On the other hand, students faced with Navi Surface by themselves were more hesitant and needed input from the observer to continue using the tool. While the questionnaires confirm that they prefer to use it in group, it is clear that without the collaboration and social discourse this interaction enables, the actions are less spontaneous and much less deeper reflection occurs.

The tool was also tested on students who were not part of the CHI course. This however proved less successful especially with students faced with the tool by themselves. As Navi Surface does not provide any details on the actual data behind the badges (blog posts, comments and tweets), the data is very unclear to outsiders. This also affected the SUS score (see above). In section 6, we will discuss how we can provide more detailed information and hereby also make Navi Surface more interesting to outsiders.

6 Conclusion and Future Work

Learning dashboards provide a means of visualizing the abundance of traces which learning analytics allows us to collect from students. We look at simplifying the data by emphasizing the more important student activities and course goals and visualizing these through badges.

While the personal dashboard has improved perceived awareness with students and the overview of class progress was deemed valuable by teachers and teacher assistants, we believe Navi Surface has more potential in helping awareness and reflection with students through its collaborative nature. In its current state, Navi Surface already enables students to understand the data quicker and plays a catalyst in discussions. Navi Surface makes the process fun and students show interest in using this tool with class mates but also with teachers.

More evaluations will give us deeper insights and we believe that there are still many unexplored possibilities which makes further development of this tool

very interesting. By simply adding more course data to the visualizations and allowing students to drill down on badges to reveal more data, students could discover why and how certain badges have been awarded (e.g. the specific blog post or comment that triggered a badge), creating a better insight of the progress and a deeper reflection on the learning process.

Adding more detailed course data to the visualization does not only benefit student and teacher, but could help outsiders comprehend the inner workings of a course better. Open school days can help students choose their future classes based on the real data provided through Navi Surface. Parents' evenings can become more interactive as parents and teacher can utilize the tabletop to dig deeper into the details of the learning process of son or daughter.

While we mainly work with blog and Twitter data, Navi Surface can easily be extended to support even richer learning analytics data. Students in a more inquiry based learning environment leave behind richer artifacts (e.g. photographs, geographical coordinates) which could provide even more interesting visualizations and therefore an even better insight through Navi Surface. Even MOOCs (Massive Open Online Courses) can benefit from the abstraction to badges and the visualization through Navi Surface.

With few developments, many new possibilities open up. We will therefore continue our research into badges and tabletop displays as a way of improving awareness and reflection in the class room and beyond.

7 Acknowledgement

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Feeler: feel good and learn better

A tool for promoting reflection about learning and Well-being

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Abstract. In this paper we present *Feeler*, a design-in-progress tool for visualization of learning performance and well-being with the aim of fostering reflection and awareness. The project combines two currently promising areas such as Personal Informatics and Learning Analytics in order to encourage learners to reflect about their lifestyle and its impact on their learning capabilities. It is expected that allowing learners to capture and visualize quantitative data about their states and habits will offer them rich materials that support individual and collective reflection-after-action processes. This project builds on participatory design and a research-based design process. Currently, the project is in a product design stage. The aim of the project is to develop a working prototype that follows a slow technology approach that can be tested in learning contexts.

Keywords. research-based design, information visualization, reflection, awareness, learning analytics, personal informatics

1 Introductory Scenario

Saga has difficulties to stay focused on her studies and she feels stressed because she can hardly complete the tasks. In a tutoring session, Saga's tutor suggests her that doing some regular exercise could actually help her to stay focused. Although Saga is skeptical, her tutor convinces her to use Feeler, a system that monitors her concentration levels and the amount of physical activity she has during a certain amount of time.

Feeler combines a head band that tracks brain activity and smart textiles to visualize the data. Small led lights are integrated in two wool wrist bands and they blink when the person loses attention for a certain time. Thanks to this gentle reminder Saga is more aware of her current capabilities and acts according to what her body needs. The light signal helps her to decide when to change the type of task or take a break. Data about exercise habits is registered through a mobile app. Information about concentration levels and physical activity is displayed in a screen. This allows Saga to identify patterns between the amount of physical activity and how long she is able to keep her attention. After a while of using Feeler, Saga realizes that after moderate exercise, she is able to keep concentrated for longer periods of time. She discusses

this with her peers and with her tutor and gets some suggestions about how to better plan her schedules.

2 Quantified-Self: a Tool for Self-Understanding

In many societies, computers have become an everyday tool that has adopted diverse forms: laptop, smartphones, tablets… The combination of these devices with Internet access and sensors has allowed people to collect data about a myriad of personal aspects dealing with physiology, behavior, habits and thoughts. In this context, the Quantified-Self movement has appeared as a way to develop self-knowledge through data. The availability of measurable personal data can be used, as [13] highlight, "for self-reflection to help people become more aware of their own behavior, make better decisions, and change behavior". (p.405)

Personal informatics, also known as Quantified-Self, has become quite popular in fields dealing with sports and health. In sports, some of the currently well-known body tracking products include Nike+ and its fuelband[1], Fitbit[2], RunKeeper[3] and Moves[4]. Concerning wellbeing, applications such as Withings[5], HeartMath[6], mindbloom[7] and Ubifit Garden[8] offer opportunities to users to learn about their progression and undertake new challenges concerning healthy habits.

In the field of e-learning, learning analytics takes advantage of the possibilities of data monitoring in order to understand and improve teaching and learning. Despite the intention is to empower teachers and learners, some critical voices [2] have warned that analytics could disempower learners by making them reliant on the institution feedback.

Considering the key role of self-knowledge for self-regulation and metacognition, self-understanding should be at the center of systems that monitor student data. In this sense, some authors [5, 3, 10] have noted that learning analytics should be considered as a tool for the student. Similarly, [17] highlight the need for a Self-Directed Learning approach in which students feel ownership, as well as they are able to self-manage and self-monitor their own learning. From this perspective, everything should be oriented to help learners to take control of their own learning processes and experiences. In order to encourage self-understanding of learning processes, it is crucial to stop considering learning as an isolated activity that does not interrelate with other aspects of peoples' lives. In general, educational institutions should understand that they are only one venue where learning happens, and to utilize holistically the other areas of life where their students are active. Qualitative aspects, such as the student's well-

1 Nike+ fuelband. http://www.nike.com/us/en_us/c/nikeplus-fuelband
2 Fitbit. http://www.fitbit.com/
3 Runkeeper. http://runkeeper.com/
4 Moves. http://www.moves-app.com
5 Withings. http://www.withings.com
6 HeartMath. http://www.heartmath.com/
7 Mindbloom. https://www.mindbloom.com/lifegame
8 Ubifit Garden. http://dub.washington.edu/projects/ubifit

being, might be worth to be taken into consideration since they can impact learning performance. In this paper, we propose an innovative approach to learning analytics since we combine data about well-being with learning performance. The research question that drives this project focuses on how to foster reflection about learning capabilities in relation to a person's well-being.

3 Visualizing the Data for Reflecting

Making sense of large datasets composed by numerical and textual information can be handled much easier if the information is visualized. Due to the power of images for synthesizing complex information, information visualization has been recognized as a powerful tool for reducing cognitive load, offloading short-term memory, allowing for easier comparisons, and generally facilitating inferences [16, 18].

According to [14], visualizations should be conceived as transformation processes within the Data-Information-Knowledge continuum. From this perspective, Masud et al. claim that visualizations are not merely the final outcome of representing data, information and knowledge, but that they should be understood as a process since they provide awareness, as well as social and reflective insights.

[7] have also highlighted the strength of visualizations as tools for sense making in which information is collected, organized, and analyzed to generate knowledge and inform action. According to these authors, sense making is often a social process involving parallelization of effort, discussion, and consensus building. Some web-based collaborative visualization systems that go in this direction are Sense.us, Spotfire[9], Wikimapia[10], Many-Eyes[11], among others.

Visualizing the data can be a powerful resource for supporting reflection, individual or in groups, and therefore gaining awareness. Considering the strong link between reflection and learning [15], we can anticipate that the reflections that take place through the analysis of visualizations would lead to learning. In this sense, visualizations can trigger reflection-after-action processes helping the learner to develop new understandings and appreciations [1].

Some of the research questions that emerge in this context, is how to make large volumes of data meaningful for users. How should this data be displayed in order to improve self-understanding, reflection and awareness? One answer to this question can be found in the design philosophy underlying slow technology. According to [6], slow technology responds to the need of actively promoting moments of reflection. Reproducing their words “A key issue in slow technology, as a design philosophy, is that we should use slowness in learning, understanding and presence to give people time to think and reflect” (p.203).

The visualization of information dealing with learning and well-being through smart textiles could be perceived as an object for reflection in the sense that it encou-

[9] Spotfire. TIBCO Software. http://spotfire.tibco.com/discover-spotfire
[10] Wikimapia. http://wikimapia.org
[11] Many-Eyes. http://many-eyes.com

rages the person to take some time to think about his/her habits. Smart textiles, also known as electronic textiles or e-textiles, refer to the use of electronic components and advanced fibers in garments [8]. Research on these kinds of smart textiles has advanced during the last years and some applications can be found in the military and medical sector (Georgia Tech Wearable Motherboard™ [12]), work (PROeTex[13]) and in sportswear (Nike Hyperdunk+[14]). Apart from that, smart textile applications can be also observed in the entertainment industry (midi controller jacquet[15]), as well as in fashion design [16] and arts communities (e-motion project[17]). Smart textiles offer great opportunities, not only for capturing data but also for displaying it to the person in a discrete, subtle and personal way.

4 Methods

To design tools that effectively assist self-reflection, it is crucial to understand how people think about well-being and learning in relation to their everyday practices. For this reason, the project builds on a research-based design process [11, 12]. It is an iterative process characterized by the following phases: contextual inquiry, participatory design, product design and prototype as hypothesis. The aim is to involve users from early phases of the project in order to incorporate their expectations and needs. In the contextual inquiry, designers focus on achieving a deep understanding of the socio-cultural context of the design. The information gathered during this phase is used to develop use scenarios that are discussed in participatory design sessions with the people who later will use the designed products. Participatory design sessions provide designers feedback and inspiring ideas that may inform the product design. It is important to note that despite users contributions are key elements of the design process, final decisions are taken by the designers. The transparency of the process and the continuous tests and redesigns guarantee that participants' views are considered throughout the process. However, designers are the experts that will make decisions on the prototypes.

At the moment, 6 exploratory interviews have been realized to people aged between 24-60 years old that combine work and studies and that are concerned about their well-being. The interviewees were asked to take some pictures and write a short text about how they would represent well-being, health and mindfulness in their everyday life. Images and texts were adapted to a card layout and used during the interviews as a starting point of the conversation. The information gathered during the interviews informed the participatory design session that took place during the 2nd Multidisciplinary Summer School on Design as Inquiry[18]. The workshop helped to

[12] Georgia Tech Wearable Mother Board™ http://www.gtwm.gatech.edu/
[13] http://www.ugent.be/ea/textiles/en/projects/afgelopenprojecten/Proetex.htm
[14] Nike Hyperdunk+. http://swoo.sh/17nJBtl
[15] Midi controller jacquet. http://kck.st/ZX78u2
[16] Fashioning technology. http://www.fashioningtech.com
[17] E-motion project. http://www.design.udk-berlin.de/Modedesign/Emotion
[18] 2nd Multidisciplinary Summer School on Design as Inquiry. http://bit.ly/1cmOunJ

gain insights of people's understanding of learning and well-being, as well as to brainstorm some ideas about what aspects could be worth to quantify and how to visualize the data. In the short-term, next steps include the development of the concept design, building of low-fi prototypes and the organization of more participatory design sessions. The aim of the project is to develop a working prototype that can be tested in learning contexts.

5 Feeler prototype

Feeler is a tool, currently still under development, that allows learners to monitor some aspects of their well-being, such as the amount of physical activity and concentration levels, in order to improve their learning. Feeler will combine data about personal well-being with metadata of learning materials such as the amount of time a student has logged into the system and the times when she connected. The reason for using learning analytics is for increasing understanding about the conditions in which a person is more willing to learn.

It is expected that this tool will support learners' reflective thinking about their lifestyle and the impact it has in their learning capabilities. By focusing in a personal matter such as well-being, the tool connects with some of the elements outlined by [4] about reflective thinking: a state of perplexity, hesitation and doubt; (in case that the data collected doesn't correlate to the learners assumptions) and an act of search directed to corroborate or to invalidate the suggested belief (people may feel motivated to understand why the data collected by the system contradicts their initial thoughts). The outcomes of engaging in such a reflection process about one's well-being and learning performance include (1) new perspectives on experience, (2) changes in behavior, (3) readiness for application, and (4) commitment to action [1].

Early prototypes of the suggested tool (fig.1) are based on the use of a headband that monitors the brain activity, for instance the Melon band[19] and a mobile app that tracks physical activity (Moves[5]). The head band can register different states of mental activity in order to determine a person's level of focus. Information about how much concentrated is the person for a specific amount of time would be displayed through a smart wool bands placed in the person's wrists. Depending of the concentration level, some led lights would activate. The more concentrated you are, the more intense would be the lights sparkling in the wool bands. Less levels of concentration would be associated to less intensity of the lights. Information about physical activity is monitored through the mobile app Moves. In this case, no specific action nor extra device are required. Once downloaded the app, the person just has to carry her phone wherever she goes and it will detect the type of activity performed (walk, run or cycle), the duration and the distance travelled.

[19] Melon. http://kck.st/13uYmbQ

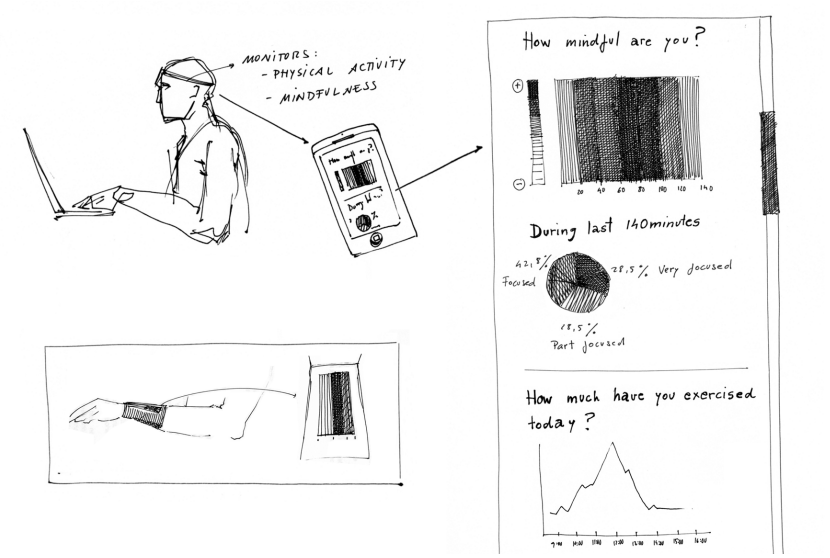

Fig. 1. Sketches of Feeler prototype.

Data about the level of focus and physical activity will be displayed together through a screen (fig. 1). The intention is to allow the person to observe trends, get into details and establish correlations. By offering the users different levels of reading, we expect they would engage in reflection processes that can lead to meaningful group discussions.

6 Conclusions

The underlying assumption of the research is that information visualization can be a powerful tool for encouraging reflection and awareness. By drawing the attention to learning and well-being, the project combines two currently promising areas such as Personal Informatics and Learning Analytics. It is expected that allowing learners to capture quantitative data about their states and habits will offer them rich materials that support reflection processes.

Even if Feeler can be used in very different settings, we consider that the tool has great potential in higher education since reflective practices help facing life's challenges and encourages attention and analysis habits key for addressing the problems of society [15].

Regarding the design of the prototype, slow technologies bring inspiring since, rather than designing for effective work, the aim is to foster reflection. In this sense, some initial sketches focus on smart textiles for displaying the information following a slow approach. In this sense, we consider that not only the tool, but the design as well should support reflective practices.

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SpirOnto: Semantically Enhanced Patient Records for Reflective Learning on Spiritual Care in Palliative Care

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Abstract. Ontologies as shared understanding of a domain of interest can support reflective processes in spiritual care. Such an ontology has been extracted from an empirical analysis of historic patient records, which has identified a key structure. This ontology is supposed to support the reflective learning process of the palliative care team, which is interdisciplinary. A first prototype for a semantically enhanced patient care documentation system has been developed which embeds links to spiritual care into practice and helps to create awareness among other disciplines about the systematic nature of spiritual care.

Keywords: ontologies, spiritual care, patient documentation, reflection

1 Introduction

Palliative care is a challenging multidisciplinary field where different perspectives need to complement each other, including nurses, doctors, social workers but also the frequently neglected aspect of spiritual care. Particularly this aspect has become more complex as a consequence for an increasingly multi-cultural society with a myriad of religious and spiritual ideas and beliefs.

Currently there is little awareness about spiritual aspects in palliative care in adjacent professions (such as physicians or nurses), and the perceived significance of this part of palliative lags behind other professions. This is due to spiritual care not being explicitly represented in boundary objects between the professions, most notably in patient records, but also due to lack of evidence about the effectiveness of spiritual interventions beyond anecdotal evidence.

An analysis of their work and learning practices has revealed that due to the demanding nature of palliative care, reflective practice can already be identified on a regular basis, particularly as regular, but informal group meetings, and as institutionalized "supervision" in larger time intervals. This is an important element of coping strategies. In these reflection sessions, narratives about patients (from varying timeframes) are used to deepen the understanding about individual cases, but also to discover patterns across cases, to rationalise encounters of everyday practice. Team members have developed a remarkably rich understanding of their work through these practices.

To promote the understanding of spiritual care, building upon those reflective practices seems to be a very promising approach. Therefore the work presented in this paper has concentrated on identifying and designing artefacts that can act as boundary objects and support the reflective learning process and that can promote the maturing of knowledge, especially through two activities: getting an overview about individual cases and discovering patterns across cases.

The key idea of the approach is a spiritual care ontology, which represents a shared understanding of the domain accessible to all involved professions. This ontology is used to enhance patient records, represents a scaffold for reflection sessions, and captures evidence about relationship between patient situations and effective interventions.

In the following sections, we present the ontology and how it was developed (section 2) and the concept of how it is designed to support the (collective) learning process (section 3) before we present a first prototype in section 4.

2 Spiritual Care Ontology

In order to come up with a meaningful and relevant ontology, an empirical approach has been chosen to develop the ontology (more details on the process are described in Stiehl et al. (2011)). As a first step, a qualitative empirical analysis of 143 records of patients between 2004 and 2010 has been conducted. The concepts found were iteratively integrated into an (informal) ontology using concept maps. This ontology was discussed with practitioners in workshops for relevance and comprehensibility to align the empirical results with the needs in everyday practice.

The structure of the resulting ontology can be decomposed into the following key elements:

- **Facts about a patient or its social environment** including relatives and friends (expressed as direct properties). This includes demographic data, information about course of disease and care status, but also the cultural background (e.g., religion, migration background, or whether an individual has been raised in rural or more urban areas).
- **Observations** that led to the identification of the facts (having a timestamp and a possibly rich description of the observation.
- **Spiritual concepts** that interpret facts (and thus also observations). This includes a large set of concepts, such as eternity and finiteness, eternal love,

love, guilt, purity, powerlessness vs. almightiness, or autonomy. The links to observable behaviour or facts are context-dependent interpretations – different individuals link the same "facts" to different concepts, depending on their background and personal expectations. The spiritual concepts originate from spiritual traditions, but are not limited to a single religion, which is particularly important with the increasing diversity in religion and culture within society.

- **Spiritual interventions** are possible spiritual care activities. These can include active spiritual support, meaningful silence, pastoral interviews, practical consultancy, or rituals.

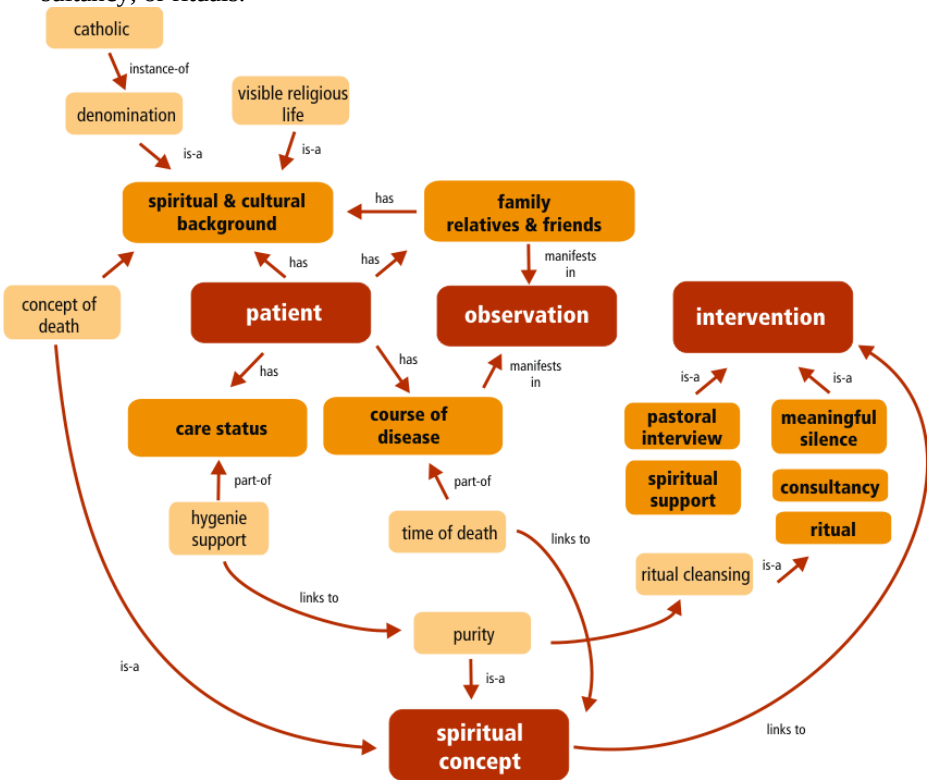

Figure 1: Small subset of the ontology for spiritual care

It is important that there is a connection between these key concepts. Observations lead to facts about a patient (or their relatives). These can be linked to spiritual concepts, such as concepts of death, purity, or forgiveness. These links show needs and unresolved spiritual conflicts that are particularly important in palliative care processes. It should be noted that spiritual care is necessary for the patient, but also for the relatives, and even for the palliative care team. Finally, the spiritual care interventions link to spiritual concepts so that the identification of concepts can help to identify appropriate interventions (and their contextualization). Such interventions could be anointing in a catholic tradition, but also ritual cleansing in other cultures. But it could

also identify topics for pastoral interviews. A small example of the ontology is shown in figure 2 (the whole ontology consists of more than a hundred elements).

This ontology does not only allow for representing the knowledge about a patient and their social environment in a systematic way; it also represents to a certain degree the knowledge about appropriate spiritual care by providing the relevant concepts and identifying the possible interventions, which is an analogy to diagnosis and treatment in medical care.

3 Ontology & the Loops of Learning

The ontology is not only intended to act as a boundary object (together with the patient record) between the disciplines, but also as a bridge between operational and reflective processes, which is common in reflective learning:

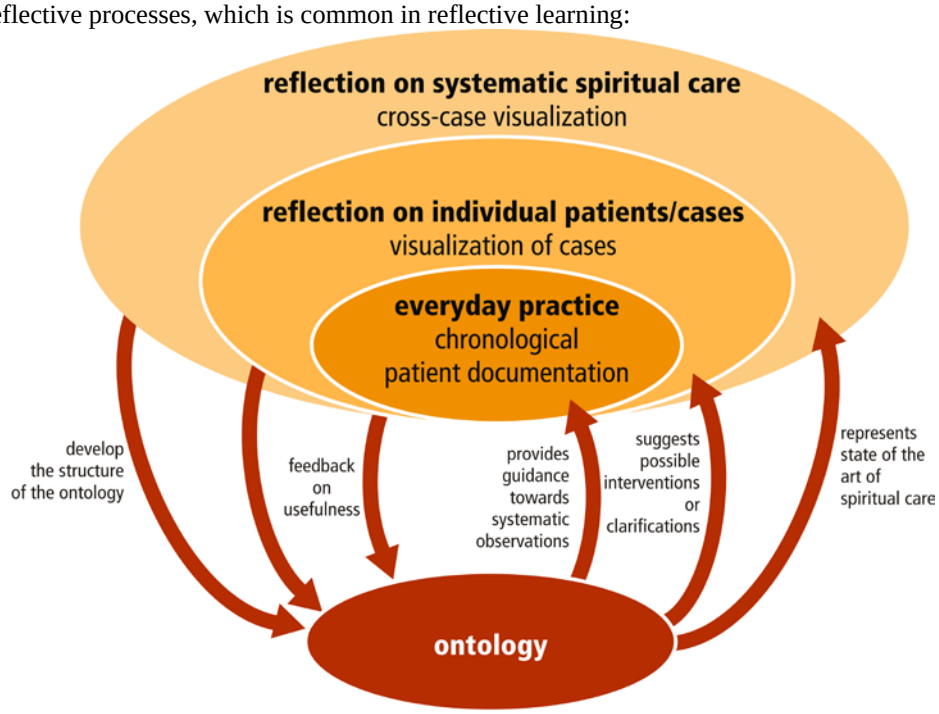

Figure 2: Levels of reflective learning and the role of the ontology

- On the **operational level**, carers document their activities as well as any observations on the state or other aspects deemed to be potentially relevant. This usually takes place in a chronological way. Palliative care processes, however, often extend over long periods of time (it also has to be taken into account that not only the patient, but also relatives are to be cared for). The key idea is that by annotating these incrementally collected notes with concepts from the ontology, a system can tie together distant observations about (possibly) the same aspect. Also the ontology can guide towards possibly neglected aspects.

- This forms then the basis for **reflection about individual cases**. Reflection is already institutionalized as regular meetings. The ontology can help as a structure to have a systematic look at aspects that might be relevant for spiritual care. It is important to note that these observations are typically made by the various disciplines and need to be put together to have a reasonably complete overview. The structure of the ontology can show gaps of information and its use promotes awareness and understanding of relevant spiritual care aspects.
- On a longer timescale, **multiple cases** can be analysed to enhance the body of evidence about effectiveness of spiritual care interventions in certain contexts. Patterns can be discovered, such as differences in age with respect to dealing with the prospect of dying (such as asking why). Such patterns can be then used to further enhance the ontology and can feed into targeted research activities.

4 The System

A first prototype for a novel patient documentation system that is guided by the ontology has been developed in a participatory design approach. The resulting system is based on a flexible backend implemented in Java ontop of Sesame RDF store and Lucene for fulltext search. The front-end is has been implemented for Windows Tablets and laptops in C# using the Windows Presentation Framework. The front-end is designed to support offline operation so that the application does not depend on network coverage at all times.

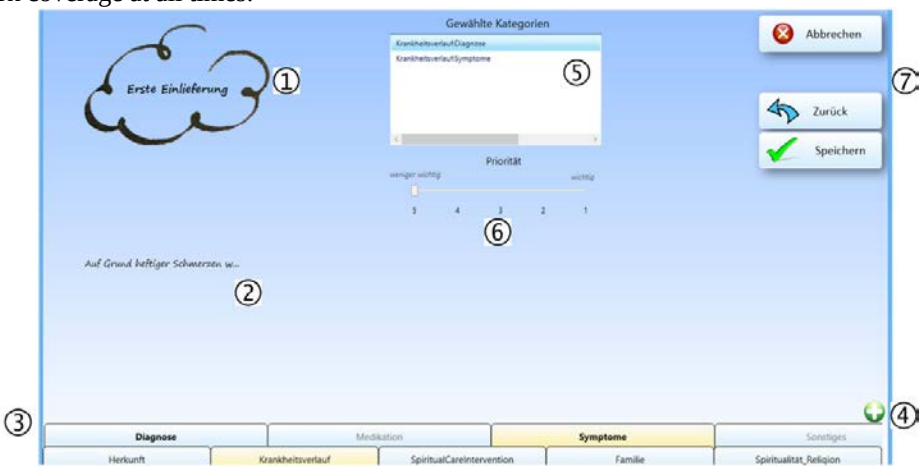

Figure 3: Screenshot showing an observation annotated with concepts from the ontology (tabs at the bottom)

The prototype allows for entering notes about patients in a chronological way. In a simple interface, the user can assign concepts from the ontology to the note. Only a small part of the ontology is static (in the sense that it can only be changed by an administrator); apart from that, users can extend the concepts in the ontology if they find

that something relevant is missing (or rename concepts introduced by others, e.g., after a discussion in a meeting). This supports the gradual maturing of the ontology, not only as part of the reflective sessions, but also as part of everyday practice by capturing aspects that are not yet covered by the ontology.

5 Outlook

While spiritual care is often belittled as lacking evidence of its effectiveness compared to other disciplines in palliative care, the development of the ontology has already shown that spiritual care follows a systematic approach. This systematic approach is made visible through the general structure of the ontology that has been derived from historic patient records: observations/facts, spiritual concepts as interpretations, and spiritual care interventions. Workshops with physicians, social workers, and carers have shown that the ontology can act as a boundary object between the disciplines and can create awareness about spiritual care and its relevance for holistic care.

A first prototype has been built that demonstrates a novel approach to care documentations where observations can be associated with spiritual care concepts in a lightweight way. This opens the possibility for enhancing the reflection on the individual patient (that already takes place) with a structured representation about individual cases (e.g., to more easily discover gaps), and for developing spiritual care knowledge further (by analysing across cases and collecting the experiences).

We are aiming at trialling the prototype and gaining additional evidence about how such an ontology can enhance both practice and associated learning processes.

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REFLECT: Community-Driven Scaffolding for Voice-enabled Reflection on the Go

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Abstract. REFLECT is a mobile app that promotes a regular reflective routine. It is voice-based so that it can be used, e.g., while driving a car or in similar situations. The reflection session is scaffolded through decks of questions that can be configured by the user and shared with others, who in turn can reuse the questions.

Keywords: Reflection, prompts, scaffolding

1 Introduction

Reflective learning is seen as one of the key activity for workplace learning that is most neglected because of time pressure in everyday business. This particularly applies to General Practitioners (GPs) who are on a tight schedule between slots for consultation and home visits. From the need to make learning activities traceable for re-certification, there is, however, an interest from doctors to reflect on learning experiences and to follow-up on learning opportunities arising from everyday practice. Key approach is to create reflection opportunities by utilizing time slots like when driving in the car from/to a home visit, or commuting.

2 Concept

The key idea behind REFLECT is that reflection support is based on voice interactions, which allows for hands-free operation. Users can record their reflection sessions, and the system transcribes it and sends it to them via e-mail for further processing, e.g., for including in a personal note-taking or task management tool, or a personal portfolio for future reference.

But reflection also needs scaffolding, particularly if it is supposed to take place embedded into working processes like in-between home visits. This is achieved through recording the reflection session in the form of a structured interview along a deck of questions. The app reads the question (via text-to-speech) and then records the user's responses. Via special voice commands (e.g., "next question"), the user can skip questions.

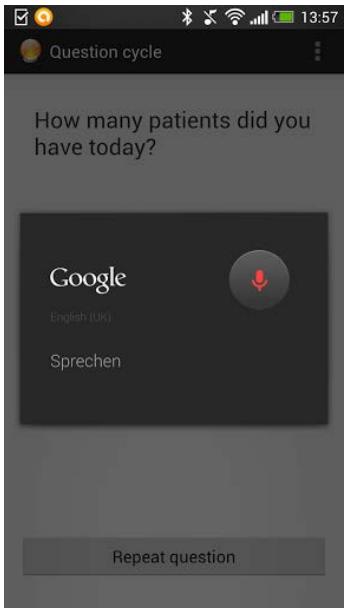

Figure 1: Android app

Useful questions for reflection cannot be predefined by the app designer, as they are situation-dependent (reflecting on the day/last patient, reflection on a longer period of time, reflecting after a training session) and there is no general knowledge about (i) which situations are relevant, and (ii) which questions are useful for which type of user. Therefore the app is complemented by a web-based interface that allows for choosing decks of questions that have been shared by others, for rating their usefulness, and – as soon as the learning becomes more confident and experienced in reflective practice to define own new questions and to share them with others.

This results in a lightweight and community-driven approach to scaffolding reflection, which also provides the opportunity for maturing the collective knowledge how to best structure such reflection sessions.

3 System

The system consists of an app to be installed on a smartphone or tablet (the current version requires Android 4.1 or higher – other systems are planned), and a web-based backend. The app allows for choosing a deck of questions, reads the questions to the user and transcribes the responses of the user and reacts voice commands. Towards that end, the Google Text-to-Speech and Speech-to-Text APIs are used. While this voice recognition does not deliver 100% accuracy, first tests have shown that under realistic conditions (e.g., in a car) the system produces a sufficient of quality of the resulting transcript to be useful for the user.

The backend is based on PHP, and users the Bootstrap framework. It gives the user the possibility to configure decks of questions, share them with others, use shared questions from others and rate them.

The app is available from the Google Play Store under http://goo.gl/m0vBc

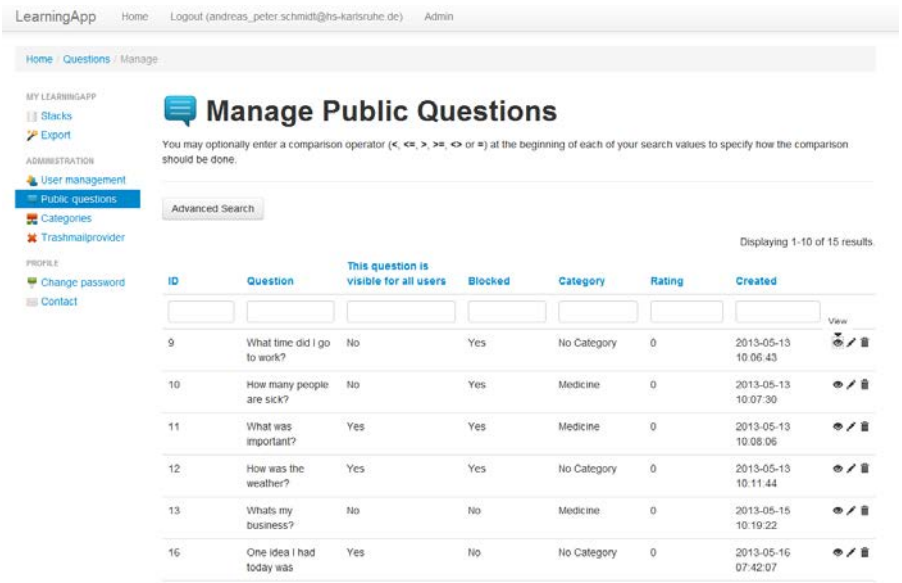

Figure 2: REFLECT back-end for defining questions and sharing them

4 Outlook

As part of the Learning Layers project, this app is planned to be evaluated with a larger number of users as part of General Practitioners' everyday work practice. Furthermore, it is planned to complement the Android app with an iOS solution to cover the different types of smartphones used by the target group.

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