The Push and Pull of Reflection in Workplace Learning: Designing to Support Transitions Between Individual, Collaborative and Organisational Learning*

Michael Prilla[1], Viktoria Pammer[2], Silke Balzert[3]

[1] University of Bochum, Information and Technology Management, Universitaetsstr. 150, 44780 Bochum, Germany
[2] Know-Center, Infeldgasse 21A, Graz, Austria
[3] Institute for Information Systems at German Research Center for Artificial Intelligence (DFKI), Saarland University, Campus, Bld. D3 2, Saarbruecken, Germany

Abstract. In work-integrated learning, individual, collaborative and organisational learning are deeply intertwined and overlapping. In this paper, we examine the role of reflection as a learning mechanism that enable and facilitates transitions between these levels. The paper aims at informing technological support for learning in organisations that focuses on these transitions. Based on a theoretical background covering reflection as a learning mechanism at work as well as the abovementioned transitions, and on observations in two organisations (IT consulting, emergency care hospital unit), we argue that such technological support needs to implement two inherently different, yet complementary mechanisms: push and pull. "Push" subsumes procedures in which reflection outcomes transcend individual and collective ownership towards the organisation through efforts made by the reflection participants. "Pull" subsumes situations in which the effort of managing the uptake of results from reflection is shifted away from the reflection participants to third parties in the organisation. We illustrate each mechanism with an application built to support it.

Keywords: Reflective Learning, Organisational Learning, Software Design

1 Introduction

One of the challenging aspects of work-integrated learning is that individual, collaborative and organisational learning are deeply intertwined and mutually dependent. Reflection as a mechanism of learning at work has great potential to support transitions between these levels of learning, as it concern both single experiences as well as

* The project "MIRROR - Reflective learning at work" is funded under the FP7 of the European Commission (project number 257617). The Know-Center is funded within the Austrian COMET Program - Competence Centers for Excellent Technologies - under the auspices of the Austrian Federal Ministry of Transport, Innovation and Technology, the Austrian Federal Ministry of Economy, Family and Youth and by the State of Styria. COMET is managed by the Austrian Research Promotion Agency FFG.

comprehensive topics. Naturally, this affects the technological support that is required within organisations to support learning. The goal of this paper is to shed light on transitions between individual, collaborative and organisational learning (ICO transitions) based on theory and two empirical studies in order to inform technology design.

2 Theory: Reflection and levels of (informal) learning

2.1 Reflection as a mechanism of informal learning at work

Reflection as we mean it can be defined as "those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations" [1] and has been recognized as a common process in everyday work – be it done by individuals [2, 3] or by groups reflecting collaboratively [4, 5]. It consists of three elements [1]: Going back to experiences, re-evaluating these experiences in the light of current insights and knowledge, including experiences of others, and deriving knowledge for future activities from this, including the planning and implementation of changes.

Given this understanding of reflection, it is obvious that besides other mechanisms such as problem based learning, reflection is a core mechanism of (informal) learning at work [6]. Its grounding in previous experiences binds it closely to the context of work and its clear focus on outcomes distinguishes it from less fruitful modes of thinking about past work such as rumination. In addition, reflection is not only bound to negative experiences and problems, but also concerns positive experiences, which may result in deriving good practice. Understanding reflection as based on own experiences means that **reflective learning can occur at an individual or collaborative level**, where the critically examined experiences are the experiences of an individual or shared experiences within a group. This does not mean that reflection is limited to contribute to individual and group levels only: On the contrary, examples from the studies presented below show that individual or collaborative learning by reflection is a powerful mechanism to create and refine organisational knowledge.

Recently, **computer support for reflection has been identified as a vital field of technology enhanced learning** (e.g. [7–10]). There are also various theoretical models on reflection these tools are aligned to [1–3], but these tools and models mainly consider reflection as a cognitive process. Only recently [4], reflection groups have been integrated into this discussion and support for collaborative reflection has been worked on specifically (e.g. [11]). Furthermore, [12] have described a model of computer-supported reflective learning support specifically in work settings, in which they describe the various roles that tools can play in the reflection process and generally allow reflection to happen collaboratively. However, there is currently no model considering the transitions between individual, collaborative and organisational learning.

2.2 Levels of learning and knowledge: Individual, collective, organisational

The description of reflection given above already indicates that its outcome – knowledge on (how to improve) work practice – may have impact on different levels: an individual may learn for herself and take the corresponding knowledge to a group of peers, while reflection in groups may result in individual outcomes (e.g. when peers collaboratively reflect individual experiences and learn for their own work) or be relevant for the groups as a whole (e.g. when a group reflects its rules for cooperation and changes them afterwards). Depending on group size and members as well as on the topics being reflected about, outcomes from group reflection may also add to organisational learning in that they provide knowledge on needs or how to change organisational practice. The influence of reflection and tools to support it on transitions between these levels, however, has not been researched intensively so far.

Learning as understood here denotes a "change in understanding, perspective or behaviour" in the broadest sense and it is the individual, a group of people (in the context of work: a team) or an organisation that learns [13]. For organisations, we understand learning as the improvement of an organisation's task performance over time, as well as the change of target values that measure an organisation's task performance [14]. Thus, we comprehend the learning process at an organisational level as structural changes, affecting individuals and groups, and subsequently individual and collaborative learning processes, within the organisation (for a more comprehensive explanation see [15]). Following this, we distinguish **individual and collaborative learning by the kind of learning process:** while individual learning can be considered a cognitive process, collaborative learning is social and happens in communication, e.g. when a team reflects on their performance. This means that collaborative learning support also needs to take into account support for communication and cooperation. **Organisational learning is based on the outcomes of these processes and characterised by the result of learning** (an organisation's task performance over time changes). This also means that the knowledge learned on an organisational level is a result of individual and collaborative learning processes.

There are many approaches describing the **relationship** between individual, collaborative and organisational levels of knowledge. Among the most popular, Nonaka (1994) [16] describes a spiral model of organisational knowledge creation, which starts at an individual level and brings knowledge to collective and organisational levels, "when all four modes of knowledge creation are ‚organisationally' managed to form a continual cycle" [16]. For this, the model describes a continuous cycle of socialisation (exchanging tacit knowledge), externalization (articulating tacit knowledge), combination (relating different bits of knowledge to each other, thus creating new knowledge) and internalisation (integrating explicit knowledge into one's own context). Learning in this sense takes place when internalisation is done by an individual. Kimmerle et al. (2010) [17] add that in the same way as learning takes place for individuals, groups (and thus organisations) learn by explicating knowledge, e.g. by making rules for their cooperation explicit. These concepts show that reflection tools need to provide correspondent functions such as making tacit reflection outcomes available for others (i.e. communicating it), explicitly sustaining outcomes

from group reflection and relate outcomes to individual or group contexts to support the transition between levels of learning.

Other approaches describe **transitions** between levels of knowledge as a communicative and contextualizing process. Stahl, for example, regards collaborative learning, which takes individual knowledge to the collective level, as a continuous interchange of perspective taking and perspective making, meaning that the individual level can only be transcended by interpreting "the world through some else's eyes" [18]. Herrmann and Kienle (2008) [19] add that a "shared context" can only be maintained by "contextual communication", meaning that learning needs to take place with a close relation to what people are learning about. In a similar approach, Beers et al. (2005) [20] describe a process in which knowledge is created by the abovementioned processes of externalization and internalisation complemented by negotiation to create a common ground from different perspectives and integration to relate insights organisational knowledge (see **Fig. 1**). Although [20] do not explicitly refer to organisational knowledge, this processes shows how knowledge is created by group and individual efforts and thus builds a base for ICO transitions.

For reflection tools to bridge between levels of knowledge, the process depicted in **Fig. 1** means that there is a need to **explicitly intertwine perspectives** of reflection participants (external knowledge), to **foster communication** between reflection participants (shared knowledge, common ground) and **to relate outcomes to organisational standards and processes** (constructed knowledge). Regarding the informal and experience-bound nature of reflection, this provides a challenge for tool design.

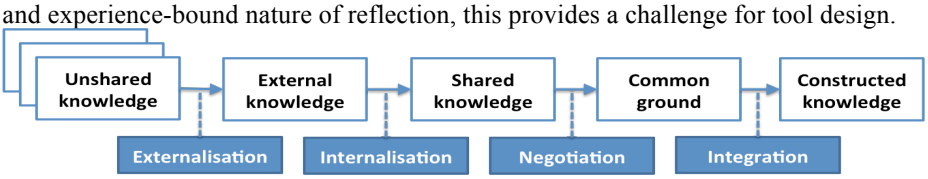

Fig. 1. Transitions between individual and collective knowledge (Beers et al. 2005).

2.3 Research goals

Based on the gaps identified by the review of existing work on reflective learning and ICO transitions, the work presented here follows two goals related to each other:

1. **Exploring reflection in practice and learning about its influence on work life an learning:** As there is not enough work available on the role of reflection in work and learning – especially not on ICO transitions –, its understanding and support depend on exploring it in practice. This will be tackled in Sect. 3 and 4.
2. **Developing an understanding and a framework enabling reflection and ICO transition support:** Our work is directed towards IT support for reflection in practice and thus, one major goal is to develop a framework for this support from our empirical work. Results on this goal are described in Sect. 5 and 6.

3 A Study on Individual, Collaborative and Organisational Learning by Reflection

3.1 Study Methodology

In order to understand reflection better (see goals above), we conducted a study using a variety of qualitative methods such as interviews, focus groups and observations in the participating organisations. The usage of these methods was targeted towards finding out **what role learning by reflection plays in everyday work life** (see goals given above). Note that consequently the study results mostly point towards "what is" and to a much smaller degree to "what could be" – however, they form a base for the design of tools supporting reflection by e.g. diminishing existing barriers or motivating currently unused opportunities for reflection. For an extensive description of study design, tools such as interview guidelines and results see [21].

3.2 Participants

The emergency care hospital unit observed in our empirical studies specializes in the treatment of neurological diseases such as stroke and epilepsy. Here, interviews were conducted with 3 physicians and 4 nurses. To cover explicitly the organisational perspective on learning, 4 interviews were conducted with representatives of the management board, from quality management, from human resources and from the advanced education department (two of these interviews were conducted with 2 participants each). Complementing the interviews, focus groups were carried out with three physicians (one group), four nurses (one group), and four therapists (physiotherapists and speech therapists, one group). Moreover, to explore the work of nurses and physicians, one nurse and one physician were shadowed for an observation time of two workdays each. In the IT consulting company, which is specialized on creating and adapting customer relationship solutions to small and medium companies, interviews were conducted with 8 sales and business consultants. To cover explicitly the organisational perspective on learning, interviews were also conducted with 2 members of management (from HR department and from the management board). In addition, two sales consultants were observed during two working days each. Table 1 gives an overview of the study participants.

Table 1: Participants in the study.

Organisation	Interviews	Observations	Focus Groups
Hospital	2 nurses, 1 physician, 1 therapist 6 representatives of management	Two days each: 1 nurse, 1 physician	3 physicians, 4 nurses, 4 therapists
IT Consulting	8 sales / business consultants 2 members of management	Two days each: 2 sales consultants	-

3.3 Data Analysis

Interviews and focus groups were transcribed, and observations were documented. From this raw material, we extracted stories that describe reflection in practice, including good practice, barriers and shortcomings. For the work described in this paper, we focused on those stories that involve transitions between individual, collaborative and organisational learning.

4 Study Results: Stories About Transitions Between Individual, Collaborative and Organisational Learning

4.1 Example 1 (Emergency Care Unit)

During our observation, a patient with an acute stroke and in very bad condition was admitted to the emergency room of the ward. After a short time, the responsible physician realized that this was not a routine case but a very critical one. The standard procedure in this case is to give an internal alarm, which causes the head physician and an emergency team to immediately come to the ward. The physician told the present nurse to use her internal telephone to give the alarm, as there was no alarm button in the room. The nurse vaguely remembered the procedure of giving the alarm and started it immediately. However, the alarm did not go off and the helpers did not arrive in the next minutes. The nurse therefore called the head physician and the emergency team directly; they came to the emergency room and took care of the patient.

After this situation, the nurse started to reflect on his failed attempt to give the alarm (and why it failed) by going through the procedure he had applied in the emergency room again and again. As he did not find a reason, he included other nurses into reflection, but they did not have much experience with the procedure and could not help him. It was only when he started to discuss and analyse the situation with the head nurse that they discovered the head nurse had had a similar experience. They realized that the emergency procedure as described in the hospital's quality manual was too complicated to be performed under the stress of treating a patient in bad shape. After this, the head nurse added the issue to the agenda for the regular ward meeting. In this meeting, the nurse who had experienced the problem explained the case to the others and the head nurse explained the problem behind it. Some of the nurses reported that they had had similar problems before. As a result, they agreed to practice essential procedures more often, that the telephone procedure should be changed and that there should be an emergency button in each patient room. As the latter two changes could not be implemented by ward staff but are subject to hospital-wide quality standards or infrastructural decisions, the head nurse agreed to promote the proposal and to talk to the quality manager in order to change the procedure.

4.2 Example 2 (Emergency Care Unit)

In one ward meeting we observed, which was attended by all nurses and physicians working at the ward, a nurse mentioned that she had been thinking a lot about the way

physicians treated patients during the ward round in the morning. She thought that physicians took too little time to talk to patients and that taking more time would make the patients feel more secure and to receive better care. Other nurses remembered that they had witnessed similar situations and supported her. The physicians started to reflect on recent cases in which they did the ward round and agreed that most of the time they could have taken more time for the patients if the ward round would not interfere with a follow up meeting they had to attend. It was then agreed to start the ward round earlier from this time on, and that the physicians would take extra time spent in patients' rooms talking to the patients. This, however, was only implemented in one ward and there was no comparison with the practice of other wards and no sharing of practice with others.

4.3 Example 3 (IT Consulting)

After a time of good success in selling products and services to customers, some sales consultants of the company realized that they were losing more pitches than they were used to. Each consultant had thought about reasons for this, but nobody had a clear idea how to change this. In the monthly meeting of sales consultants, in which they usually iterate through current activities, one consultant mentioned that he had experienced problems in winning pitches over the company's competition recently. The other consultants realized that this was not only their problem and reported similar issues. As a result of this, they focused the meeting on pitches that had been lost recently and started to reflect on potential reasons for these losses by going through the experiences reported by the respective consultant for several pitches. They found that in most pitches the customer had asked the consultant to demo the system. However, the approach of the company was to not use demo systems but to invite potential customers to the site of reference customers in order to show them a fully-fledged system and how well it suited the needs of the respective customer. The consultants realized that in most cases of lost pitches the responsible consultant reported that the customer was dissatisfied with the lacking demo system and that competitors had demo systems with them during pitches. They decided that from now on they would take a demo system with them. The head consultant agreed to talk to the company's IT department in order to set up a demo system with realistic data. He also reported this to the management, who agreed to change the company standards to include demo systems into the process for customer acquisition. However, management complained that they had not known about the problem earlier and that this had caused severe losses of orders.

5 Analysis of Study Results

5.1 Observed Transitions Between Individual, Collaborative and Organisational Learning By Reflection

Analysing the examples described above, a common pattern of the transitions between individual, collaborative and organisational learning can be found (see Fig. 2):

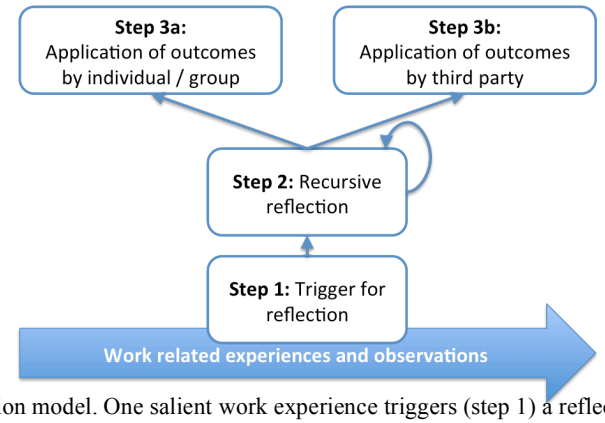

Fig. 2. Transition model. One salient work experience triggers (step 1) a reflection process (2 – either individual or collaborative reflection). The reflection outcomes may lead to consecutive reflection processes (recursion into step 2). The outcomes can then either be applied directly by the reflection participants (step 3a) or by third parties (step 3b)

1. **Trigger for reflection:** In all examples above, an individual or a group makes a work-related experience that triggers reflection of an individual or group (in all examples above this is an individual). For example, the emergency procedure does not work properly in an emergency situation (example 1) or more sales pitches are lost than it is usually the case (example 3). It should be noted, however, that this trigger does not need to be explicit, nor does the decision to reflect need to be taken explicitly: Reflection might also be triggered during group conversations – then the trigger implicitly leads to reflection, but is still there.
2. **Recursive reflection:** The trigger leads individuals or a group to **reflect** on their observations and experiences in order to find a resolution. For example, the nurse asks a colleague, tries to find out the emergency procedure and looks for solutions to the problem in example 1; the sales consultants start to reflect on lost pitches as one of them reports on a lost pitch (example 3). In line with the theory described in section 2, the transition from individual knowledge to a collective level depends on communication in all examples. Communication starts the spiral of knowledge and crosses the boundary between individual and collaborative learning. Such reflection may also result in the externalization of rules and their integration into existing knowledge and practice, as illustrated in example 2 when staff agrees on changes in the ward round schedule. This stage is **recursive**, as individual reflection can trigger reflection in groups, which in turn triggers individual or group reflection again and so on – example 1 illustrates this nicely.
3. **Application of outcomes:** After (potentially recursive) phases of reflection, in all examples the reflection participants achieve a learning outcome (insights into reasons for a problem, partial or full solutions, plans for action etc.). However, there are two alternatives concerning the implementation of outcomes:
   (a) **Application by reflection participants:** Sometimes, outcomes can be implemented by the reflection participants (individuals or groups). In the examples above it was always, finally, a group. Examples for this are the decision to extend training in example 1 or the decision to adapt the ward round schedule in example

(b) **Application by third party:** In some cases, outcomes cannot or can only partially be implemented by the reflection participants, and a decision or action of others is required. Examples for this are the changes in emergency handling (example 1) or the need for a demo system (example 3).

These observations can be related back firstly to Boud et al. (1985) [1], who distinguish as three key elements for reflection the experience(s) on which reflection is based (step 1), re-examining these experiences (step 2, recursive) and deriving applicable outcomes (steps 3a and 3b). Secondly, we see that for transferring individual to collective knowledge by reflection, the foremost needs are communication support and enabling individuals or groups to relate to outcomes of earlier reflection sessions. Both are necessary when iterating between reflection sessions in step 2, as well as when moving from step 2 to 3a or 3b. In the examples described above, we also see that (iterative) reflection makes knowledge more generally applicable. The recursion into step 2 thus obviously contains the knowledge creation and transition process of Beers et al. (2005) [20] that lies between externalization and integration (see Fig. 2).

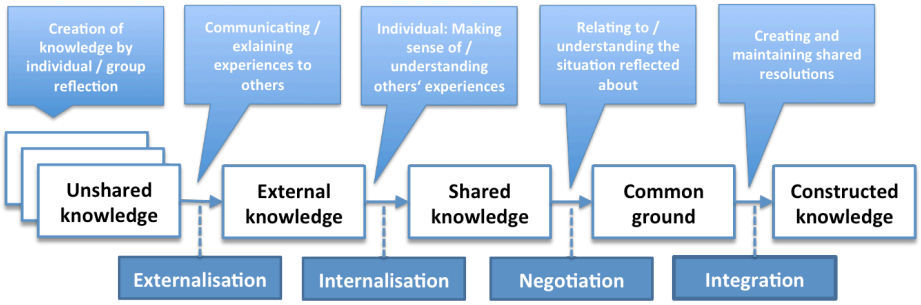

Fig. 3. The knowledge creation and transition process by Beers et al. (2005) [15], complemented with influences of reflection (top level elements).

5.2 Lost Learning Opportunities

As interesting as analysing what we observed, is **what we did not observe**. In the study, we observed how learning by reflection currently happened in the investigated organisations. The examples given above show successful learning in organisations. However, it is also interesting to **speculate where opportunities for learning were "lost" in practice**. Indications for lost learning opportunities stem from the above described stories as well as from within the rest of our collected data. The quality manager at the hospital for instance was very interested in proactive input from the operational levels and reported that she was dependent on this input in order to "verify" that the organisational processes work in practice. This is well argued e.g. by [22], who report that successful companies of knowledge workers ensure that their employees are motivated in "investing" into the company by sharing their insights and applying their knowledge proactively. At another point, we were told by an employee of the IT consulting company that he focused mainly on his core responsibilities because it was too frustrating to make suggestions for improvements outside this sphere and

not seeing them followed-up. This obviously is a barrier for employees to invest time in thinking about how organisational processes could be improved.

Relating back to the transition model in Fig. 2, we see that the report of the employee corresponds to step 2 with a lack of following up, neither by initiating subsequent reflection sessions, nor by applying outcomes in the sense of step 3a (because others need to be involved) or relating insights to others who could act on gained insights. This points to a crucial factor that determined and constrained the success of the three examples described in section 4: In all these examples, one individual (a nurse in both examples 1 and 2, and a sales consultant in example 3) was motivated and able to follow up on own observations and to initiate subsequent collaborative reflection sessions. In each reflection session, again at least one person (the head nurse in example 1, the physicians in example 2, the head consultant in example 3) took responsibility for continuing the recursive reflection, for applying outcomes of the reflection session or for communicate further the gained insights (to the quality manager in example 1, to the company management and the IT department in example 3). The examples also contain learning opportunities lost, as both in examples 1 and 3, multiple nurses / sales consultants had already experienced the same problem without changing work practice in the end (before our stories started). This means that often, there is a **barrier to the propagation of knowledge** (gained through reflection in our examples). This barrier lies between what individuals and groups concerned with operative work can achieve and reflect and what third parties such as management or other groups can implement. This is a known challenge for organisational learning by reflection, as per definition the knowledge needs to be created out of the work experiences of an individual or a group (i.e. the operative level). Organisational learning however can often only be implemented at management levels of hierarchy.

6 Synthesis and Outlook: Push and Pull Mechanisms for Transitions between Individual, Collaborative and Organisational Learning

The transition model (see Fig. 2 and Sect. 5.1) shows the transitions between observations rooted in work experiences (trigger experiences), reflection sessions, and the application of outcomes. It expresses that typically multiple, iterative reflection sessions are required to create organisational learning out of individual and collaborative reflection and that in organisations the reflection participants and the people who implement reflection outcomes may be different people (step 3b).

In order to fully understand ICO transitions, the communication mechanisms that underlie the transition model need to be understood. All examples described in Sect. 4 are characterized by a **"push"-mechanism of communication**. By "push"-mechanism of communication we mean, that the reflection participants actively initiate the communication necessary to move between stages and that the chain of communication finally reaches the organisational level: The reflection participants (either all or one out of a group) push information to other people than current reflection

participants, and thus initiate iterative reflection sessions or the application of insights and solutions on superior and, finally, organisational levels.
The lost learning opportunities discussed in Sect. 5.2 are lost because those reflection participants who had valuable observations or insights did not or could not push this information to other people. A mechanism of communicating or applying outcomes may have helped in these situations. This mechanism would need to shift the burden of communication or application from reflection participants to other people within the organisation, who are capable of or responsible for the reflection or application of insights on the organisational level. We call this a **"pull" mechanism:** It assumes that there are stakeholders within an organisation who are interested in pulling together valuable observations and insights from knowledge workers within the company.
Clearly, both mechanisms may also work without technology support: For the "push"-mechanism this can be seen in our examples, for the "pull" mechanism, verbal communication or paper based workflows also work. However, technology can provide benefits: For instance, technology can support communication by facilitating documentation of experiences, sense-making by relating knowledge expressed by others to own knowledge, relating insights to the original experiences by allowing rich and hyperlinked documentation, and support maintenance of shared solutions in context of the original rationale. For a fine-grained discussion of computer support for reflection (but not specifically targeted towards ICO transitions), we refer also to [12].

Below we describe two apps that are designed to support ICO transitions, but using different communication mechanisms. The design of both apps was informed by the theoretical considerations discussed in this paper.

6.1 Example ICT Support for the Push-Mechanism: The Talk Reflection App

The Talk Reflection App (see also [11]) is designed for physicians, nurses and carers who need to regularly lead emotionally straining conversations with patients and their relatives – these conversations often include conveying bad news and the like. The app (see **Fig. 1**) supports the documentation, individual (A) and collaborative (B) reflection and sustainment of learning outcomes (C) on conversations between medical staff and patients or their relatives. Such conversations are already being documented on paper as part of staff's work, but this documentation lacks relevant information for reflection such as how straining the conversation was for the physician (F and H: the spider diagram show assessments of emotions for a conversation).

Relating back to Beer's model (Fig. 4), the App supports documenting experiences and, by making comments to documented talks (E), encourages deeper observations of own and shared documentation. It also supports preparing observations for communication with others (by marking cases, G) as well as communication about specific conversations via the sharing functionality (D). Furthermore, it enables collaborative work on shared material via comments and respects the need to relate insights to initial observations by providing a comment function (E). The app thus enables recursive reflection into groups that may then implement solutions found for talking to relatives – in the case of the hospital this would be a group of head physicians. The burden of initiating (recursive) reflection sessions, and communicating further any

insights is left to the reflection participants (push-mechanism): physicians can use the app and reflect on conversations with a group on their ward, senior physicians can use and reflect on outcomes from these reflection in the meeting of different wards and finally, the head physicians of the hospital can reflect on these outcomes and decide whether to apply them in the whole hospital The app is currently being evaluated at the hospital that also participated in the empirical work (cf. [11]).

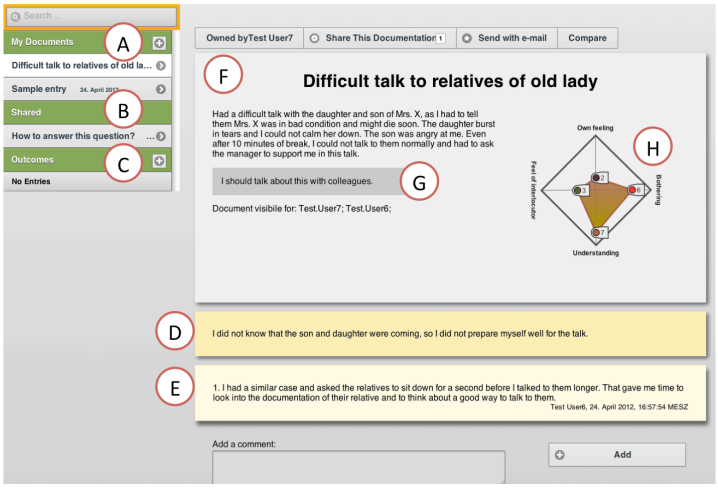

Fig. 4. The Talk Reflection App used to reflect on conversations with patients and relatives (A, F), including functionality to share own experiences with others (B, D), an illustration of own assessments of performance during talks (H), comments (E) and markup for discussion needs

6.2 Example ICT Support for the Pull Mechanism: The Issue Articulation & Management App

The Issue Articulation & Management App (IA&M App, see Fig. 5) is designed to bridge the gap between those who create knowledge relevant for the organisation in daily work (operational workers) and third parties, who are able to implement it (non-operational stakeholders or decision makers) – it thus implements the pull mechanism. In this context, the app supports the articulation of issues (observations, insights, etc.), their relation to tasks and the corresponding business processes as well as the provision of different visualisations according to stakeholder's needs and requirements. These visualisations may take the form of e.g. EPC notation (A), and can be enriched by notes on how many issues, classified according to the type assigned, are related to certain tasks (B). By clicking on such an annotated task, a list of the corresponding issues is derived, which allows for detailed insights in the issues process participants have inserted (C). A tag cloud based on tags provided by the users while articulating an issue gives an overview of topics discussed (D).

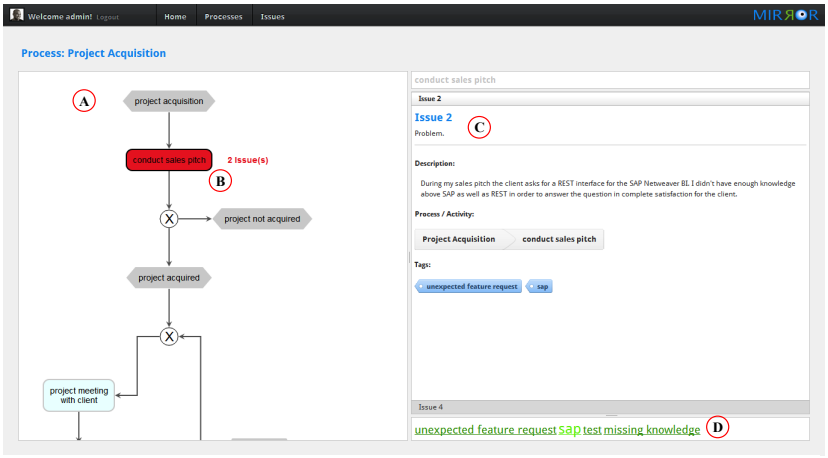

Fig. 5. The Issue Articulation & Management App

Analysing the **IA&M App** from the viewpoint of Beer's model (Fig. 5), it supports employees in **articulating**, **collecting** and **sharing** observations about work experiences and performance. The app also supports the aggregation and visualisation of these observations and relates these to specific work tasks and business processes. In this way, the burden of initiating point-2-point communication about observations is shifted: Operational workers can communicate their observations in direct relation to business process tasks, without needing to identify relevant reflection participants, engaging them in reflection, etc. Non-operational stakeholders like for instance a quality manager can take over this task by having access to such observations and insights – and if necessary can initiate reflection sessions and/or application of insights (pull mechanism). Furthermore, an aggregated overview of annotations can help to identify topics that are discussed and annotated over all work processes, indicating starting points for reflective learning on an organisational level. If many people indicate a problem with a specific work task in a business process for example, it may be valuable for the corresponding decision maker to reflect about changing the underlying working routines or even the whole business process. The IA&M App is currently being evaluated at the hospital and planned to be evaluated at the IT consulting company that participated in the empirical work.

Acknowledgements

The work presented in this paper is a joint effort and supported by numerous researchers being part of the MIRROR project. We thank them for their contribution. In addition, we thank Andrea, Anne, Dominik, Manuel and Volker for allowing us to gain deep insights into their respective company.

References

1. Boud, D.: Reflection: Turning experience into learning. Kogan Page, London (1985).
2. Kolb, D.A.: Experiential learning: Experience as the source of learning and development. Prentice-Hall Englewood Cliffs, New Jersey (1984).
3. Schön, D.A.: The reflective practitioner. Basic books New York (1983).
4. Dyke, M.: The role of the Other'in reflection, knowledge formation and action in a late modernity. International Journal of Lifelong Education. 25, 105–123 (2006).
5. Hoyrup, S.: Reflection as a core process in organisational learning. Journal of Workplace Learning. 16, 442–454 (2004).
6. Eraut, M.: Informal learning in the workplace. Studies in continuing education. 26, 247–273 (2004).
7. Fleck, R., Fitzpatrick, G.: Teachers' and tutors' social reflection around SenseCam images. International Journal of Human-Computer Studies. 67, 1024–1036 (2009).
8. Lin, X., Hmelo, C., Kinzer, C.K., Secules, T.J.: Designing technology to support reflection. Educational Technology Research and Development. 47, 43–62 (1999).
9. Loo, R., Thorpe, K.: Using reflective learning journals to improve individual and team performance. Team Performance Management. 8, 134 (2002).
10. Scott, S.G.: Enhancing Reflection Skills Through Learning Portfolios: An Empirical Test. Journal of Management Education. 34, 430–457 (2010).
11. Prilla, M., Degeling, M., Herrmann, T.: Collaborative Reflection at Work: Supporting Informal Learning at a Healthcare Workplace. Proceedings of the ACM GROUP (2012)
12. Krogstie, B., Prilla, M., Knipfer, K., Wessel, D., Pammer, V.: Computer support for reflective learning in the workplace: A model. Proceedings of ICALT (2012).
13. Harri-Augstein, E.S., Thomas, L.F.: Learning Conversations: The Self-organised Learning Way to Personal and Organisational Growth. Taylor & Francis (1991).
14. Argyris, C., Schön, D.A.: Organisational learning II: Theory, method, and practice. Addison-Wesley (1996).
15. Balzert, S., Fettke, P., Loos, P.: A Framework for Reflective Business Process Management. In: Sprague, R.H. (ed.) Proceedings of HICSS (2011).
16. Nonaka, I.: A dynamic theory of organisational knowledge creation. Organisation science. 14–37 (1994).
17. Kimmerle, J., Cress, U., Held, C.: The interplay between individual and collective knowledge: technologies for organisational learning and knowledge building. Knowledge Management Research & Practice. 8, 33–44 (2010).
18. Stahl, G.: Collaborative information environments to support knowledge construction by communities. AI & Society. 14, 71–97 (2000).
19. Herrmann, T., Kienle, A.: Context-oriented communication and the design of computer supported discursive learning. International Journal of CSCL. 3, 273–299 (2008).
20. Beers, P.J., Boshuizen, H.P.A., Kirschner, P.A., Gijselaers, W.H.: Computer support for knowledge construction in collaborative learning environments. Computers in Human Behavior. 21, 623–644 (2005).
21. Wessel, D., Knipfer, K.: Report on User Studies. Deliverable D1.2, MIRROR IP. (2011).
22. Kelloway, E.K., Barling, J.: Knowledge Work as Organisational Behaviour. International Journal of Management Reviews. 2, 287–304 (2000).