Computer Support for Collaborative Reflection on Captured Teamwork Data

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Abstract. This paper introduces collaborative reflection for the purpose of team learning at the workplace and describes requirements for its support by IT tools. In particular, we identify three processes to be supported and discuss solutions necessary for collaborative knowledge construction and meaning making based on captured teamwork data. This includes support for articulation work, transfer of established scaffolding and guidance concepts to reflection at the work place, and strategies of convergence for collaborative knowledge construction. The paper also sketches potential technical solutions embedded into organizational procedures to facilitate collaborative reflection and team learning.

Keywords: Reflection, collaborative reflection, collaborative knowledge creation, team learning, workplace learning

1 Introduction

Employees learn far more from experience than through formal training ([1], [2]): while they can be prepared for their job in formal learning scenarios and may receive vocational training, adopting and adapting work routines or cooperation structures are subject to informal learning and experience. Consequently, reflection on work practice has been identified as a central learning mechanism ([3], [4]) leading to a better understanding of work and guiding future behavior ([5], [6]). Since in most organizations people work in teams, research should also consider *team learning by collaborative reflection*. This paper describes methods and tools to support such learning at the workplace, explaining the usage of data on work practice. The work described here is part of the project *MIRROR - Reflective Learning at Work*[1].

2 The Significance of Collaborative Reflection for Team Learning

Most models of reflection have a strong individual focus (e.g. [3], [7], [8]). The social dimension of reflection has only recently been described by [9], who highlights the

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role of sharing experiences for the purpose of learning (see also [10]). In this context, the discussion of experience can stimulate and deepen individual reflection. Other social activities such as asking for feedback on work and social comparison are also important aspects of reflection ([11], [12]) and serve as *indicators* for the occurrence of (team) reflection. In this context, it is important to understand that reflection in teams includes both learning done individually by team members and team learning.

Many definitions of team learning explicitly include reflection, defining it "an ongoing process of reflection and action" ([13]). Understanding learning as co-construction of knowledge ([14]), "team learning occurs when individuals share their experiences thus, contributing their unique contextual knowledge to the team" ([15]). Thus, the explication of individual experiences and understandings during team reflection can lead to a deeper insight into shared work practice. This is illustrated by a team learning scenario we observed at a SMB IT consulting company in Germany:

> In a company selling software for customer relationship management, sales consultants regularly visit trade fairs to present their products. There, they meet with their customers and get in touch with interested parties.
> Some days after visiting another fair, the consultants met to review the trade fair at the headquarters. This meeting started with a reporting session, where every participant described her personal impressions of the fair. The team discussed about customer meetings, topics encountered and feedback received. Other consultants asked further questions such as whether talks worked out as planned, whether they achieved their goals, or how the fair will affect the upcoming contracts.
> In addition, more general questions were raised by the head consultant. He also made notes about any reports and stimulated discussions about similar experiences with customers. Once, for example, he asked whether and how cloud computing had been discussed with customers. During a lively discussion, some consultants contributed various stories about their experiences on this. Others reported on articles about the topic they had read and offered to send them around. The team also discussed the perceived relevance of cloud computing on the market, and whether it is a market trend or hype. After some discussion, they concluded that the topic is indeed relevant for their company and has to be discussed further. When they started planning the upcoming trade fair and again discussed cloud computing. They decided to use it as an eye catcher at their booth next time. Thereby they hope to get into deeper discussion about cloud computing with customers and offer assessments of suitability for cloud products in the customers' environment.

As the story illustrates, potentials of collaborative reflection include learning from peers about their experiences, reciprocal sense making, explication of individual understanding and integration of perspectives. It also shows the complexity of establishing a shared understanding in teams and the important role of shared material and experiences for this process. Our work aims at reducing this complexity and supporting the usage of data for reflection by computer tools.

3 Computer Support for Reflective Team Learning

As stated above, designing computer support for collaborative reflection is of vital interest for many organizations. Recent accounts for collaborative *learning* and

knowledge construction might be helpful for collaborative *reflection* as well: There are many approaches supporting collaborative learning, including prompts for elaborated explanations, external representations for co-constructing ideas and means to make cognitive conflicts salient. Additionally, wikis (e.g. [16]), collaborative tagging systems (e.g. [17]), concept maps or systems for group discussions (e.g. [18]) have been applied successfully to support collaborative learning. Additional, there are concepts supporting discursive learning by contextual annotations of material ([19]), the coupling of chat and graphical data ([20]), guidance and scaffolding of knowledge building ([21], [22]) or negotiations ([23], [24]). However, while these approaches work well in educational settings, their value for collaborative reflection and workplace learning has yet to be analyzed as this context raises additional challenges.

4 Dimensions of Collaborative Reflection at the Workplace

Our approach transcends existing work on computer-supported collaborative learning in two ways: First, only little is known about the applicability of IT support for learning by reflection at the workplace. Second, our approach uses data representing real teamwork practice. This raises questions which data to gather, how to do this and how to facilitate interaction with huge amounts of data.

4.1 The Context Dimension: Task and Social Aspects of Teamwork

Reflection on teamwork at the workplace refers to two levels of work done. First, it is about tasks to perform. Second, it addresses social demands of coordination and communication during teamwork. For both of these levels, learning from past experiences is crucial for enhancing future performance of the team as well as individuals ([13]). Additionally, the task and social dimensions of teamwork also show the advantage of reflecting on teamwork collaboratively, justifying the extra effort stemming from collaborative reflection (cf. [11]). In this context, team reflection might occur in different settings such as pre-planned meetings, regular handover sessions and spontaneous encounters of team members.

4.2 The Data Dimension: Teamwork Data as Basis for Collaborative Reflection

While formal learning can be supported by material edited for teaching purposes, workplace reflection needs data representing real work practice. Such data can enhance a team's awareness on shared work practice and make problems or good practice visible. For this data, we need to consider a variety of different granularity and semantic levels. Table 1 shows a choice of such data, including data that might have been useful in the story described above (section 2) such as shared calendar entries to review the performance at the fair or notes consultants took during the customers talks about cloud computing. Additionally, it shows data such as mood levels of individuals, which can be used in the scenario to determine stressful phases

and thus support reflection on whether it was a challenging customer or an unknown topic that. Other data such as pictures and workflow data can be helpful in reflecting individual performance or a team's communication structure.

Table 1: Data types for reflection, with examples from the story above.

Type of data	Instance	Reflection purpose
Sensor data	Mood level measures	Spontaneous assessments
Workflow data	Duration of conversations	Analyze communication
Pictures and videos	Pictures from the fair	Recall / compare work practice
Application content	Shared library or bookmarks	Rebuild context of topic
Explicit notes	Notes from individual reflection	Explicate personal learning
Work documentation	Meeting minutes	Review conversations

Initial trials of using such data such as shown in Table 1 for collaborative reflection purposes show that workers perceive the data as a meaningful basis for reflection and that support for this not only needs means of gathering and aggregating data supporting people in interacting with this data, e.g., in identifying relevant data, relating different data pieces to each other and making meaning from this data. Additional, individual understandings of the data need to be shared explicitly and in relation to the data. In further work, this is intended to result in a continuous cycle of interpreting data, collaborative sense making and sharing individual understandings. Obviously, this process cannot be supported solely by technology, but also needs corresponding organizational procedures, as we will explain in the next section.

5 Designing Computer Support for Collaborative Reflection

Collaborative reflection involves individual reflection, sharing individual understandings, establishing a shared understanding and construction of knowledge. This is in line with Stahl's cycles of individual and collaborative learning ([25]), the co-evolution model of [16] and the conceptualization of distributed cognition by [26]. Our analysis of the challenges described above, which are taken from our empirical work with 3 companies shows that respective support will at least need to include three main activities: the explication of experiences by articulation, guidance for the reflection process and support for convergence into joint knowledge.

Articulation support. As described above, team reflection needs explication of individual experiences and understandings of work. This can be supported by means to comment on captured data. Annotations on teamwork data stemming from such articulation work (cf. [27]) can then be used for team reflection on this data material. In our story, available support for articulation could have helped team members to make their experiences from the fair explicit for discussion during and outside the meeting. For this purpose, the annotation of data by textual comments, tags, audio or video can be used. Through this, a rich base of contextualized experience is available for team reflection. For tool support of this process, multimedia-enabled wikis, in which content can be easily linked, could be used as a starting point.

Scaffolding and guidance support. As stated above, team reflection on work data needs support in using such data and structuring the reflection process. Thus, support by scaffolds ([21]) and means of facilitation ([19]) can be useful to make team reflection successful ([11]). In our story, the consultants could have used a more structured approach guided by prompts of an application and better facilitation to better make sense of their experiences at the fair. This indicated that support for guidance will be combination of facilitation and other human activities with tools such as prompts and proposals for actions.

Synergy support. In order to help teams to derive implications for future work from reflection, converging insights from reflection has to be supported, too. In the story above, convergence support might have helped to derive solutions how to go on with the cloud computing topic faster. We suggest implementing support such as means for graphically structuring the content and tools for negotiating meaning.

6 Summary and Outlook

Our work intends to provide solutions for supporting collaborative reflection on captured teamwork data for the purpose of team learning. Research on collaborative learning and reflection does not provide enough information to build proper tools for such support. For this support, we identified the articulation on shared experiences and teamwork data, the implementation of guidance for the generic scope of reflection and support for convergence to be processes of primary interest for collaborative reflection to be crucial for supporting collaborative reflection. These processes have to be supported by socio-technical solutions combining organizational processes with information technology. Moreover, means used to support such reflection will have to pose little extra effort on people, as they might not be used otherwise. In order to accomplish these goals, further work will be focused on developing prototypes for supporting and investigating collaborative reflection support in real world settings.

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