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).
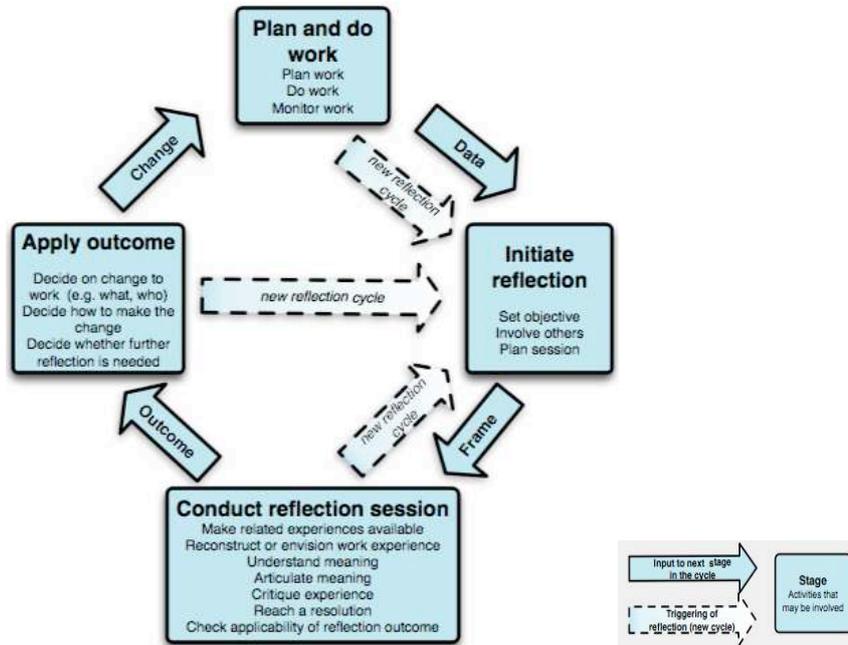

Figure 1: CSRL model v1.2.1 Reflection cycle diagram

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.
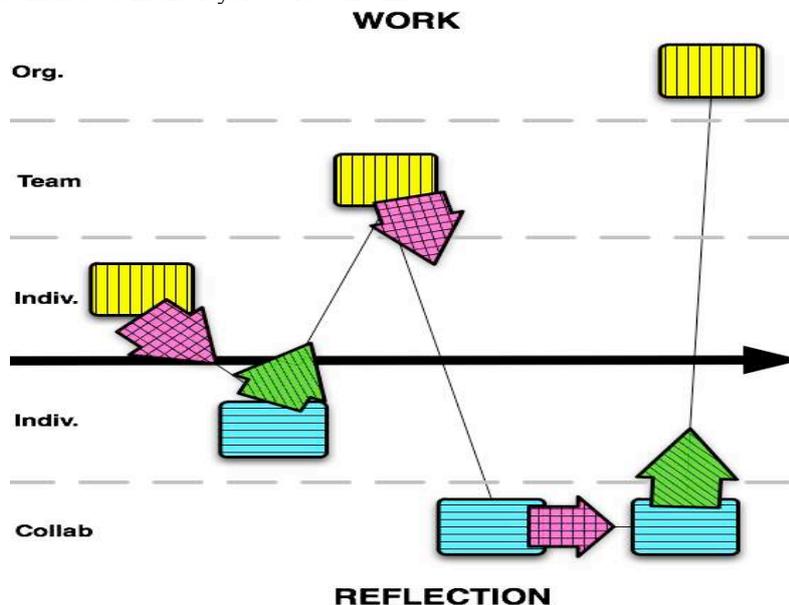

Figure 2: A model in the CSRL timeline view

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 re-searcher 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.
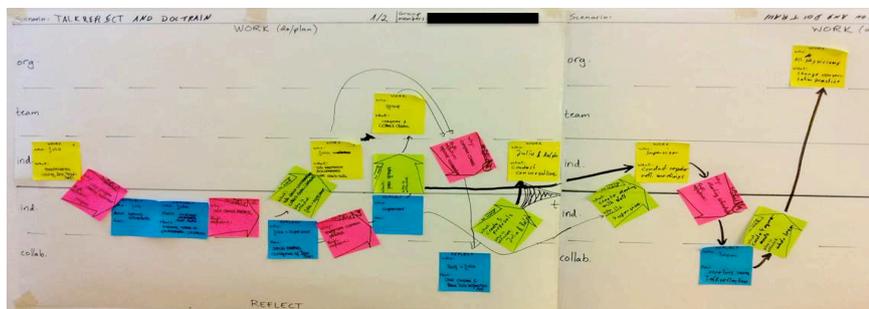

Figure 4: Example 1: CSRL timeline model (scenario including use of two reflection apps)
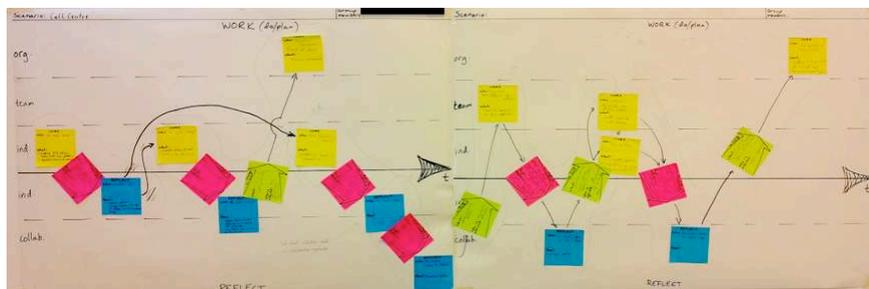

Figure 5: Example 2: Scenario including use of three reflection apps

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.
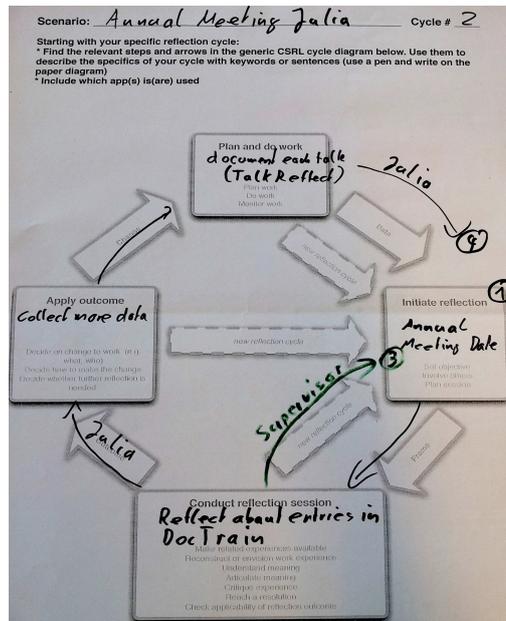

Figure 6: Reflection cycle detailing a single cycle from the timeline in Figure 4

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.

7   References

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