CROSS-TEAM REFLECTION WORKSHOPS IN SOFTWARE ENGINEERING STUDENT PROJECTS

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Development projects are a core element of Software Engineering education because they help students put theoretical knowledge in practice. As in real practice, retrospective reflection workshops can help to improve learning outcomes by having students re-evaluate their project experiences and relate them to core challenges of Software Engineering project work. One of the challenges connected to reflection workshops in SE education is related to the limited experience of students and the consequent lack of input that they can bring into the reflection process to complement the specific experience of the project on which they reflect upon. In this paper we propose the use of reflection workshops organized with participants from different project teams, e.g. cross-team reflection workshops, in order to offer opportunities to learn from experiences made in other projects, increasing the breadth of input to the reflection process. Based on a case study from a Software Engineering project course this paper addresses the particular benefits of cross-team reflection workshops. We outline what we see as important considerations through a set of lessons learned about the workshops.

1 INTRODUCTION

Retrospective reflection workshops in Software Engineering (SE) student projects help students learn about the typical challenges of SE project work by relating their project-specific experience to the more general knowledge and skills of Software Engineering. The workshops also give a hands-on introduction to SE reflection practices that the students may later apply as SE practitioners (Van Aalst 2009, Boland and Tenkasi 1995).

Typically, reflection workshops are conducted with members of a project team, what we will call within-team reflection. Within-team reflection leads to the collaborative (re) construction of a shared understanding of the project, e.g. a shared trajectory/narrative and important lessons learned. This understanding can serve as a starting point for process improvement as well as for deriving more general insights about SE work to be used in future projects (Boud et al. 1985). The specific challenges of a project offer an opportunity for in depth insights.

However, within-team reflection workshops are strongly shaped by the experience of the specific team, making it difficult to shed light on different aspects of SE or put problems and solutions in a wider perspective. The sharing of experiences across projects is recognized as valuable in Software Engineering, as seen e.g. in experience factories (Brown 2000). In this paper we will argue about the benefits of sharing experiences across projects running in parallel by conducting cross-team reflection in workshops with participants from different project teams. Our research objective with this paper is to contribute to a better understanding of the sharing of experiences in collaborative learning settings where different participants’ experiences are related (e.g. originating in the same work practice) but do not originate in the same events. We want to understand how reflective, collaborative learning by sharing experiences unfolds. We present a case study in which we analyse reflection workshops organized in a capstone SE undergraduate course. The aim of the workshops is to promote collaborative learning. The setting we investigate is characterized by participants engaging in the same SE work practice, but not working in the same projects within this practice. This means that while the stories, concerns and specific
experiences of the participants differ, there is likely an overlap in topics of interest, motivating knowledge sharing and knowledge building relevant to the work practice. By sharing their stories, the participants reflect and elaborate on their own experience (making sense of their project experience), but they also get input from others (making sense of what they got from the workshop experience).

The paper is structured as follows: In the Background section we outline our rationale for conducting cross-team reflection in SE student project courses. In section 3 we turn to our case study, explaining how cross-team reflection workshops were organized in this course and how we collected and analysed the data. In section 4 we present three illustrative episodes from the workshops. In section 5, we outline a set of phenomena related to cross-team reflection, referring to the episodes. For each phenomenon we present a lesson learned about the organization of cross-team reflection in project-based learning. In the concluding section we address some limitations and future work.

2 BACKGROUND: REFLECTIVE LEARNING IN SE PROJECTS

In Software Engineering industry, project postmortem reviews have become established practice of collaborative reflection among participants in a project team (Van Aalst 2009), for instance in the form of project retrospectives in agile development (Basili and Caldiera 1995, Derby et al. 2006).

Reflection is an essential part of learning from experience (Dewey 1933). Reflection includes reconstructing experience, re-evaluating it, and creating an outcome (Boud et al. 1985), considering that experience involves behavior, ideas and feelings. Emotion is a key element of human experience (Tomkins, S. S. 1995) and enables people to make sense of their situation and choose appropriate actions. Emotions can be considered as adaptive patterns of perception (Lazarus 2006) that help people survive by helping them understand their own situation and become motivated to do something about it (Ellsworth and Scherer 2003). Emotion is information about experience on two levels: in the situation and when considering the experience in retrospect (Greenberg, L. S. et al. 2002). The emotional side of experience, e.g. from project work, should thus be addressed in reflection.

Collaborative reflection involves articulating, sharing and comparing participants’ individual experiences to create a shared outcome, and tends to be intertwined with individual reflection (Prilla, Michael et al. 2013). Individual reflection is triggered in situations of discrepancy, when something is surprising, strange, or disturbing.

Collaborative reflection can be seen as involving collaborative knowledge building (Cress and Kimmerle 2008, Stahl 2002) based on participants’ experiences. Knowledge-building discourse means building a deep understanding of a problem, asking questions promoting deep thinking, and continually refine and improve ideas (Hmelo-Silver, C. E. and Barrows, H. S. 2008). Facilitators play an important role in driving the process forward e.g. by asking questions (Hmelo-Silver, C. E. and Barrows, H. S. 2008). Collaborative reflection activities may also involve peer feedback (Topping, K.J. 2009), which facilitates learning for the giver as well as the receiver of the feedback.

The organization of collaborative reflection events in SE projects involves a selection of techniques (e.g. activities/steps/exercises, use of representations such as visualizations, e.g. timelines (Bjarnason et al. 2014)) and technology (e.g. paper, whiteboard, post-it notes, social software, project management and versioning tools containing logs from the project) and facilitation, together scaffolding the reflective learning process. Facilitation ensures that certain activities are conducted and adapted to the specific needs and potential of the workshop (e.g. the people and resources involved, the workshop objectives, and the state of the process as the workshop proceeds) (Dingsøyr 2008). Project retrospective techniques have been successfully applied in SE student projects, contributing to students’ learning (Krogstie and Divitini 2009).
Reflection in SE student projects tends to address typical challenges inherent to SE project work in general, or more specifically linked to the educational setting. Well known types of challenges pertain e.g. to managing the relationship with the customer, specifying requirements, learning new technologies required for the solution, dividing work and assigning team roles, and writing documentation (Krogstie and Bygstad 2007). The success in handling such challenges can have a significant impact on the project results, and experiencing such challenges in the middle of a project may strongly motivate students to acquire the knowledge needed to solve the current problem. When the experience of a project challenge involves strong negative emotion, this in itself will also encourage sharing with others (Rime 2009).

Within-team reflection workshops offer good opportunities for reflection going into depth on issues of particular importance to the specific project, e.g. in order to improve the ongoing project process. Team members may learn about how experiences of the same process and events vary among people with different backgrounds, roles and personalities. Experience sharing and discussion within the team is based on the team’s common knowledge about the project, which means that most issues can be addressed without providing the full context. In-depth discussion of project-specific issues can result in more general insights about SE work (Krogstie and Divitini 2009).

3 CASE AND RESEARCH APPROACH

In this section we describe the project course of our case, how cross-team reflection workshops were organized in the course, and our research approach.

3.1 The project course

Our case is connected to a capstone project course that takes half of the workload in the final (6th) semester of a Bachelor of Computer Science program (equivalent to 15 ECTS). The project tasks are unique to each project. Each group has an external customer specifying a product to be developed, and the primary project objective is to meet customer requirements. In addition, each group has a supervisor that they meet every second week throughout the semester. Each project is expected to provide a realistic work setting and requires a high level of independence in terms of choice of process and technology. The freedom to choose the approach and the differences between the project tasks mean that the work experiences differ considerably among the project groups. For example, some project tasks require acquiring a considerable amount of new knowledge, e.g. in terms of programming language and tools, while in others the existing knowledge of students is enough. Some projects start with a well-defined set of requirements, while for others the requirement elicitation process is more time demanding. However, all the groups work within a scaffolding framework that helps them meet the course learning outcomes. This includes requirements set by the course for project deliverables, most notably a project report to be delivered in a preliminary, mid-term and final version. Groups have some common deadlines and templates framing their work. Also, all the supervisors provide guidance considering the course evaluation criteria, striving to ensure feedback consistence among the groups. The course started with 66 students (52 male and 14 female), all European, 60 of which were Norwegians, organized into 11 groups.

Summarizing, the main goal of the course is to learn the practice of Software Development by experiencing it in a realistic but protected setting, where different scaffolding mechanisms are introduced to promote reflection on the experience, and therefore learning.

3.2 Supporting learning from the project work: Cross-team reflection workshops

As part of the course, we organized a retrospective reflection workshop after all the groups had delivered the mid-term version of their report. Project postmortem approaches (Derby et al. 2006, Dingsøyr 2005) have been successfully adapted to the educational setting, e.g. supporting experience sharing and collaborative knowledge construction by use of timelines and experience curves (Krogstie and Divitini 2009). Work on reflection of experience in software engineering factories and previous workshops focuses on shared experience (participants reflect on the same experience from different perspectives).
We decided to bring together in the workshop students from different groups. This was expected to allow each student to get a glance of different problems and solutions, to help them rethink their own experience in a new perspective. Even though the experiences that are shared are essentially different (different project, different groups, etc.), they are all dealing with the same practice, i.e. Software Development (SE). It is within this common practice that participants in the workshop are able to connect, as they are experiencing similar or contrasting emotions about specific events and issues within this practice. The sharing might lead to learning about the practice in general, or more specifically about an experience of that practice. For our students it meant to acquire some general lessons learned to apply in their project or more generically apply in future projects.

The workshop was organized in the middle of the semester and not at the end, so that students could apply lessons learned immediately to improve their project work. For the workshop, students were organized into 12 groups (1 of 3 students, 2 of 4 students, 3 of 5, and the others of 6; 4 students did not participate). Except for one group that had 2 members from the same development group, the reflection groups had only one participant from each development group. The workshops, each lasting 90 minutes, took place one after the other over four consecutive days. The workshop structure was designed by one of the staff members with the help of a researcher with previous experience with the course and reflective workshops. Workshops were facilitated by one facilitator at a time, with two facilitators taking turn.

The workshops had two main parts. In the first part, participants individually reconstructed their project experience and presented it to the others. This was done by aid of a project timeline on an A3 sheet of paper. The participant individually marked significant events along their timeline and then drew an ‘experience curve’ indicating the emotional valence (good/bad) associated with being in the project over time. This is a type of representation that has been successfully used for comparing experience curves of team members within a project (Krogstie and Divitini 2009) to feed collaborative reflection. In the cross-team workshop there was a different project timeline for each participant. For the presentation of the timeline and curve to the other participants, the paper sheet was pasted onto a whiteboard so that after the presentations everyone’s timelines and curves were visible for inspection and comparison (see Figure 1). After the presentations there was a facilitated discussion addressing issues of project work based on the presented experiences.

Figure 1: Project timelines, experience curves and post-its with lessons learned, all pasted on the whiteboard in a cross-team reflection workshop with four participants

In the second part of the workshop, lessons learned were individually formulated on post-it notes, pasted onto the timeline sheet (at specific points on the curve if the lessons were connected to particular events) and presented to the others (see Figure 1). Finally the lessons learned were discussed in the group.

3.3 Research approach

Our study can be considered an exploratory case study drawing on data from the reflection workshops described in Section 3.2. Other data sources from the course have also been used, allowing for data triangulation. In every reflection workshop, one or two researchers were present, making notes and taking photographs of the timeline sheets. Additionally the workshops were audio recorded. The students were
asked to provide a brief evaluation immediately after the workshop by answering some questions (using a paper form). The mandatory reflection notes written by the students at the end of the course, e.g. about 1.5 months after the reflection workshops, answer to a couple of questions about the workshops. It should be noted that the researchers have several years’ background as course staff and researchers in the project course. Our written notes from the workshops guided the investigation of the audio recordings and the selection of excerpts to be fully transcribed. We did not aim to quantify aspects of the observed processes, but when certain phenomena occurred in several groups, we considered them as representative of how cross-team reflection may evolve under the conditions described above. In selecting material for this paper, we aimed to focus on what is specific to cross-team reflection, leaving out insights that pertain also in the within-team setting (for which research has previously been conducted).

4 EPISODES FROM THE WORKSHOPS

In this section we present some episodes reconstructed from the data collected. These episodes show representative examples of how the sharing of experiences unfolds. Episode 1 shows how students reconstruct their experience and how, by recounting it to others, it may uncover hidden details that will help them further elaborate on it. Episode 2 shows how participants deal with negative experiences (e.g. not feeling confident for a lack of IT skills) through the help of other students and the facilitator. Episode 3 shows how some participants are able to engage with their audience and how the workshop experience can influence future project experiences.

4.1 Episode 1: Returning to Experience

In workshop 8, Grace has to check her calendar to see what has happened throughout the project. She populates her timeline with standard events (e.g. meeting, Sprint0, Sprint1). The other participants do not use any information resources for populating their timeline. Then during the second individual activity, participants draw their mood curve along the timeline, representing the ups and downs of their project (see Figure 2).

When Grace has to present her timeline and curve to all the others, she shortly introduces herself, the project and the customer and adds “I got a very good impression talking with the customer at our first meeting … Then we met the supervisor and we got good feedback on the way we were working.” Everything seemed to work fine; her curve is positive and growing. “But then the problem started”. Something happens to her curve, it starts descending. It is not clear what the cause is as there are no events represented along the timeline (see right arrow along the curve in Figure 2).

Figure 2: Grace’s timeline and curve sheet
“The customer did not provide us with the information and data he was supposed to. And the group started dividing in two smaller groups.” These two events that seem to have impacted significantly on her mood are not represented on the timeline. “Then we met with the customer and the supervisor where we heard that things were still working fine, but we did not get the information we were expecting to get. And at this point our motivation started dropping dramatically. We still had no communication within the group. We met with the customer who said that his company itself was going to do exactly what we were supposed to do [in the project]. So we had no task to work on basically” and she explains “It felt a bit stupid to wait so long to get the information and the data, for nothing.” Then she goes on “But at the beginning of Sprint 2 we discussed things among us in the group, and decided we have to do something with the communication within the group and we did. And then the improvement was immediate!” This is another event that was not represented on the timeline and had influenced her view of the project.

4.2 Episode 2: Attending to feelings

Gennine and Blair belong to the same group. By mistake they end up coming to the same workshop, and the facilitator allows them both to attend. Blair is the third one presenting his curve. Then it is Gennine’s turn “What I have to say is quite similar to what Blair said. But my curve is a little less exaggerated and the reason for that is that I...I”, she hesitates a bit and explains, “I am sorry I really hate speaking in front of people.” Then she continues, “I used to study Computer Science but then I switched to Informatics bachelor. I don't want to work in IT; I just wanted to finish some education. So I don't feel confident, which is why my mood is slightly low.”

At the end of the discussion in the workshop, the facilitator tries to bring the attention to Gennine’s lack of confidence “You feel you couldn't contribute as much as the others?” Gennine replies “I don't feel I had the same technical skills as the rest of the group. I try to do my best on the writing of the report and documentation but I am not really sure how to get going with the coding [...] I feel a bit stupid about it because it's so cliché that I am the only girl in the group not contributing. I just don't want to accept that.” The facilitator addresses the other participants “I don't know if anyone else feels that way when it comes to it [lack of technical skills], if they have examples in their group.” Lauren comments “With us this is a bit of an issue, because this is the first time working on Android.” The facilitator also asks “Are you doing anything so that more people can be part of the technical stuff?” Bobby, another participant, suggests “Pair programming is useful. Because we also have a group with various levels of capabilities, and having someone who's confident with the programming part pair up with someone less experienced, that really helps. It helps with the overall mood of the group.”

At the end of the workshop, in answering the questionnaire, Gennine thought the workshop worked fine, she admitted that “I was thinking more carefully why something was not working, instead of just what.” However, Blair perceived the workshop differently. He wrote “I hope it was helpful to others” and also “There was not much discussion about the relevant issues to the group”.

4.3 Episode 3: Recounting and re-evaluating the experience

Bobby took part in the same workshop as Gennine and Blair. When it is Bobby’s turn to present his timeline and curve (see Figure3), he starts by saying “I am a bit hung over” and the other participants smile. The Informatics students had organized a party the night before and some of the other workshop participants had been there too. Then Bobby presents his curve “I felt really good about the course, looking forward to it”. His curve is initially high. “All the projects were good and I could do any of them. The group matched well together. Then we got problems with the customer and he was not able to provide us what we needed, and my mood spoiled downwards. We got the code base and the curve went up and then dooooooown. The language and the framework were unfamiliar [...] this period here is just struggling to understand the solution and getting things to work. And we started to get it here, really really good. We were able to implement lots of things and then the customer just in a meeting says ‘Well, on a national level we have decided to create a project which is basically the same thing you are doing
now’. This created a lot of FUD - Fear Uncertainty and Doubt [the other participants laugh] because we had no idea 'Am I doing something worthwhile now? What I am doing now, is it going to be used?’”

Figure 2: Booby’s timeline and curve sheet

Bobby in his questionnaire thought that the workshop was “useful to reflect on experiences for your own awareness” and also that “It is helpful to look at the project from some distance. Other experiences put your own experiences into perspective”. In retrospective, at the end of the course Bobby still felt like the workshop helped him and his group. This is what he wrote on his reflection notes about the workshop “It helped the whole group put the project in perspective and we used the lessons we took from the workshop afterwards. This gave us a huge relief in the second half of the project.” His group agreed on sharing what happened at the workshop “We took a round around the table and discussed what each of us had experienced in the workshop. The session took no more than 20 minutes, but really helped us in what came after.”

5 FINDINGS AND LESSONS LEARNED

In this section we present findings from our analysis of data from all the groups, structured into a set of observed phenomena taken to be important for successful cross-team reflection. They include: providing new perspectives, learning by recounting to oneself and others, engaging (or not) while recounting, finding support and feeling connected, increasing confidence and motivation, the important role of the facilitator, and bringing back reflection outcomes to the projects. In addressing these aspects, we refer to the episodes outlined in Section 4 for illustration.

While the work domain of the student projects in our case is Software Engineering, we do not consider the phenomena presented in this section as being strictly linked to Software Engineering. Similar approaches to reflection facilitation can be applied to project work in other domains. We accordingly derive insights for project-based learning more generally. For each observed phenomenon discussed in this section, we have formulated a “Lesson learned about cross-team reflection in project-based learning”.

5.1 Providing new perspectives

During the workshop, new possibilities in projects become apparent. Students recognized the value of others’ experience and of others’ point of view. In the post- workshop questionnaire, many participants report having got new perspectives about the project. Bobby wrote that the workshop was “helpful to look at the project from some distance. Others’ experiences put your own experiences into perspective”. Also in retrospective, at the end of the course this is what Bobby wrote on his reflection notes about the workshop “It helped the whole group put the project in perspective and we used the lessons we took from
the workshop afterwards. This gave us a huge relief in the second half of the project.” Like Bobby, 28 other students found new solutions and saw new possibilities. These are excerpts from their questionnaires:

“Get other feedbacks than you would get from your group. Yes, you get a better overview of what works and what does not”.

“I understand that we do not have the best of everything in relation to other groups. What I have heard of the other groups has put things in perspective.”

“Got new perspective on the same problems ... I learned what the others do. Maybe they had solutions I can suggest to the group”.

Even when students were not actively participating in the discussion, they benefit to listen to others’ experiences. For example, a student felt forced to stand up and present. As a result he did not take part in the later discussion and did not produce any lessons learned (that he would also have to present). As reported in the reflection notes at the end of the course, this student did not think it was useful to share his own experience to reflect on what he had learned. However, he found it was useful to listen to others and “hear multiple viewpoints and ways of doing things”.

Lesson learned about cross-team reflection in project-based learning: Cross-team reflection workshops are a good tool for SE education because they help students get different perspectives

5.2 Learning by recounting to oneself and others

When populating the timeline with events and drawing the mood curve, people think through their experience, recounting it to themselves. Through this process there might be aspects that remain tacit. By presenting the timeline and the curve to others (recounting the experience to others), students may learn something by externalizing their knowledge; and by trying to make sense of their emotions to others, they are forced to identify and explain causes and effects of their problems and successes.

For instance, in Episode 1 when Grace recounts her experience to others in her presentation, she provides details that were not apparent when she recounted the experience to herself, see Figure 2. From her timeline it was not clear what happened that made her mood curve turn down. While presenting, she pauses to think about what happened, and her way of presenting her experience changes from presenting things in a formal way (this is what happened and this is what I felt) to telling a story. She starts adding more detail about things that were not visible to others, telling about her frustration and feelings, and also connecting episodes and following them up.

Many details about how the experience unfolded were tacitly expressed in the timeline and curve of several students. Only while presenting their story to others, students were forced to go into more details, explicitly reflecting and addressing causes and effects of their ups and downs. This is what some of the students reported in their post-workshop questionnaire about the use of the timeline: “Smart visualization that forced reflection”, “It was a challenge, but it worked fine. It was good to put things into perspective, but most of all it forced myself to think about what has happened”. Overall, 79% of the students were positive using the timeline in the workshop, 3% were negative, 13% were neutral or did not express any preference and for the rest it was a challenge. Similarly, 74% of the students were positive using the curve in the workshop, 8% were negative, 16% were neutral or did not express any preference and for the rest it was a challenge. Both the timeline and the curve provided support for reconstructing an experience for most of the students.

During the workshop, 95% of the students did not look at information resources (e.g. calendar, pc) to reconstruct the experience, recalling events and attending to feelings. In the post-workshop questionnaire, 13% of the students admitted that they had difficulties recall events or that it was difficult to reconstruct the experience. Only three students looked at their calendar and notes on pc to recall certain events. However, even with the use of such resources it was not always possible to ensure that all meaningful
events had been captured. Grace (Episode 1), who looked at her calendar, did not represent some events that emerged to be relevant to make sense of her experience to herself and others when she presented it.

**Lesson learned about cross-team reflection in project-based learning:** Explaining the project timeline to peers who have not participated in the same project, encourages being explicit about experience not shared by the audience. This aids recall and sense making of the project process.

5.3 Engaging (or not) while recounting

When an issue is given little emphasis by the presenter, it will hardly make it to a shared discussion even if it represents a valid topic to be discussed. In Episode 1, Grace’s formal way of presenting (single event and corresponding mood) was not making an impact on the audience. Only when she started telling a story, it became more appealing to the others to listen to her. In Episode 3, we see how Bobby managed to attract other participants’ attention (making them smile and connecting to their reaction) and maintaining it. He used different strategies. He was not just telling how he was feeling, but why (e.g. “I felt really good... All the projects were good and I could do any of them”). He stressed his curve’s trend in his way of presenting it, and participants could feel his mood was dramatically descending without looking at his sheet when he said “the curve went up and then dooooooown”). He triggered curiosity making up his own terms and making others laugh. He also recreated what was going on in his mind “we had no idea ’Am I doing something worthwhile now? What I am doing now is it going to be used?’”.

If people are not engaged in what has been presented, it is more difficult to identify points of interest for further discussion. Engaging others and capturing their attention on particular issues is crucial for sharing experiences and discussing them. We asked the students to reflect and judge the usefulness of the ‘experience of sharing their experience’ in the post-workshop questionnaire. This is what students thought: 94% of students found it useful or interesting to listen to the experience of others, 3 % of them thought it was not useful and the rest was neutral. At the same time 79% of students found it useful to share their experience with others, 6.5 % of them thought it was not useful and the rest was neutral. People are interested in listening to others’ experiences, but they are slightly more reluctant to share their own experience. The reasons could be shyness, lack of trust in people they do not know well or lack of confidence. Designers that aim at promoting reflection through sharing of experience should take this asymmetry factor into account.

The facilitator can contribute in bringing up an event or an issue that they identify as relevant for discussion. In our case, if participants did not find a common interest, they would shortly report on their experience to answer the facilitator question and terminate the discussion briefly after. There are however other roles that the facilitator can play throughout the workshop that are particularly relevant when focusing on the role of stories and dialogue during the workshop. The facilitator can: (1) prompt for articulation of lessons learned; (2) provide new stories to contrast or to complement the ones provided by students (one of the facilitator had been a student himself in this course a few years before, and he would sometimes mention his own experiences); (3) prompt for clarification; (4) suggest topics of discussion based on practice or told stories.

**Lesson learned about cross-team reflection in project-based learning:** In supporting/facilitating a participant’s explanation about their project, focus should be not only on covering relevant issues but also on encouraging story-telling which may engage peers without stake in the project.

5.4 Finding support and feeling connected

Sharing experiences and troubles with other people helped some of the participants feel a sense of relief from their frustration when appropriating what had been told at their workshop. In the post-workshop questionnaire, 14 students admitted that talking with people outside their project group was helpful. Some participants felt a sense of relief. This is what a participant wrote in his questionnaire “Being able to tell and express things that have been good and bad, I feel it relieved pressure on my shoulders”; and this is what Grace wrote “Good to talk with someone outside the group...I appreciated liberating my ideas and
listening to others.” Other participants felt a sense of connectedness discovering they were not the only ones facing challenges in a project (“Nice to hear that others had the same thoughts as me about the process”), e.g. struggling with some members or having troubles dealing with the customers or supervisors (“Nice to hear how others have solved problems with customer and team members”).

At times it is thanks to the facilitator that participants are able to find a solution to their problem. In Episode 2, Gennine’s lack of confidence (in the project) and feeling uncomfortable (at the workshop) pushed the facilitator to bring the participants attention back to her problem, to try to deal with it collaboratively and possibly find solutions. Gennine, for instance, benefited from it. At the end of the workshop, in answering the questionnaire she wrote “it was useful to hear what others think about things that are problematic, and get suggestions for what can be done to improve the situation”. Sometimes, it is difficult for the facilitator to decide whether or not to pursue a specific issue, weighing the general relevance of the issue within SE practice against the relevance for most of the participants with their particular projects. If the facilitator had not triggered the discussion about Gennine’s problem, maybe she would not have brought the issue into the discussion to seek suggestions. However, pushing the discussion in a specific direction could be counter-productive for others. Blair, for instance, thought that the problems of his (and Gennine’s) group were not addressed. In his post-workshop questionnaire Blair wrote “There was not much discussion about the issues relevant to the group”. Focusing too much attention on solving what he considered to be Gennine’s personal problem could be one of the reasons.

It is not only people experiencing problems that find support and feel relief listening to others. Also those having more positive experiences benefited from the workshop «Nice to know that others also have the same experience... because others may have a greater problem that makes you not feel that you have it so bad yourself».

Lesson learned about cross-team reflection in project-based learning: Students generally appreciate the opportunity to talk about their project, e.g. emotional aspects, to peers not involved in their project. Peers from different projects can provide support and help each other feel connected in ways not possible within the projects (with their project-specific challenges and group dynamics).

5.5 Increasing confidence and motivation

The students who found relief after the workshop were not the only ones appreciating sharing their experiences. Also those contributing with successful experiences recognized their role in providing useful suggestions and support. A participant wrote in his questionnaire: “It shows that other groups have problems we have not been close to. This made me like my own group and task even more”.

Seven participants felt particularly excited at having made a contribution by showing another fellow student how to improve their process. This is likely to make the contributors feel more confident about themselves in general, motivating them in the group work that lies ahead.

Also participants having problems before the workshop were motivated to face these problems and try to find a solution or applying a suggestion. This is what a girl wrote on her questionnaire after the workshop regarding her problem to deal with a group with a flat structure: “I will share all the suggestions, in particular feedbacks on the division of roles among members”.

Lesson learned about cross-team reflection in project-based learning: Reflecting with peers from other groups may provide students with new insight, and also confidence and motivation, to bring back into their own projects.

5.7 The important role of the facilitator

Episode 2 illustrates how a facilitator may take part in the common discussion. The input of the facilitator serves to encourage experience sharing. His concluding remarks in on the other hand close the discussion – possibly at the expense of collaborative reflection.
Good facilitation of collaborative reflection in this type of setting requires knowledge about SE project work. Such knowledge enables the facilitator to recognize general issues in the experiences shared by participants and judge what issues to address, and when, to help trigger individual reflection and fuel experience sharing. A facilitator with this kind of knowledge will also have experiences and opinions of his own, which he may use to encourage collaborative reflection, e.g. providing opinions to which participants may agree or disagree (1) or acknowledging what participants have said (4). Also, experience sharing by the facilitator may help to keep a friendly, informal tone in the discussion. On the other hand, a facilitator sharing his own experiences and opinions may effectively stop reflection, e.g. by defining what is true and valid. In (7), the facilitator’s concluding remarks may be perceived as invalidating the opinions of the participants, as he states that “there is nothing to do” about issues that the teams are in fact currently trying to address. A good facilitator needs to stay in control of the temptation to share his experiences and opinions, and do it only to encourage collaborative reflection.

Some data we collected also shows that going into great detail on the experience of single participants does not necessarily lead to experience sharing from others with similar challenges, and could possibly be seen as unfair use of workshop time. The facilitator needs to balance these concerns.

A difficult task for the facilitator is to identify and continuously update the set of possibly reflection-triggering issues. The recognition of interesting connections between various experiences is key input to this process, along with the identification of cues (information, questions) that might help participants connect and compare experiences and maybe share their thoughts with the others. Essentially, reflection is about creating outcomes that could not be predicted in advance, and cannot be completely managed. Facilitation requires attention to how the collaborative process evolves: learning opportunities may emerge, whereas some discussion topics thought to be interesting may turn out to be dead ends with respect to reflection.

Lesson learned about cross-team reflection in project-based learning: Facilitation plays a critical role to assure a successful workshop and requires competencies in SE and in group dynamics.

5.8 Bringing back reflection outcomes to the projects

Insights from the reflection workshop are useful if they can be directly applied to work, but also if they help fuel constructive discussion and process improvement in the project teams. The study gives some insights about how the outcomes of the cross-team reflection were brought back to the project teams, as it was addressed in a question to be answered in the reflection notes at the end of the project.

Reflecting on the workshop outcomes within the team was not a mandatory activity; it was however encouraged, e.g. by sending to each student the electronic version of the individual timeline and curve from the workshop (photographed by the researchers)– an artifact that could be shared with the others in their project team. Some students reported that they did share the outcomes in their team. Students from one project group wrote: “The group briefly discussed how the reflection workshop had been and what we had learnt from it. We took these experiences with us in the group for the rest of the project period” “We had informal conversation about what we and others had been telling. No concrete actions were implemented immediately as a consequence of this, but it is not unlikely that people kept a memory of it”. A student from another project group reported: “We discussed internally in the group how each member’s reflection workshop had been. In that way we got to know what problems are recurring and how to handle them (or NOT handle them)”. Finally a student from a third group wrote: “We just touched upon it, that we had learnt much more than we had expected beforehand, and then we discussed a bit what mistakes the other teams had made. Unconsciously I think this lead us to handle those things correctly, even if we did not do it explicitly.”

Whereas it is hard to conclude from these data about the application of the within-team discussion outcomes in the work of the project group, it seems that many students perceived it as beneficial to have a within-team experience sharing after the cross-team workshop. In some groups this was however
differen, which is interesting from the point of view of considering how the step could be better supported. One student wrote that he felt silly reporting on the workshop, as he felt the others did not see the value in it. Another wrote: “Unfortunately I felt that [my project] group was too formal to really discuss the workshop in more than one sentence”. A third student explained: “In my group there were some negative preconceptions [Norwegian: “ukultur”] from which people did not see the value in it. I tried to bring it up, but people laughed it away a bit, and I felt slightly silly trying to talk more about it”. A fourth: “It was briefly mentioned what was done in the workshop after the first group member had been there. Most regarded it as totally wasted and chose not to bring it up again”. Other comments pointed out that by the time the team discussed the workshop findings internally, they had already identified the lessons learned and did not need to discuss them more. There were also students who thought that the insights from the workshop (in the middle of the semester) came too late in the project. From the study, it seems that the reasons for not bringing the results back to the project teams, vary, and include challenges of collaboration and communication.

Insights emerging from the workshops represent opportunities for the students to improve their projects. However, if what is learned in the workshops is not turned into actual changes, the overall value of the workshops is significantly reduced. There has to be enough time (and energy) in the workshop, after the experience sharing and discussions – and/or as part of them - to bring reflection outcomes to a stage that makes them useful in future project work. Reflection outcomes may be directly applicable to the project work, and/or serve as constructive input to discussion in the project teams. The facilitator may be critical in helping the students develop actionable knowledge.

**Lesson learned about cross-team reflection in project-based learning:** Bringing back reflection outcomes to the project might be problematic. This could be addressed by appropriate facilitation and change of timing. Additionally, support and possibly mandatory activities might be needed, e.g. asking each group to prepare a list of changes to the process after the workshop.

### 6 CONCLUSION

In this paper we discuss cross-team reflection workshops in SE education and their potential to support reflective learning in SE student projects by offering a broad base of project experiences to be shared and reflected upon. The empirical study showed that the workshops lead to experience sharing and comparison across projects. The study also showed the importance of the workshop facilitator, who needs to identify core SE challenges for which there are comparable experiences in the workshop. Based on the empirical data, we drew lessons learned that can be useful to educators in capstone projects in SE as well as project courses in other domains.

The fact that the organizing of the project course and the reflection workshops was driven by strictly pedagogical concerns, ensured that the workshops were authentic cases of reflective learning on project work, of real importance to the participants. The researchers’ prior involvement with the project course necessarily lead to preconceptions about the case, but also gave a more informed background for interpreting the data.

The complexity of project work and reflective processes suggests caution in drawing conclusions about what aspects of the workshop organization lead to the observed interaction and what reflective learning resulted from it. In our data analysis we have chosen to focus on elements of the workshops that could relatively easily be observed and documented, e.g. the conversations taking place through the presentation of individual project experiences and the subsequent common discussions. We acknowledge that there may be factors influencing these processes that we have not systematically considered or addressed in this paper.

For students to get the most out of the cross-team reflection setting, the presentation and discussion of participants’ different experiences should result in collaborative knowledge building around issues of
shared interest in the group. We have pointed to the challenge for the facilitator in recognising the potential for collaborative knowledge building in the specific workshop group. Also, the available time in a reflection workshop may be a limiting factor with respect to the reflective learning process. Extending the time for discussion *within* the workshop might help in this regard. Strengthening reflection support *beyond* the workshop might give better opportunities to achieve the type of discussion that leads to deeper understanding and refinement of ideas. This includes preparation on part of the facilitator as well as the participants, and follow-up activities, e.g. addressing the students’ actual use of reflection outcomes in their project work. Furthermore, it is possible to have more than one reflection workshop in the same group, e.g. one workshop mid-term and one towards the end of the project. Having more than one workshop will make it easier for the groups to address project improvement and refine understanding of project issues by drawing on actual project work experiences: did the participant actually apply insights from the previous workshop? Why/why not? What happened? Support for reflective learning in cross-team groups over the duration of the projects will strengthen the role of the groups as a forum for getting project-external feedback on project experiences.

An issue in considering support for reflective learning through cross-team reflection groups are clearly the resource demands. The use of human facilitators in workshops, as exemplified by our case, is a challenge to economy of scale. Extending the support for reflection beyond the workshops is likely to require even more teaching resources. However, not all scaffolding of reflective learning need the continuous attention of a human facilitator. In the cross-team reflection setting the students serve as learning resources for each other. A more systematic use of peer feedback (Hattie, John and Timperley, Helen 2007) should be considered, e.g. as a way of strengthening the learning outcomes from facilitated workshops. How to do this effectively is a topic for further research. Another question that should be explored is whether the facilitator in a workshop can be fully or partially substituted by computerized support. Further work should more generally address whether the benefits of collocated, cross-team reflection are attainable in a distributed setting.

We suggest that the lessons learned presented in our paper be used to inform further research on cross-team collaborative reflection. We also see the lessons learned as useful input to course organizers and teaching staff who consider including similar reflective learning activities in their project courses.

8 REFERENCES


