# Analyzing Collaborative Reflection Support: A Content Analysis Approach

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**Abstract.** Collaborative reflection helps groups to learn from work experiences for future work. Although its potential has been recognized and initial work is available, insights on how tools support people in collaborative reflection at work are scarce. We present an approach to analyze collaborative reflection support based on content analysis and an initial study in which it was applied to four cases of using a tool for collaborative reflection. From this we derive design suggestions such as levels of support for different groups and support for the creation of results from collaborative reflection. Our work contributes to CSCW by showing how tools can foster collaborative reflection at work.

## Introduction

Reflection is a process of going back to experiences, re-assessing them in the current context and learning from this for the future (Boud, 1985). Outcomes of this process include new ideas for work, new perspectives on own experiences and changes in behavior. Reflection is a typical and desirable activity at work (Kolb, 1984; Schön, 1983), e.g. when workers think about how to improve individual or common work, and when peers help each other to understand and change practice. It has been described as a necessary attitude for nowadays' professional practice (Schön, 1983) and as a *mind-set* to be cultivated and spread in organizations (Reynolds, 1999). While this takes a look at reflection as an individual, cognitive activity a lot of reflection happens in groups and has implications on cooperative work (Boud et al., 2006; Daudelin, 1996; Hoyrup,

2004; Prilla et al., 2013). Despite this potential there is little work available on tool support for such **collaborative reflection** at work (see below).

In this paper we describe a research approach to analyze the content of reflection threads in a tool used to support collaborative reflection. The contribution stemming from this is the analysis of a study with 48 participants in four cases, in which we analyzed *how* the tool was used, *what* it was used for, and how support for collaborative reflection *leads to reflection results*. For the study we developed a content coding scheme for (collaborative) reflection content, which helped answering these questions. From the analysis we derive implications for the design and improvement of collaborative reflection support.

## Collaborative Reflection Support: State of the Art

The potential of supporting collaborative reflection has been recognized recently (Baumer et al., 2014; Marcu et al., 2014; Porges et al., 2014), but the term is interpreted differently: While it is used for processes of data pooling and decision making (Marcu et al., 2014), most work (including this paper) understands it as collaboratively reviewing experiences and learning from them (Baumer et al., 2014; Boud, 1985). Despite these differences, it is common understanding that collaborative reflection needs communication to share experiences, critically discuss them and draw conclusions together (Daudelin, 1996; Scott, 2010), especially if there is no time or possibility to meet in person. Therefore, in the same way as articulations provide "a set of activities required to manage the distributed nature of cooperative work" (Bannon & Schmidt, 1992), collaborative reflection needs support for the articulation of experiences, of perspectives on these experiences and of ideas for change.

Supporting collaborative reflection at work faces different **challenges**: Time pressure makes it hard to step back and reflect (e.g., in meetings), and reflection is a secondary process at work, which is not implied by most work tasks. To cope with this, there is a need to establish reflective practices such as regular exchange of experiences (Vince, 2002) and a need for facilitation (Daudelin, 1996). Questions by a facilitator in face-to-face settings help facilitate collaborative reflection and create results from it (ibid). This may also help to overcome differences in people's ability to articulate problems and assumptions (Bjørn & Boulus, 2011) or to address others' contributions (de Groot et al., 2013). Whether and how it translates into tools for collaborative reflection remains open.

As reflection depends on memories of experiences, which may be incomplete or get blurred over time, and on the continuation of reflection across single occurrences, **tools** can support it by providing data to reconstruct and sustain experiences or by reminding people periodically to reflect (Isaacs et al., 2013; Scott, 2010). Tools investigated for reflection include learning portfolios or

journals (Scott, 2010), which contain write-ups of learning, and images captured during a certain event and later used for reflection (Fleck & Fitzpatrick, 2010). Such tools capture data enabling and supporting reflection and help to diminish memory loss or deviations in perceptions over time, but they usually do not support reflection explicitly but expect it to happen, e.g. in group meetings. Another area of individual reflection support is **prompting** users to reflect (Davis, 2000). In approaches as reported by Isaacs et al. (2013) tools prompt users to reassess experiences regularly, which helps them to stay aware of reflection, to structure the re-assessment and to gain insights from reflection over time.

Despite its value existing work focuses on individual reflection or education settings, in which reflection can be made an integral part of learning. Insights on how support for collaborative reflection creates impact at work are missing.

## Related streams of work

There are certain overlaps of collaborative reflection with existing concepts, but it also differs from them in decisive aspects: Sensemaking and collective mind (Crowston & Kammerer, 1998; Weick, 1995) need people to collaboratively reach an understanding of past events, but sensemaking processes described in the literature usually do not have a clear focus on deriving insights for future work, which is a necessary step in reflection (to lead to change). Group decision support systems (Dennis et al., 1988) are about exchanging perspectives and arriving at decisions in teams, but focus on gathering data to reach a decision rather than creating new or alternative solutions (Power & Sharda, 2009). Approaches of collaborative problem solving (Roschelle & Teasley, 1995) use joint spaces to solve problems, but have to deal with the "shared information bias" (Baker, 2010), in which information known to all collaborators from the start tends to be followed more than information held by individuals. Collaborative reflection, in contrast, needs experience exchange and critical discourse among all participants.

# Analyzing Collaborative Reflection Content

Articulation support was described above as a central need for collaborative reflection: Reflection participants need to make their experiences, understanding and ideas explicit in order to reflect together. Therefore, in our work we used *content analysis* as a tool to analyze the articulations made by reflection participants in order to understand the course and output of collaborative reflection in tools. This, in turn, can create insights for the analysis and design for collaborative reflection support.

Content analysis is key to understanding how tools support communication processes (Lockhorst et al., 2003; Suchman, 1987), and it enables a better

understanding of them (Wever et al., 2006). It is a common method of understanding group communication in CSCW (e.g., Newman et al., 1995; Prinz & Zaman, 2005) and regarded as the preferred method of analyzing communication if manual coding is possible (Introne & Drescher, 2013). Differences in content, however, can only be understood by looking at further information such as the background and context of users and constraints of usage in the cases. Therefore, we complement content analysis by feedback from users, which is described to further extent in Prilla (2014) and Prilla and Renner (2014). Our analysis also cannot be used to make statements about reflection in general, as reflection also happens in face-to-face interaction among users of tools. Therefore we use our approach to explain how and why the app was used in the different cases and what led to reflection results being described in the app.

## What is Collaborative Reflection? A Model

Analyzing content needs a model of what is analyzed, that is, a "theoretical base and operational translation" (Wever et al., 2006) of collaborative reflection. De Groot et al. (2013) provide such an operationalization differentiating describing problems, critical reasoning and critical reflection dialogues. Moon (1999) proposes a nine-stage model including the expression of experiences, the clarification of issues in the experience, reviewing experiences and emotions together and transforming ideas into possible actions. Fleck and Fitzpatrick (2010) describe six activities in reflection such as returning to experiences, providing, sharing thoughts, offering alternative interpretations and the intent to create results. Others add steps such as inquiry to identify new practices (Raelin, 2002), asking for feedback (van Woerkom & Croon, 2008) and detecting patterns from experiences (Boud, 1985). From these approaches we distilled core steps of collaborative reflection and created an initial model of it. The model contains **three levels** of activities and corresponding articulations in reflection (Table I).

| Level | Description |
|---|---|
| 1 | **Describing experiences**, emotions and rationales for action (Boud, 1985; Fleck & Fitzpatrick, 2010; Moon, 1999; Tigelaar et al., 2008). |
| 2a | **Referring to experiences** by commenting and engaging in reflection (de Groot et al., 2013; Fleck & Fitzpatrick, 2010; Raelin, 2002; Tigelaar et al., 2008; Zhu, 1996). |
| 2b | **Referring to experiences** and triggering interaction by asking for information or feedback (van Woerkom & Croon, 2008; Zhu, 1996). |
| 3 | **Creating results** from reflection through drawing from experiences and transforming insights into practice (Boud, 1985; de Groot et al., 2013; Fleck & Fitzpatrick, 2010; Moon, 1999). |

Table I. Levels of (articulations in) reflection.

Besides differentiating levels of reflection and thus allowing for a characterization of progress in reflection processes this model helps to recognize successful reflection: Along our understanding of reflection we regard reflection as successful when the process reaches level 3, that is, if it creates results.

## A Content Scheme for Collaborative Reflection

When we started our work there was no scheme for analyzing collaborative reflection content available: Literature contains schemes for the analysis of computer-mediated communication (Lockhorst et al., 2003; Wever et al., 2006), and there is work describing reflection activities (see above). Based on literature analysis and the model presented above, we created a scheme for the analysis of collaborative reflection (Table II). It includes 15 codes related to the levels shown in Table I. There is **no sequence of codes implied** in the scheme: For example, users may have mentioned learning (code 9) without any traces of codes 6, 7 or 8.

| Code | Description and example(s) from the study | Level |
|---|---|---|
| 1 | **Mentioning issues or good practice** based on experiences, e.g. "I had a rude person on the phone. She […]". | 1 |
| 2a | **Mentioning own emotions** in an experience (e.g., "Was not fun man" or "this made me angry"). | 1 |
| 2b | **Mentioning emotions of others** in an experience (e.g., "[resident] said he is unhappy living here") | 1 |
| 3 | **Interpretation or justification** of actions and situations (e.g., "As far as I am aware I had done nothing to deserve this". | 1 |
| 4 | **Linking an experience to other experiences (**e.g., "I made a similar experience", "X told me he was through this before …"). | 2a |
| 5 | **Linking an experience to knowledge, rules or values** (e.g., "never accept blame for another's mistake"). | 2a |
| 6a | Responding to interpretation of the action by *challenging* **existing interpretation(s)/ suggestions or adding perspectives (**e.g., "Hmmm. Is this really different from …"). | 2a |
| 6b | Responding to interpretation of the action by *supporting* **interpretation(s) and suggestions** (e.g., "Agreed!"). | 2a |
| 7 | **Giving advice** without a reason or reference to experiences (e.g., "Never accept blame for another's mistake") | 3 |
| 8 | **Proposing solutions** with a reason and/or link to experiences, without suggesting how to set them in practice, including a reason (e.g. "from my experience a list of FAQ's is useful"). | 3 |
| 9a | Insights from reflection **as single-loop learning: Different or better understanding of experiences.** Expressed by reporting insights ("I realised that I shouldn't have …"). | 3 |

| Code | Description and example(s) from the study | Level |
|------|-------------------------------------------|-------|
| 9b | Insights from reflection **as double-loop learning: Generalising from experiences.** Expressed by patterns or roots of a problem (e.g., "The best way I found to deal with this is …"). | 3 |
| 10 | **Drawing conclusions and implications from reflection** by suggesting to apply new practice or reporting on changes *done or planned* (e.g., "Will definitely try and do … in the future"). | 3 |
| Q1 | **Questions for *information* on the experience** (e.g., "what do you mean by …" or "what happened afterwards"). | 2b |
| Q2 | **Questions triggering discussions**, asking for an *interpretation* of a situation, for opinions or proposals (e.g., "what do people think about …"). | 2b |

Table II. Coding scheme for the analysis of content in (collaborative) reflection support tools.

## Coding Level 1: Articulations used to describe experiences

The **description and sharing of experiences**, which forms the basis for reflection, is represented by mentioning issues or good practices (code 1 in Table II). When shared a description may trigger reflection (Tigelaar et al., 2008) and enable users to return to the experience reported (Boud, 1985; Fleck & Fitzpatrick, 2010). If descriptions include **emotions** (code 2), this may influence collaborative reflection positively, as others are more likely to react (Ellsworth & Scherer, 2003). Concerning emotions we differentiate between emotions of the author of a report (code 2a) and reported emotions of others (2b) to distinguish between personal feelings during the event and contextual description. Reports may also include **initial interpretations of actions** (code 3) by the author of the report, which can help others to understand the experience better (Raelin, 2002). A statement from one of the cases analyzed below includes codes 1, 2a and 3:

*"So it's been quite a tough week, one of those where I haven't wanted to talk to anyone or immerse myself in any meetings. Sadly, I've had a few meetings! But I did make a couple of mistakes which I feel really bad about.* [codes 1, 2a and 3] *Has anyone else been in such a situation? How did you overcome your mental slump?* [code Q2]

From our literature analysis we assume that both **emotions and initial interpretations in experience reports positively influence reflection** by improving the understandability of the report and triggering others to refer to it.

## Coding Level 2: Articulations used to refer to others

Referring to each other and relating to experiences shows interest in other content, which is important for the creation of results from reflection (Daudelin, 1996; de Groot et al., 2013; Fleck & Fitzpatrick, 2010). Exchanging experience enables participants to learn from each other. Therefore, contributions to a thread in which **experiences are linked to others** (code 4) are crucial (de Groot et al., 2013; van Woerkom & Croon, 2008). Similarly, one may **link knowledge, data, values and other sources** (which do not stem from or explicitly refer to experiences) to experiences (code 5; Boud, 1985). While these ways of referring to experience are similar (Daudelin, 1996), linking experiences to each other constitutes reflection processes while linking experiences to existing knowledge often refers to existing solutions (Zhu, 1996). We can therefore assume that **linking experiences to each other has a stronger effect on reflection results than linking experiences to knowledge**. Two comments on the same report from one of our cases show the differences between these ways to refer to each other:

*A: "I have been in the same situation. I usually just tell my manager with an apology and reason and then ask if she wants to re-arrange it."* [code 4]
*B: "I would [...] suggest staying late and working harder."* [code 5]

Referring to each other includes **challenging** or **supporting interpretations of actions** (Fleck & Fitzpatrick, 2010; Raelin, 2002; Tigelaar et al., 2008) as covered by codes 6a and 6b (see an example for 6b in the section below): We thus assume that the **occurrence of codes 6a and 6b positively influence the occurrence of results**. Questions play a special role in reflection, as they trigger engagement. Along with Zhu (1996) we differentiate questions for additional information (code Q1) from questions to provoke discussion (code Q2, see the first example above). The former is supposed to increase activity in reflection, while the latter should improve the quality of outcomes (Daudelin, 1996; Zhu, 1996). We thus assume that **questions have a positive impact on the occurrence of results**.

## Coding Level 3: Articulations used to describe results from reflection

Learning from reflection means thinking towards solutions. This step was described above as a differentiator to similar concepts. Learning may start with **solution proposals** (Daudelin, 1996; code 8). We differentiate **advice** (code 7) from solution proposals, understanding it as proposals given without explanation or relation to experiences, and therefore as **support that does not stem explicitly or directly from reflection**. Solutions proposals based on experiences are often more valuable (Hatton & Smith, 1995), and therefore we assume that **solution proposals have more impact on results from reflection than advice**.

Results from reflection also include **insights** (learning) and **change**. Reflection participants may either gain a better **understanding of (single) experiences** (code 9a), which is related to single-loop learning (Argyris & Schön, 1978), or they may draw **more general conclusions** on the reasons behind problems (code 9b), which is related (Greenwood, 1998) to double-loop learning (Argyris & Schön, 1978). **Deriving change** (code 10) is the final and constructive step of reflection (Daudelin, 1996; Moon, 1999). Given their direct relation to reflection in the analysis we use the **occurrence of any code 8, 9 or 10 as an indicator for results from the reflection process**. The example below shows a statement from one of our cases with learning (code 9b) and change (code 10) mentioned.

"*I do agree* [code 6b] *that the less you want to communicate, the harder you'll likely find it to maintain high standards*. [code 9b] *Will definitely try and be resilient if/when this happens.*" [code 10]

## Analyzing Collaborative Reflection in Practice

We applied the coding scheme described above to four cases (see Table III) in which workers used the "TalkReflect App", which was designed to support collaborative reflection, in different settings. The app supports reflection activities such as the documentation of experiences, sharing these experiences and collaboratively reflecting on them. It includes features proposed by related work:
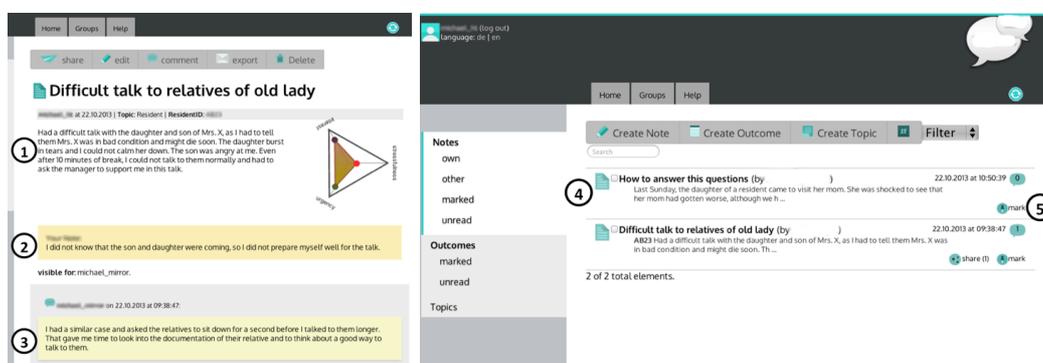


Figure 1: The TalkReflect App with an experience report (left) and shared reports (right).

- **Creating experience reports:** Users can document experiences and personal reflections. Figure 1 (left) shows an experience report (no. 1) with a personal reflection (2). Reporting on experiences may trigger reflection (Scott, 2010).
- **Sharing experience reports:** Private to users initially, experience reports can be shared. Once they are shared, other users can find and mark them as favorites (Figure 1, 4 and 5). Sharing experiences with others can be regarded as asking for feedback or opinions (c.f. van Woerkom & Croon, 2008).

- **Commenting on experience reports:** Users can comment on shared experience reports (Figure 1 left, 3) to describe similar experiences, suggestions or other reflective content.

Besides the core features the app includes additional features such as feedback (e.g. via a 'like' button for helpful comments) and it allows for creating custom groups for sharing reports with certain co-workers (e.g., omitting superiors).

In all cases daily interaction with others (patients, residents, relatives, clients, citizens or colleagues) was found to be demanding by the participants and their superiors. The app was used to improve this. The study was conducted in the second half of 2013. Table III provides an overview of the cases, which shows that group sizes and usage periods varied. In all cases the app was moderately used (concerning the number of reports and comments created), which shows that there was a demand for collaborative reflection support in all cases.

| Case | Interns | Service | Care | Hospital |
|---|---|---|---|---|
| **Users** | 18 | 12 | 9 | 9 |
| **Days** | 51 | 80 | 50 | 42 |
| **Reports**[1] | 24 | 45 | 15 | 25 |
| **Comments** | 47 | 65 | 25 | 39 |
| **Time** | Sep-Oct 2013 | Aug-Oct 2013 | Aug-Sep 2013 | Jul-Aug 2013 |

Table III. Studies conducted with the TalkReflect App.

Two of the cases took place in a public administration unit of a large city in the UK. The first case included interns working in different departments of the organization (referred to as the **interns** case in this paper). The organization wanted them to learn how to interact with colleagues and members of the public professionally, and to take away learnings for future work. The second case involved two departments providing similar services to the public (referred to as the **service** case). These departments were to be merged, which involved processes and physical workplaces. The aim here was to reflect on practices with the respective other department to support the merging process.

The third case was conducted in a British dementia care home (referred to as the **care** case). Staff used the app to improve their skills in conversations with residents and relatives. These skills are crucial for the wellbeing of residents as well as the reputation of the care home. Case four was done with physicians of a German hospital (referred to as the **hospital** case). The physicians and their superiors felt they needed to improve their abilities to conduct conversations with relatives. This puts physicians in an emotionally demanding situation, and the physicians felt they were not prepared well for this in medical school.

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[1] Total amount of reports and comments, later analysis is based on a selection of threads (see results section).

We chose these different cases to include diversity in the study, thus avoiding effects specific for certain domains or workplaces. Variations included the education of the participants, as physicians and interns held university degrees, while care staff is usually recruited from lower educational levels, and different hierarchies among participants, ranging from strict hierarchies in the hospital to no hierarchy among the interns. In addition, there were differences in the involvement of superiors: In the hospital and service cases a superior was very active and in the care and interns cases no superior was involved in using the app.

## Methodology and Course of the Studies

All studies were done in a similar fashion. In the beginning the TalkReflect App was introduced to the participants by walking them through examples of reflection with the app and by letting them try/test it. It was then discussed how the app could be used in daily work, and how long the usage period would last. After that the studies were run without further intervention. By the end of the usage period the researchers collected feedback from the participants in group interviews, in which they were asked about their perception of using the app.

# Results: Analyzing Reflection in the TalkReflect App

Two coders independently applied the scheme to the content created in the TalkReflect App. Before coding, we removed experience reports from the dataset that were not shared with others or not commented on by others than the original author in order to analyze collaborative reflection only. After coding we removed all threads without reflective content (e.g. no explicit relations to experiences). For example, we removed a thread in which participants discussed dinner dates. This created a set of 65 threads (see Table IV). Coding was done in a rigid way to ensure that only reflective contributions were coded. For example, even if a comment sounded like it related to experiences (e.g., "this should be done another way") it was only coded as linking experiences to each other (code 4 in Table II) if an explicit reference (e.g., a key phrase like "in my experience") was present.

After coding, the coders compared their results, discussed differences to ensure they had used the coding scheme in a similar fashion, and adapted their coding if necessary. This procedure resulted in a total of 689 codes (291 and 298 codes) with an average for Krippendorff's Alpha of 0.91. To even increase the quality of the final dataset we only included the intersection of codes from both coders.

## What happened inside the App? Results of Coding

The distribution of codes from the four studies is shown in Table IV below. To show the differences in the proportions of codes applied to threads from the

different cases, high and low values for each code are highlighted in the table. In addition, to analyze whether the proportions of codes differ significantly between cases we conducted χ2-tests and (where the prerequisites for a χ2-test were not met) Exact Fisher Tests. In addition Table IV includes combined variables of codes (8), 9 and 10 to show differences between the cases.

| Code | Level | Interns | Service | Care | Hosp. | G1: Int. & Serv. | G2: Care & Hosp. |
|---|---|---|---|---|---|---|---|
| **Threads** | | 17 | 20 | 10 | 18 | 37 | 28 |
| **1** | **1** | 100% | 95% | 100% | 100% | 97% | 100% |
| **2a** | **1** | 35% | 25% | 20% | 17% | 30% | 18% |
| **2b$^{EF}$** | **1** | 6% | 10% | 80% | 39% | **8%$^{CHI}$** | **54%$^{CHI}$** |
| **3** | **1** | 29% | 30% | 70% | 28% | 30% | 43% |
| **4$^{CHI}$** | **2a** | 65% | 20% | 40% | 22% | 41% | 29% |
| **5** | **2a** | 41% | 20% | 0% | 17% | 30% | 11% |
| **6a** | **2a** | 0% | 0% | 0% | 6% | 0% | 4% |
| **6b** | **2a** | 29% | 40% | 20% | 33% | 35% | 29% |
| **7** | **3** | 59% | 70% | 20% | 67% | 65% | 50% |
| **8** | **3** | 41% | 45% | 10% | 17% | **43%$^{CHI}$** | **14%$^{CHI}$** |
| **9a** | **3** | 12% | 10% | 20% | 0% | 11% | 7% |
| **9b** | **3** | 35% | 10% | 0% | 11% | **22%** | **7%** |
| **10** | **3** | 12% | 15% | 10% | 6% | 14% | 7% |
| **8_9_10$^{CHI}$** | **3** | 71% | 55% | 30% | 28% | **62%$^{CHI}$** | **29%$^{CHI}$** |
| **9_10** | **3** | 47% | 30% | 30% | 11% | **38%** | **18%** |
| **Q1$^{EF}$** | **2b** | 41% | 20% | 10% | 0% | **30%$^{CHI}$** | **4%$^{CHI}$** |
| **Q2$^{CHI}$** | **2b** | 59% | 65% | 10% | 6% | **62%$^{CHI}$** | **7%$^{CHI}$** |

Table IV. Percentage of codes applied to threads from the cases (left) and groups (right), including combined codes for (8,) 9 and 10. Black cells highlight high values, cells in light grey low values. Differences of the proportions of codes marked by $^{CHI}$ are significant (p<0.05) with a χ2-test and differences marked by $^{EF}$ are significant (p<0.05) with an Exact Fisher Test.

Table IV shows that the interns and service cases have higher values for levels 2 and 3 of the coding scheme (codes 4-10, Q1/2) than the care and hospital cases. While the difference is moderate for some codes, for example the value of the combined variable of codes 8, 9 and 10 (summarizing all results from reflection) is about twice as high in the interns and service cases than in the other two. The care case however shows a much higher amount of codes 2b (emotions of others) and 3 (initial interpretation of experiences) compared to the other cases.

## What the App was used for: Differences between the Groups

The differences of code proportions (Table IV) suggest that the participants used the TalkReflect App for different purposes and to a different extent.

In the **care** case the app was mainly used to document and share experiences, while figures for most codes on levels 2 and 3 are low. Emotions and initial interpretations may have occurred often because dementia care is an emotionally demanding job, in which it is very hard to understand the behavior of people being cared for. A typical example of a report reads *"BB 21* [anonymous code for the resident] *said he is unhappy living here, he wants to leave and live on his own"*. While in some threads experiences were related to others (40%) the app was thus mainly used to **document and share** experiences and related emotions, but rarely for reflection on shared experiences.

The **hospital** case shows low values for follow-up activities such as referring to experiences and results of the reflection process. There is an exception for advice. An example for this can be found in one participant stating *"If you get blamed you can also offer a conversation with a senior physician to the relatives"* after another user had described a difficult experience with relatives of a patient. Most of advice given (8 of 12 occurrences of code 7) stems from the same user and therefore we conclude that results documented in the app mainly stem from this user giving advice (rather than from reflection of these cases). This conclusion is backed up by feedback from participants (see below).

The **interns** and **service** cases show higher values for codes 4-10 and Q1/2. This indicates higher activity on levels 2 and 3 in our reflection model, and especially higher interest in shared experiences and comments (indicated by asking questions). There are differences among the cases: the interns case shows more occurrences of codes 4 and 5 (relating experiences or knowledge to shared experience) as well as more results on the level of double-loop learning (code 9b). Despite these differences we can conclude in these cases the app was used on all three levels of our reflection model in both cases, and that these cases created significantly more results from reflection than the other two cases ($\chi2=8.117$, $p<0.05$ for codes 8, 9, 10; similar for codes 2a and Q1/2, see Table IV).

The differences among the cases led us to the creation of two groups: Group 1 (G1 in Table IV) consists of the interns and service cases, which used the app on all levels of the model in Table I, and G2 contains the care and hospital cases, who mostly used the app on level 1 and (partly) level 2. Table IV shows that the coding values between the groups differ considerably for levels 2b and 3 ($\chi2=7.2$, $p<0.01$ for codes 8, 9, 10; $\chi2=20.4$, $p<=0.01$ for Q2). In our analysis we use the differentiation between the groups to identify which types of contributions supported reflection in the app: Focusing our analysis to G1 means focusing on those threads from the cases in which the app was used on all levels of reflection.

## How App usage was influenced: Context Factors and Explanations

The differences in the distribution of codes allow us to identify cases in which the app was used for all levels of reflection and thus to analyze the impact of certain

articulations as described above, but do not explain why the interns and service cases differed from the care and hospital cases. Feedback given by participants in the interviews, which is described and discussed in Prilla (2014) as well as Prilla and Renner (2014) helps to explain these differences. From the feedback we can identify different constraints on using the app in the different cases: In the interns and care cases staff used the app in a self-directed way, while in the service and hospital cases we were told that one participant (a manager and a senior physician) facilitated the discussion. In the service case the manager was very active, providing topics, commenting on statements and asking questions. This caused high activity in the app. In the hospital case physicians told us that the senior physician provided advice (code 7) for many reports after a short period of time, which prevented some physicians to create further comments (as advice from a senior is not questioned in this hospital). Opportunities for face-to-face communication also differed: Care home and hospital staff worked on the same floor, the interns worked in different departments and in the service departments were located in different buildings. Some physicians told us that they had often already known experiences reported in the tool, and care staff mentioned that it was easier to discuss face-to-face than in the tool. **This difference may be the main reason for the differences in usage between G1 and G2**, as the value added by the app was lower for G2 than for the interns and service cases.

## What leads to Reflection Results: An Exploratory Analysis

The coding scheme shown in Table II was created with the underlying assumption that all types of articulations represented in the scheme are of (equal) importance to reflection. As can be seen from Table IV the codes are not evenly distributed and there are differences between the cases, which suggests that in our cases different types of articulations had different impact.

| All threads | | | G1 | | | Service | | |
|---|---|---|---|---|---|---|---|---|
| **Codes** | **R** | **p** | **Codes** | **R** | **p** | **Codes** | **R** | **p** |
| 2a/4 | 0.324 | <0.01 | 2a/4 | 0.426 | <0.01 | 2a/4 | 0.577 | <0.01 |
| 2a/9_10 | 0.339 | <0.01 | 2a/10 | 0.435 | <0.01 | 4/9a | 0.667 | <0.01 |
| 4/9_10 | 0.515 | <0.01 | 4/9a | 0.422 | <0.01 | 4/9_10 | **0.764** | <0.01 |
| 5/9_10 | 0.322 | <0.01 | 4/9_10 | **0.718** | <0.01 | | | |

Table V. Selected correlations between codes. Bold figures depict strong correlations.

In an exploratory analysis we investigated the impact of these articulations. For this we used correlation analysis to find possible dependencies between codes, and $\chi2$-tests to determine differences in the proportions of codes. While we investigated relations between all codes we had a particular look at G1 and the interns and service cases to focus on impact on levels 2b and 3 of our model.

| All threads | | | | G1 | | | |
|---|---|---|---|---|---|---|---|
| Category | Code | χ2 | p | Category | Code | χ2 | p |
| 8_9_10 | 2a | 3.8 | <0.05 | | | | |
| 8_9_10 | 4 | 6.8 | <0.01 | 8_9_10 | 4 | 10.4 | <0.01 |
| 8_9_10 | 5 | 6.8 | <0.01 | 8_9_10 | 5 | 5.5 | <0.05 |
| 9_10 | 2a | 7.5 | <0.01 | 9_10 | 2a | 4.4 | <0.05 |
| 9_10 | 4 | 17.2 | <0.01 | 9_10 | 4 | 19.1 | <0.01 |
| 9_10 | 5 | 6.7 | <0.05 | 9_10 | 5 | 4.4 | <0.05 |

Table VI. Cross tabs for combined variables of codes (8), 9, 10 as categories.

We found several moderate correlations between codes 2a (mentioning own emotions), 4 (linking own experiences to shared experience report) and 5 (linking knowledge to shared experience reports) to the combined variable of codes 8, 9 and 10 as well as some strong correlations between code 4 and code 9_10 (Table V). These correlations can be found for all threads, for threads of G1 and for threads of the service case. This suggests that codes 2a, 4 and 5 may have had an effect on results from the reflection process. Cross tabels and corresponding χ2-tests show similar results: If we separate the threads by the combined variables of codes (8), 9 and 10 we can find significant differences in the proportions of codes 2a, 4 and 5 (see Table VI), again with strongest effects for code 4. This supports the potential effect of the articulations depicted by the codes on results from the reflection process. There are only a few other correlations among codes and no other significant differences in the proportion of codes than shown in Table VI. Therefore we focused further analysis on codes 2a, 4 and 5, as they are likely to have impact on results of reflection.

We used linear regression to determine the impact of codes 2a, 4 and 5 on the combined variable of codes (8), 9 and 10, that is, to which extent a certain code can explain the variance of these variables. An analysis of all threads revealed only minor explanation of variance. Looking at G1 and G2 separately we reached considerable results for G1. The regression models are shown in Table VII.

| Dependent variable: 8_9_10 | | | | Dependent variable: 9_10 | | | |
|---|---|---|---|---|---|---|---|
| Model | R$^2$ | F | Sig. | Model | R$^2$ | F | Sig. |
| 2a | 0.069 | 2.6 | <0.05 | 2a | 0.120 | 4.8 | <0.05 |
| 2a, 4 | 0.283 | 6.7 | <0.01 | 2a, 4 | 0.517 | 18.2 | <0.01 |
| 2a, 4, 5 | 0.296 | 4.6 | <0.01 | 2a, 4, 5 | 0.520 | 11.9 | <0.01 |
| 2a, 4, 5, Q2 | 0.324 | 3.8 | <0.01 | 2a, 4, 5, Q2 | 0.550 | 9.8 | <0.01 |

Table VII. Regression analysis for threads from G1, using the combined variables of codes (8), 9, 10 as dependent variables.

Table VII shows that code 4 (linking own experiences to shared experiences) has the strongest influence in the model, explaining 21% of the variance of the

variable 8_9_10 and 40% of the variance of the variable 9_10. By removing code 2a, which is moderately correlated to code 4 within threads of G1($r=0.426$, $p<=0.01$), from the model the impact of code 4 even rises ($R^2=0.282$, $F=13.7$, Sig.$<=0.01$ for codes 8, 9, 10; $R^2=0.515$, $F=37.2$, Sig.$<=0.01$ for codes 9, 10). This shows that the occurrence of code 4 has had an effect on the occurrence of results such as (proposals), learning and change in the threads of G1.

The other codes for articulations with potential impact on the results of the reflection process in cases G1 have moderate to literally no explanatory value. Code 2a (own emotions) explains 7% of the variance in variable 8_9_10 and 12% of the variance in variable 9_10, which suggests that emotions can have a slight impact on the occurrence of results. As code 2a is correlated to code 4, it is also likely that it had an influence on the occurrence of code 4 rather than on results from the reflection process.

Code 5 does not add much to the regression model and therefore has no considerable impact on the occurrence of results from reflection. This emphasizes the difference between collaborative reflection and other conversations on past experiences by showing that the decisive difference between them actually created a difference in the impact on results in G1.

The analysis also shows that other types of articulations such as emotions of others (code 2b), initial interpretations (code 3) and supporting or challenging assumptions (codes 6a/b) did not have an impact on results from reflection. There is also no considerable impact of solution proposals (code 8) to results. This does not mean that these types of articulations do not support reflection and learning from it at all: there may be influences, which just did not become obvious in our studies. Furthermore, some codes like 2b (for G1) and 6a were rarely used and may therefore not have shown impact in our data.

Also the role of questions remains unclear from this analysis. Despite being seemingly obvious from the (significant) difference in the proportions of codes Q1 and Q2 between the groups shown in Table IV, there is no significant correlation for them, and the regression model shows negligible explanatory value of Q2 (and Q1, which is not shown in the table).

# Discussion: Implications for the Design of Collaborative Reflection Support

The results of our analysis provide insights for tool support of collaborative reflection, which we summarize in two themes. First, they help us to differentiate between levels of support for different kinds of groups and constraints. Second, they provide insights on how to guide collaborative reflection processes in terms of facilitating communication.

## Tailoring Support for Groups: Levels and Scale of Support

The participants in the interns and service cases used the app for all levels of our model, and the participants of the care and hospital cases mostly stuck to level 1. Together with the feedback given by the participants described above, this led us to the creation of suggestions for the design of support for different groups. We suggest three levels of support:

- **Support level 1:** The care and hospital cases can be differentiated from the other cases in that the participants formed a co-located group in which members interacted frequently as part of their jobs. In such groups face-to-face interaction is the preferred means of communication. Therefore, support for collaborative reflection in these groups can focus on enabling people to **write down, share and sustain experiences**, leaving reflective communication to face-to-face situations. Tools may also remind users of existing experience reports, show them relevant experiences to foster face-to-face reflection or remind them to write down and share results from reflection.

- **Support level 2:** In the hospital case most activities following sharing experiences were focused on giving advice. This suggests that even in co-located situations reflection tools provide meaningful support by **sharing experiences, getting feedback on them and sustaining the feedback**. A tool may route experience reports to experienced users in order to have them comment on the experience. The terminating effect of advice in the hospital case (see above) suggests that there is a need to guide users of such tools away from giving advice (7) to providing solution proposals (8).

- **Support level 3:** The service and interns cases were conducted in a (partly) remote setting that made frequent face-to-face communication difficult. The TalkReflect App allowed the participants to share and discuss their experiences, thus adding extra value by providing an additional communication channel. In such contexts tool support **offers means for experience exchange and discussion as part of collaborative reflection and may thereby lead to documentation and sustainment of results from reflection**. This, however, either needs intrinsically motivated participants (interns case) or support by facilitation (the manager in the service case) to succeed.

The proposed support levels can provide a framework for further work. In particular, they may help to create appropriate collaborative reflection tool designs by analyzing group characteristics such as co-location, communication preferences and the need to get and sustain feedback **upfront**. In our further work the application and evaluation of these levels in additional cases of collaborative reflection will play a major role.

In addition, the levels point to design issues of scope and scale for collaborative reflection support. Support for levels 1 and 2 is appropriate for

small, co-located groups, but it might not always be the best support option overall. For example, physicians in the hospital case may have benefitted from exchanging experiences in talking to relatives with colleagues outside their ward (e.g., from a different hospital). This upscaling of support adds value to tools like the TalkReflect app and makes support level 3 applicable to co-located groups like in the hospital case. Therefore, besides asking how a particular group can be supported in collaborative reflection we should ask for the most appropriate scale in order to provide adequate support for collaborative reflection.

## Guiding Collaborative Reflection: Fostering helpful Articulations

Our analysis reveals that articulations such as emotions, linking experiences to each other, linking knowledge to experiences and asking questions co-occur with results documented from reflection processes. It also shows that in our cases the only considerable impact on results among these articulations can be shown for linking experiences to each other. This **supports** our assumption that linking experiences has a larger impact on reflection results than linking knowledge, but **speaks against** assumptions made for emotions, questions and other articulations.

Concerning the **positive impact of linking experiences to each other**, we can conclude that reflection support tools should facilitate this actively. This may be done by making users aware of relevant content (i.e. content similar to theirs) or by prompting users to share similar experiences through questions (e.g., "Have you been in a similar situation? What did you do?"). **Linking knowledge to experiences did not have an impact** on results but is similar to linking experiences in its intention. Tools may thus provide a frame for users by prompting them to link their statements to experiences rather than linking them to knowledge or not mentioning a link to experiences. Concerning the support levels described above, this may also be key in turning a situation in which mostly advice (code 7) is given to one in which solution proposals (code 8) are provided.

For (own) **emotions and questions** we did not find considerable impact on reflection results. However, this does not mean that they are not supportive in collaborative reflection. Especially given the differences in using questions triggering discussions (code Q2) between G1 and G2 we may rather take the occurrence of emotions and questions in threads of collaborative reflection as a sign of engagement and moderation that keeps threads going and triggers people to contribute. Further work will have to look closer at these types of effects.

It is surprising that **solution proposals did not have an impact** on learning (codes 9a and 9b) and change (code 10). There is a significant difference between the distribution of these codes on G1 and G2 (see Table IV). Therefore, solution proposals might be used as a differentiator between types of reflection groups as discussed above. It may simply be that we did not see an effect on learning and change because proposals were not suitable or not applied for other reasons.

# Conclusion and Outlook

This paper deals with an approach of analyzing the impact of tools supporting collaborative reflection. It is based on content analysis and complemented by feedback from users of the tool. By applying this approach to four cases of using the TalkReflect App we investigated whether and how the app was used and what led to results created in the app. We found that there were different ways in using the app, which relate closely to purposes and constraints of collaborative reflection in the respective groups. From this we derive suggestions for levels and scale of support. In addition, we found that certain types of articulations in the app facilitate the creation of results in the app, and we have created design suggestions to foster these articulations.

The results of our analysis suggest that our approach is an appropriate way to go forward in research on collaborative reflection. The size of our study and the number of threads analyzed are not sufficient to explore the full value added by the coding scheme, problems of its application and adaptations needed. Therefore, we are preparing additional studies, and we invite others to do so as well.

Our work contributes to the state of the art in research on collaborative reflection in two ways. First, it provides a **novel scheme for the analysis of collaborative reflection content** and an **initial study** of applying it. Second, it shows **how tools may be designed to enable groups to reflect together on different levels and scopes of support**. We are, however, aware of the fact that our results are mainly based on the content created in the tool, and that reflection also (or mainly as in some of our cases) happens in face-to-face interaction. Therefore our results do not allow more general insights on collaborative reflection. We rather suggest that it should be combined with other approaches focused on social interaction. It can then complement qualitative data from ethnography, interviews or experience sampling, and help to explain usage data such as frequency of tool usage in order to create more general insights on collaborative reflection inside and outside tools.

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