

In-App Reflection Guidance for Workplace Learning

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Abstract. In-app reflection guidance for workplace learning means motivating and guiding users to reflect on their working and learning, based on users' activities captured by the app. In this paper, we present a generic concept for such in-app reflection guidance for workplace learning, its implementation in three different applications, and its evaluation in three different settings (one setting per app). From this experience, we draw the following lessons learned: First, the implemented in-app reflection guidance components are perceived as useful tools for reflective learning and their usefulness increases with higher usage rates. Second, smart technological support is sufficient to trigger reflection, however with different implemented components also reflective learning takes place on different stages. A sophisticated, unobtrusive integration in the working environment is not trivial at all. Automatically created prompts need a sensible timing in order to be perceived as useful and must not disrupt the current working processes.

Keywords: Workplace learning · Reflective learning · Reflection guidance · Reflective note analysis

1 Introduction

Reflective learning can be seen as the conscious re-evaluation of past situations or experiences with the goal to learn from them and to use the gained outcomes to guide future behaviour. This is in-line with the definition of Boud et al. [3], who define reflective learning as *“those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations”*. In the area of workplace learning, reflection has been identified as a core process, with the goal to get new insights, derive better practices, and finally to improve the own work [3, 25]. Because reflective learning is a cognitive process based on intrinsic and extrinsic motivation of the

individual, it cannot be directly enforced, but techniques like prompting [5, 6, 12] can foster reflection while using applications at work.

This work reports an in-app reflection guidance concept, that conceptualises reflection guidance as adaptive components. We see this concept as a promising instructional strategy, as these components aim at triggering reflective learning. At the workplace, such components should draw the workers' attention to their own thoughts and experiences, and motivate them to understand and reflect on their daily working tasks. To illustrate how the concept can be instantiated in work-related settings, we implemented different components of the concept in three applications, adopting various approaches to support reflective learning. The three studies cover mood tracking in a call centre [9, 22], game-based learning in a hospital [8], and activity tracking in an IT company [16].

In this paper, we investigate the usefulness of the implemented reflection guidance components as well as the stage or depth of reflection (first, second and third stage [20]) achieved by the users. By analysing the results we aim at answering the following research questions: (i) How were the implemented reflection guidance components perceived with regard to their usefulness at work? (ii) To what extent (at which stage) does reflective learning occur?

2 Related Work

Technologically supported scaffolding types to trigger reflective learning are of major interest in the area of self-regulated learning and extensively investigated within learning management systems. In such settings, prompts are used very often to organise, retrieve, monitor or evaluate knowledge as well as to reflect on student's learning [2, 12, 13, 31].

Davis [5] distinguishes between *self-monitoring prompts* and *activity prompts*. The first encourage students to reflect on their own learning by asking "Thinking ahead" or "Checking our understanding" questions. The second motivate students to reflect on their progress in the activity and specifically about whether they have devoted attention to each aspect of their project. In both cases different types of sentence starters are used. Furthermore, Ifenthaler et al. [12] follow the categorisation of prompts from Davis [6] and refer to *generic* and *direct* prompts. While the generic prompts only ask learners to stop and reflect about their current problem solving activities, the directed prompts also provide them with an expert model of reflective thinking in the problem solving process. In our work we follow Verpoorten et al. [29], who created the term *reflection amplifier*, which is a "*deliberate and well-considered prompting approach, which offers learners a structured opportunity to examine and evaluate their own learning*". In work-related settings, there is little research on usage of prompts. Prilla [19] discusses the usage of prompts with regard to collaborative reflective learning at work. His prompting approach tries to motivate people to use his reflection tool and the socio-technical nature of communities or face-to-face meetings. Rivera et al. [23] investigate the notions of active (e.g. notifications) and passive (e.g.

visualisations) triggering in work-related settings. Another approach for reflection at work is the voice-enabled reflection app REFLECT [15], which supports scaffolding by community-based questions.

The work of Thillmann [27] puts the focus not only on what to prompt, but also when to prompt. Providing prompts before as well as during the learning process shows that presenting a prompt at the right time had a positive effect on the learning outcome. In this connection, the current user context plays an important role. First of all, by including the current context in the decision of when to present a prompt, the stress caused by interruptions can be reduced as presented for mobile devices in [11, 18]. Secondly, using automatically or manually gathered context information for reflection (e.g. by giving a hint of what has happened during a working day or week) supports the re-evaluation of past experiences and therefore the reflection process itself.

Other tools and techniques to technologically trigger reflective learning are diaries, reflective journals and e-portfolios, which are predominantly used in formal educational settings [4, 7, 10, 17]. Diaries are personal notes not meant to be shared, hence most studies focus on the effect diary writing has on learning e.g. [26]. In contrast, the term “journal” is mostly used to describe diaries that are intended for sharing. They are used in different training settings (e.g. athletes) [30] and sometimes also in work-related settings, e.g. with nurses [28]. E-Portfolios are mostly defined as a collection of information and (physical) artefacts, gathered for specific purposes by a user over time [1], in educational [7] as well as work related settings [10]. All these tools and techniques have in common that they are very time-consuming in being kept and maintained.

From literature we know that prompting approaches are very successful in formal learning environments, however only very little research has been conducted in work-related settings. Investigating and evaluating prompts in learning environments can benefit from the fact that the learning activities and tasks of the learners are known beforehand and the prompts can easily be adapted according to these activities. In contrast, in a work-related setting the tasks are not always known beforehand or only vaguely known. Therefore, it is very challenging to provide meaningful prompts in a working environment. Secondly, because a learner uses the learning environment actively while learning, the prompts can be displayed according to the current learning task. In a working environment the time to present prompts is not as obvious as in learning environments. Third, most workplaces are very stressful and work-intensive. Therefore, it has to be very well considered, if and how time consuming approaches like diaries can be applied in work-related settings.

3 Components of the Reflection Guidance Concept

Schön [25] defines *reflection-in-action* as reflection which takes place while doing own work, whereas *reflection-on-action* refers to analysing reactions to any situation and exploring the reasons and consequences afterwards. Consequently, the design components are divided in these two main categories:

3.1 Reflection-in-Action Components

“Reflection-in-action” components present motivational triggers to provide a more accurate guidance of the reflective process and should make people aware of any significant changes or unusual behaviour. These components are automatically presented to the user when starting to use an application or during the usage of an application. We define two types of reflection-in-action components:

Reflection Interventions: Reflection interventions are prompts that aim at motivating users to utilise an application in general. This type of prompts are similar to the *activity prompts* by Davis [5], which have the goal to facilitate the completion of specific aspects of given activities. Reflection interventions pop up when opening the application for the first time of the day or at the end of a day. They occur during a working day, if the application was not used for a longer time or if a new event (e.g. beginning of a meeting) is starting. All these prompts ask for input regarding the user’s activities.

Reflection Amplifiers: Regarding the *reflection amplifiers*, we follow Verpoorten et al. [29] seeing them as deliberate and well-considered prompting approach for initiating reflection. This is also in line with Davis [5], whose so-called *self-monitoring prompts* provide questions to foster planning and reflection. At work, reflection amplifiers support planning and reflection by making users aware of deviations from standard behaviour, unusual working patterns or other significant situations on an individual or collaborative level. Furthermore, they motivate users to reflect about such situations and to insert their thoughts directly into a corresponding application.

3.2 Reflection-on-Action Components

“Reflection-on-action” components are features that can motivate users to reflect about the gathered data after having used the application, e.g. at the end of a working day. These components consist of reports as well as reflection diaries or reflection journals. “Reflection-on-action” components encompass:

Reports: Reports provide an automatically created summary of past experiences or events captured during work. Depending on the purpose of the application, such reports present working tasks or activities including unusual situations worth being reflected on. The aim is to provide guidance for reflection based on the available data and in relation to different time periods (e.g. hourly, daily, weekly reports). Re-evaluating or comparing them with own or others’ working behaviours can lead to the detection of behavioural patterns, insights about one’s own working behaviour and finally result in learning outcomes.

Reflection Diary: The reflection diary is used to store insights, thoughts, artefacts, or learning outcomes in a structured way. Using this diary consequently (e.g. at the end of each shift) in a reflective learning application can result in an important collection of learning outcomes. Re-evaluating these entries again can trigger reflective learning and in the end lead to the detection of significant working patterns or meaningful insights to guide future behaviour at work.

3.3 Intertwined Component

Contextualisation: In order to be able to return to experiences, which is a relevant step for reflection as suggested by Boud et al. [3], it is important to track the context either automatically or manually during the application usage. Automatically tracked context can gather all interactions with an application and consists therefore of vast amounts of data. In contrast, manually inserted context can be a self-defined word, a short phrase or the selection of pre-defined context types adapted to the current working environment; it is just a hint, which represents what is currently going on during work. This contextualisation can support reflective learning twofold: first directly when entering context information the user has to think about it. Secondly, displaying the available context information when revisiting the captured data later on (e.g. at the end of a day) supports the user to better remember the respective working situation.

4 Methodology

The applications and the implemented reflection guidance components were evaluated within user studies conducted in real work settings. All evaluations followed a similar approach using the tools listed in Table 1. Objective usage rates were captured via users' log-data and written text entries were collected within the apps. Demographic data was gathered in the pre-questionnaire, whereas the post-questionnaires contained questions on how supportive the apps were with respect to reflective learning (app-specific reflection questions) and how useful participants perceived the reflection guidance components. In the post-questionnaire, the items were presented as 5 pt. rating scales ranging from 1 - "I strongly disagree" to 5 - "I strongly agree". For the app-specific reflection questions we used an existing item pool of 43 questions (see [14], p. 38), which cover a wide variety of features reflection apps may provide. Out of this, an adequate subset of items was selected for each evaluation (see Table 2).

The conducted interviews and the workshop provided deeper information about the applications and the implemented reflection guidance components. For the analysis of the written content with regard to the achieved stages (first, second and third) of reflection, a qualitative analysis schema [20] was used. The first stage encompasses descriptions of experiences and emotions. The second stage includes the interpretation and justification of actions and working on solutions. The third stage consists of insights, learning and conclusions from reflection. All notes were independently analysed and categorised by three researchers.

5 Applications and Their Evaluations

In this paper, we focus on the usefulness of the reflection guidance components. More details regarding the applications and their support for reflective learning can be found in [8, 9, 16, 21, 22].

Table 1. Used evaluation tools

Tool	Application	Stage	Content
log data	all	at the end	interactions with the application, quiz results
pre-questionnaire	all	at the beginning	consent form, demographic data
post-questionnaire	all	at the end	feedback about the applications and the guidance components, questions about reflective learning
interviews	all	at the end	deeper feedback about the applications and the guidance components
workshop	Quiz	at the end	group discussion about the evaluation and the quiz

5.1 MoodMap App and Its Evaluation in a Call Centre

The MoodMap App [9, 22] (MMA) is a web application that maps mood on a coloured map along the two dimensions of Russell’s Circumplex Model of Affect: valence (feeling good - feeling bad) and arousal (high energy - low energy) [24]. In the MMA, the contextualisation component is implemented in a mandatory way. For each inserted mood, a pre-defined context has to be chosen (e.g. “after a call”, “after a coaching session”, “after a break” or “other”) and a note has to be added. To support the note taking, a reflection amplifier question like “*What are you currently thinking?*” or “*What influences your current mood?*” is presented. The purpose of this mandatory contextualisation is to ‘force’ the user to think about the current inserted mood and add the user’s thoughts into the application. Reports summarising the mood development of a day and a reflection diary were also available.

Setting: Four teams out of two call centres of a large telecommunication company in Great Britain participated in this evaluation (see [21], p. 52). Such call centres can handle an average of 27.000 calls from all over the UK every day, working in a range of functions from directory enquiries to residential and business broadband. Each team consists of call takers, coaches and managers. The call takers are responsible for taking the calls and solving any issues directly with the customers. The coaches support and coach the call takers for their work, while the managers ensure that the call takers are performing against their targets, review their performance and supervise the training sessions.

Learning: Mood self-tracking and reflection on own as well as the team’s mood can lead to insights of how mood influences the work with regard to work performance and collaboration within a team.

Procedure: The evaluation lasted four weeks. The MoodMap App was introduced by the responsible project manager of the telecommunication company.

All participants (call takers, coaches and managers) were asked to integrate the MMA in their daily working routines. Their task was to state their moods, choose a mandatory context and add a note during all days of the evaluation period. They were also asked to reflect about their inserted moods and notes individually. The coaches and managers were additionally instructed to use the team visualisations in order to reflect about the mood development of their teams and take actions if necessary.

Participants: From the 33 participants who used the application and filled out the post-questionnaire, 2 gave interviews, and 24 shared their demographics. Of these, 14 are male, 10 female, 67 % were aged between 20 and 29, 26 % between 30 and 39, 8 % between 40 and 49.

5.2 The Medical Quiz and Its Evaluation at a Stroke Unit

The Medical Quiz [8] (MQ) is a web-based quiz especially developed for nurses working at a Stroke Unit in German hospitals. The quiz consists of four different quiz types presenting randomised content-based questions out of a question pool. The content-based questions are enriched with reflective questions - an integrated form of reflection amplifiers. Depending on the quiz type the reflective questions are posed at the beginning, during or at the end of the quiz. The reflective questions at the beginning address the current knowledge status (extracted from previous quiz attempts) and the user's play frequency. The in-between questions put the players' focus on the content-based questions, while the questions at the end of the quiz ask explicitly for gained insights or new knowledge with regard to the currently played quiz. Both draw a connection to real working experiences.

Setting: The Medical Quiz was introduced to the nurses participating in a qualification program for stroke nurses, which takes place once a year in a German hospital (see [21], p.137). All participants were nurses working in different German hospitals and were in education to become a nurse for a Stroke Unit. The qualification program lasted for 5 months. In one week of each month the participants came together for the training at the organising hospital.

Learning: The goal of the quiz is not only to provide an easy to use possibility to refresh existing knowledge or to gain new knowledge, but also to connect theoretical knowledge with working practices and to reflect about it.

Procedure: In the first week of the qualification program, the Medical Quiz was introduced to the participants by the evaluation responsible of the organising clinic. They were asked to play the quizzes consequently, on the one hand for memorising and strengthening their newly gained knowledge and on the other hand for reflecting about the content of the quiz and for drawing connections between the new knowledge and their daily work practices with the help of the integrated reflective questions. In the fourth week of the program, the post-questionnaire was handed out. In addition, a half-day workshop and interviews were conducted to collect deeper insights from the participants with regard to the quiz and its reflection support.

Participants: 18 nurses (16 female, 2 male) participated in this evaluation and 3 gave interviews; 66% were aged from 20–29 and 33% between 30 and 59.

5.3 KnowSelf and Its Evaluation in an IT Company

KnowSelf [16] (KS) is an application that automatically records working activities on a personal computer by capturing resources and applications used during work. Manual project and task recording, as well as manually inserted notes and comments complete the data captured by the application. The application visualisations expose, in particular, the frequency of application and resource switching, the time spent in numerous applications and the time spent on different activities. In this application, time-triggered reflection interventions and event-triggered reflection amplifiers are implemented. The time-triggered prompts are shown on a specific day at a specific time which remind the user of reflecting by offering feedback on various topics regarding the user's behaviour. The event-triggered amplifiers are generated when a significant change has been detected (e.g. when the number of switches is higher than usual or after long periods of idle time). Additionally a reflection diary is implemented, where all notes, thoughts or insights after reflection can be stored.

Learning: KnowSelf is designed to support individual reflective learning regarding time management and self-organisation of knowledge workers.

Setting: The evaluation took place in a consulting company that consults, sells, and personalises Customer Relationship Management (CRM) Software to help analyse and optimise the marketing, sales and service processes of their customer companies (small and medium enterprises). The employees have many meetings with customers at the customers' site and their daily work is heavily focused on customers' needs. This requires a high level of flexibility and the development of individual best practices. Consulting and sales thus involve a high degree of reflection regarding interactions with the customers.

Procedure: In a kick-off meeting at the company, the application was presented and explained to the participants by the evaluation responsible of the company (see [21], p. 25). They were asked to install KnowSelf on their business PCs and to use the app over a period of six weeks as well as to reflect on the collected data on a daily basis. During the six weeks, they received a weekly email including a reminder to reflect on the captured data, enter observations and to fill in a short online questionnaire to provide feedback.

Participants: 10 employees (3 females, 7 males) participated in the evaluation and 7 gave interviews; 10% were younger than 19 years, 40% each were aged from 20–29 and from 30–39 and 10% were aged from 40–49.

6 Results

6.1 Usage Data

The MMA study had 33 participants; the Medical Quiz study 18 and the KnowSelf study 10 participants. During the evaluation period, the average number of interactions of the participants with the MMA was $M = 42.67$ ($SD = 72.7$), ranging from 1 to 338 interactions. KnowSelf was used on average for $M = 38.5$ min ($SD = 23.8$) by each participant, with a maximum of 53.72 and a minimum of 7.76 min. The participants of the Medical Quiz answered on average $M = 461.9$ ($SD = 341.0$) questions, with a maximum of 1358 and a minimum of 25 questions. Thus, participants used the apps frequently enough in order to test and evaluate the implemented reflection guidance components.

6.2 Reflective Learning

The post-questionnaires of the three studies contained seven app-specific reflection questions (see Table 2) for the MMA and the Medical Quiz and five questions for the KnowSelf. Mean ratings range from 3.25 ($SD = .92$) for the MMA over 3.28 ($SD = .66$) for the KnowSelf to 3.51 ($SD = .42$) for the Medical Quiz. The ratings indicate that all apps can slightly support reflective learning. Relating the objective usage data to these ratings, reveals positive correlations between the extent of app usage and how users perceive the apps' support for reflective learning. More exactly, for the Medical Quiz the Pearson coefficient reveals a significant correlation of $r = .612$ ($p = .015$), for the KnowSelf $r = .850$ ($p = .015$), whereas the correlation for the MMA ($r = .226$) is not significant.

6.3 Usage and Usefulness of Reflection Guidance Components

The implemented reflection guidance components were adopted as follows:

Contextualisation in the MMA was evaluated by means of three questions asking how helpful the contextualisation of mood points was for associating the inserted mood to certain situations (Q1), for recalling past experiences (Q2) and if the chosen activities (e.g. a call) helped to better reflect about a past situation (Q3). With mean ratings of Q1: $M = 3.39$ ($SD=0.86$), Q2: $M = 3.21$ ($SD = 0.74$) and Q3: $M = 3.24$ ($SD = 0.94$) the participants perceived the contextualisation as slightly positive. The analysis of the context information shows that 31 % of the moods were inserted "after a call", 6 % "after a break", 2 % after "a coaching session" and 61 % in "other", not pre-defined contexts.

Reflection interventions, in form of time-triggered prompts were implemented in KnowSelf and evaluated with two explicit questions in the post-questionnaire. Users rated the reflection intervention reminding them to use KnowSelf in general (e.g. by looking at the switching frequency between resources or writing diary entries) with $M = 3.22$ ($SD = 1.09$) whereas the reminder of project recording was perceived slightly negative $M = 2.75$ ($SD = 1.28$).

Table 2. Application specific reflection questions

Questions	Apps
[The app] helped me to collect information relevant to reconstructing experiences from work	MMA, KS
[The app] helped me to reflect on experiences from work	MMA
[The app] helped me to collect information that could help me decide when to reflect	MMA
[The app] helped me to reconstruct a work experience	MMA, MQ
[The app] helped me by capturing my reflection outcomes	MMA, KS
[The app] helped me by making reflection outcomes available for later use	MMA, MQ
[The app] helped me by capturing information for evaluation of learning/reflection	MQ
[The app] helped me by reminding me to reflect	MQ, KS
[The app] helped me by providing information relevant for the decision to reflect	MQ
[The app] helped me by providing accurate information about my work	MQ, KS
[The app] guided me in capturing information about my work experiences	MMA
[The app] guided me in deciding whether/when to reflect	MQ
[The app] provided relevant content for reflection	KS

Reflection amplifiers were implemented in all three apps. For the MMA, the amplifier in form of a prompt to add a note to the mood-context resulted in 475 notes inserted by the participants. The perceived usefulness of the prompts was not explicitly evaluated. In the Medical Quiz, we integrated reflection amplifiers by presenting reflection questions at the beginning, during and after a quiz play. Out of 1205 reflective questions, 603 (52%) were answered in a meaningful way, which indicates that the quiz players have thought about the posed question and that reflective learning could be triggered. Looking at the time the questions were posed, results indicate that users preferred questions at the beginning of the quiz (59.3% responses) over those at the end (51.5%) and were most reluctant to deal with questions while playing the quiz (42.4% answered). In KnowSelf, the usefulness of the event-triggered reflection amplifiers was explicitly raised. Participants rated the notifications about most used resources as rather helpful ($M = 3.30$, $SD = 1.25$), whereas the notifications about unusual amounts of idle time ($M = 2.57$, $SD = 0.79$) and notifications about specific amounts of switches ($M = 2.30$, $SD = 1.34$) were not perceived as very helpful.

In KnowSelf, the participants documented their experiences, insights and comments regarding the application in the **Reflection Diary**. Six participants were willing to share their explicit data and altogether 103 statements were

inserted in the diary (the content is discussed in the next section). In contrast, the MMA provided **reports** including a **reflection diary** but these were not used by the participants. In the quiz there was no diary implemented.

6.4 Content Analysis of the Inserted Notes

The final coding of the analysed and categorised notes of the MMA and KnowSelf contains all those notes which were assigned in agreement after discussing deviating assignments. Altogether the MMA participants attached 475 non empty notes to 548 inserted moods. Out of these, 283 could be identified as individual reflective items. 95 % of the reflective notes were assigned to the first stage, which includes descriptions of experiences or emotions. The remaining 5 % belong to the second stage which refers to interpretations and justifications of actions and working on solutions. From the 103 statements inserted in KnowSelf, 33 statements were classified as non-reflective and for 11 entries there was no inter-coder agreement. The remaining 59 statements were classified as individual reflection items. Most of the notes, namely 47 %, were assigned to the second stage of reflection, 22 % to the first stage, and 27 % to third stage. For the latter, the diary entries included insights, learning outcomes, or conclusions drawn from reflecting. The coding schema could not be applied to the inserted answers of the reflective questions in the quiz, because in this case parts of the questions were formulated as closed questions which allowed a simple yes or no as answer.

7 Discussion

In the following, we discuss the reported results from the three conducted evaluations together with the findings obtained from the interviews and the workshop.

General Insights. The evaluation of the reflection guidance components implemented in three different applications revealed that the components were perceived as useful and that reflective learning has taken place. Results from two evaluations (Medical Quiz and KnowSelf) show a positive correlation between the extent of app usage and how users perceive the apps' support for reflective learning. This indicates that participants who used the apps more often, also dealt more intensively with their captured working activities or the quiz questions, and consequently also reflected more about it.

Usage and Usefulness of the Components. In the MMA evaluation, the participants confirmed that the contextualisation of each mood point helped to better reconstruct past working experiences. Although the predefined contextualisation possibilities had been defined together with managers and users of the call centre and were based on the main call takers' activities, they did not cover all the situations in which participants used the MMA. The "other" option was often chosen, which led to the assumption, that participants used the app not only in typical recurring work situation, but also in other work-related situations e.g. after dealing with a problem or successful event, start/end of day. Thus, contexts

should be adaptable to individual preferences. This way, the contextualisation will encompass all relevant situations, but still be quick and easy to use.

By integrating reflective questions at the beginning, during and at the end of the quiz, we were able to show that asking the right questions at the right moment can trigger reflective learning. Altogether over 50% of the 1205 posed reflective questions were answered in a meaningful way. The willingness to reflect on the reflection questions was given more with the questions presented at the beginning and at the end of the quiz. Interviews and workshop discussions revealed that the in-between reflection questions were perceived as more disruptive for the learning process. The results from the quiz are also in-line with the KnowSelf evaluation. Here, the participants perceived the notifications sometimes as disruptive because they popped up at times when they were working intensively on a task and were therefore seen as additional source of work fragmentation. On the other hand, the general reminder to reflect about the data in the app and the notification about the most used resources were positively evaluated. Taken together, the users did not profit from the prompts as much as we have expected it, especially when interventions disrupted the natural work-flow. In other words, reflective guidance does foster reflective learning, but the time of interventions is crucial with respect to acceptance. If timing is 'messed up', users will not accept the reflective learning guidance components, and consequently not learn (but rather spend their energy on being annoyed at the interruption).

Stages of Reflection. The analysis of the notes indicates that the participants reflected. The MMA evaluation showed that reflection took place mainly on the first and second stage of reflection, while the notes of the KnowSelf include all stages of reflection. Taking a closer look at the MMA notes, they deal with work experiences, encompass mostly emotional-based notes including own emotions, emotions of others (e.g. customers) and some notes regarding interpretation and justification of actions. This shows that the participants become aware of their own and others' mood and also reflected about them, which was the main purpose of the MMA. Most of the notes in the KnowSelf evaluation were related to the second stage of reflection. The participants did not only describe their experiences, but they were mostly explaining their experiences and suggested solutions to observed problems. Also more than a quarter of the reflective entries documented insights gained and conclusions drawn from personal experiences. These findings confirm that the participants gained new insights and a better understanding of their work experiences. These could then be used as a basis for changes in behaviour and thus sustainably improve related work processes, as e.g. time management. From the interviews conducted in all three evaluations, we also learned that a great part of the reflection process takes place in informal face-to-face communications. Thus, it is not possible to conclude from the captured notes, on which stages reflection was actually triggered by the guidance components. Especially with respect to the third stage, it seems reasonable that insights, learning and conclusions from reflection rather develop in personal discussions with colleagues than while using an app.

8 Conclusion

In this paper, we introduced an in-app reflection guidance concept to facilitate technology-supported reflective learning at work. Reflection-in-action and reflection-on-action components have been implemented in three different applications. Due to the fact that the apps were very heterogeneous, chances are high that reflection guidance can be successfully added to any app designed to support reflective learning. Generally, we observed that the users' perception of the apps' support for reflective learning positively correlates with the extent of app usage whereas the achieved reflection stage varied among the different settings. The correct timing of reflection interventions and reflection amplifiers is a crucial issue in order to avoid disturbing interruptions of the ongoing work process. This is not trivial at all, as identifying interruptibility is an ongoing research challenge. Therefore we suggest as good practice from software design to "simply" give users control over the way they are notified and when this notification should take place.

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