
The Known Universe of Reflection Guidance: a Literature Review

Abstract:

Reflective learning has been established as a process that deepens learning in both educational and work-related settings. We present a literature review on various approaches and tools (e.g. prompts, journals, visuals) providing guidance for facilitating reflective learning. Research considered in this review coincides common understanding of reflective learning, has applied and evaluated a tool supporting reflection and presents corresponding results. Literature was analysed with respect to timing of reflection, reflection participants, type of reflection guidance, and results achieved regarding reflection guidance. From this analysis, we were able to derive insights, guidelines and recommendations for the design of reflection guidance functionality in computing systems: (i) ensure that learners understand the purpose of reflective learning, (ii) combine reflective learning tools with reflective questions either in form of prompts or with peer-to-peer or group discussions, (iii) for work-related settings consider the time with regard to when and how to motivate to reflect.

Keywords: Reflective Learning, Reflective Learning Tools, Guidance for Reflection, Literature Review

1 Introduction

Reflective learning [1, 2] has been identified as a core process for both educational and workplace learning. The goal of reflective learning is to make learning more effective by re-evaluating past experiences and learn from them to guide future behaviour. Because reflective learning is a cognitive process based on intrinsic and extrinsic motivation of the individual, it cannot be directly enforced. Reflection techniques like prompting approaches, diaries as well as video recording or meaningful visuals etc. can spark respectively foster reflection while using tools or applications in educational as well as work-related settings.

In this work, we will present a literature review on technologies, tools and applications using various techniques like prompts, journal writing, visuals for guiding reflective learning. Then, we will analyse and categorize the investigated literature according to four different dimensions. In “Dimension I: reflection-in-action and reflection-on-action” we will analyse the proximity between reflection and action meaning whether the corresponding reflection tool is more useful in reflection-in-action or reflection-on-action [3]. In “Dimension II: reflection participants: individual vs. collaborative” we will have a closer look at which level reflection is supported. “Dimension III: reflection guidance” looks if and how reflection guidance approaches were applied [4]. In “Dimension IV: success and results of reflection” we will review the success of reflection achieved by different tools. Finally, we will conclude with several design guidelines and recommendations emerging during the literature review and the categorisation.

The contribution of the work is twofold: After the categorisation of literature, we analyse it according to four different dimensions. This analysis will provide deeper insights on (i)

which type of technology supports which type of reflection, (ii) which guidance approaches work with which tool and (iii) the success of supporting reflective learning in educational or work-related settings. Second, from this categorisation we were able to derive insights, guidelines and recommendations, which can support researchers and software developers to design reflection guidance functionality in computing systems

2 Related Work

2.1 Reflective Learning

Reflective learning can be seen as the conscious re-evaluation of past experiences with the goal to learn from them in order to guide future behaviour. This is in line with the definitions of Boud et al. [1], 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*” and Dewey [2], who specifies reflection as an “*active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends*”.

Schön [3] differentiates between “reflection-in-action” and “reflection-on-action”. Reflection-in-action, describes reflection during an action in which a change can still be applied to the action itself. This is often triggered by surprises that differ from routinised practice [5]. Reflection-on-action focuses on past, finished actions where the outcome of the detached reflection cannot influence the action anymore. The actions in Schön’s examples have various time spans lasting from hours (an orchestra conductor in a session) over months (the orchestra conductor in a season of sessions) to years (lawyers in long-lasting trials). Eraut [6] states that the existing definition of Schön is impractical for categorizing reflection support since it neglects time pressure. Time is a major factor for how much focus and deliberation one can spend on reflection and thus affects the kind of reflection support tools have to offer. Eraut [6] differentiates between “deliberate reflection-in-action” and “rapid reflection-in-action”. The former describing reflection-in-action in situations in which a decision has to be taken quickly and the latter describing situations in which one can take a break from the action for reflection.

2.2 Existing Literature Reviews

In literature, we have found a handful of research papers presenting different approaches of literature reviews dealing with reflective learning. Kottkamp [7] conducted one of the first literature reviews with regard to tools (e.g. writing, journals, case records) supporting reflective learning. Verpoorten et al. [8] focused their work on reflection amplifiers, special prompts motivating to reflect in learning environments. They developed a framework for identifying relevant attributes necessary for reflection amplifiers split into input and output attributes of reflection processes. Baumer et al. [9] did a literature review on how to design for reflection. In their analysis they come up with patterns, trends and themes followed by an interpretation and suggested directions of future work on designing for reflection. They suggest, “*that engaging with the conceptual and theoretical literature may provide valuable grounding and inspiration for more sophisticated, subtle, or nuanced designs for reflection*”. Subsequent, Baumer [10] comes up with the term of “reflective informatics” which is a “*conceptual approach that helps bring clarity and guidance to the discussion of*

designing for reflection” based on three dimension of reflection, namely breakdown, inquiry, and transformation. Kori et al. [11] made a literature review of reflection technologies with regard to reflection support in technology-enhanced learning. They divide the tools found into technical tools, technical tools with predefined guidance and technical tools with human interaction guidance.

Until now the literature reviews focus either on pure technologies with or without guidance for reflection [7, 11], or on one specific technology like prompts [8] or on the design for reflection tools [9, 10]. What is missing is a review on existing reflection guidance approaches. We investigate (i) tools with regard to their usefulness in educational and workplace settings in combination with the timing component [3, 6]; (ii) the implemented and applied reflection guidance and (iii) the achieved results.

3 Literature Review: Paper Selection Process

At the beginning, we defined three major prerequisites for papers in order to be considered for this review. First, the definition of reflective learning has to correspond with our understanding of reflection, being the conscious re-evaluation of past experiences with the goal to learn from them to guide future behaviour. Second, a technology, a tool or an application has to be presented (stand-alone or integrated in for example a learning environment) which aims at motivating, guiding or triggering users to reflect. Third, this tool (“tool” is now taken as synonym for technology or application) has to be evaluated with regard to reflective learning and present corresponding results (e.g. Did reflective learning take place?)

After having defined these prerequisites, it became clear, that a conventional keyword search in ACM, Springer or Google Scholar would not fit to find relevant papers. The authors of this paper are dealing with reflective learning for more than five years within the projects “MIRROR - Reflective learning at work”(http://mirror-project.eu) and “EMPLOYID” (http://employid.eu). We took all papers collected for these projects as starting point, used their lists and skimmed conferences dealing with TEL in general and reflective learning in particular. Furthermore, we restricted the literature found to the years between 2000 - 2015. We do not claim completeness for all papers available in this area. Finally, we analysed 44 papers fulfilling our prerequisites mentioned above.

4 Literature Overview

During the literature review, the following three main technological approaches emerged and are used to categorize the reviewed literature accordingly: (i) prompts, (ii) journals, ePortfolios and diaries, and (iii) visuals for reflection. The category miscellaneous was added for papers fulfilling our prerequisites but which did not fit to one of the three previous categories.

Where possible, we also will distinguish between educational and workplace learning [4], because they have different demands with regard to reflection guidance (e.g. known activities vs. unknown activities, time pressure during work).

4.1 *Prompts*

Prompts are not a tool per se, but can be seen as kind of intervention combined with or without a specific, IT based tool. They are often used in the form of questions or instructions [12] in order to facilitate recall strategies. The term “reflection prompt” by Chen et al. [13] defines prompts as a strategy to engage learners in reflective practice in online learning environments. Another approach of prompts are so-called “reflection amplifiers” defined by Verpoorten et al. [8] as a “[...] *deliberate and well-considered prompting approach, which offers learners a structured opportunity to examine and evaluate their own learning*”. Additionally, a prompt should be context-specific regarding the context a user is currently in [14].

4.1.1 *Prompts in Educational Settings*

Davis [14] distinguishes between self-monitoring prompts and activity prompts. While self-monitoring prompts use “Thinking ahead” or “Checking our understanding” questions to motivate students to reflect on their own learning and understanding, activity prompts focus reflection on the student’s progress in their activity and create awareness to pay attention to each aspect of their project. Later on Davis [15] focused her studies on generic and directed prompts presented before and after a learning activity. Directed prompts contain specific instructions how to approach a certain task, while generic prompts ask students to “stop and think” about the learning activity. Ifenthaler et al. [16] follow Davis’ [15] categorisation to support self-regulated learning within problem solving processes. Van der Boom et al. [17] investigated if reflection prompts are fruitful to increase the student’s self-regulated learning competences. Three types of reflection prompts, “forethought” (reflection-before-action), “intermediate thought” (reflection-in-action) and “afterthought” (reflection-on-action), were implemented and enhanced with individual feedback from tutors. Furberg [18] investigated content-oriented reflection prompts in order to motivate students to reflect about the currently learned topics. Chen et al. [13] use high-level prompts in form of comprehension questions or integration questions in combination with high-level peer observation, a special form of guidance for learning, to enhance the learner’s reflection level. O’Hanlon and Diaz [19] evaluated process modelling supported by videos and self-monitoring prompts in an online course assignment in two courses. Tabuenca et al. [20] investigated the learning affordances of students throughout a day by sending them reflection amplifiers via SMS. The students reflected directly when receiving the SMS. Kori et al. [11] investigated if reflective prompts could enhance the reflection quality and transformative inquiry skills based on the given tasks on research projects. The design and phrasing of the reflective prompts was aligned with the four reflection levels of Leijen et al. [21], namely description (lowest reflection level), justification, critique and discussion (highest level). McNicol et al. [22] developed two tools for collaborative reflection on student’s project work. With the first tool, students can record audio newsflashes guided with prompts, while the second tool was a kind of diary for the recordings. Verpoorten et al. [23] follow the approach of reflection amplifiers as defined in their previous work [8]. They investigated an annotation tool in an online course with regard to reflection under three conditions - without the annotation tool, with annotation tool and free-style notes, and with annotation tool and question-based notes.

4.1.2 Prompts in Work-place Settings

In work-related settings, there is little research on the usage of prompts and their implementation in tools or applications. Although the following two papers did not evaluate a tool and present research results, they lay out a concept on how prompts might be valuable for reflective learning at work. Prilla [24] discusses the usage of prompts with regard to collaborative reflective learning at work and developed a concept of prompts addressing different levels of reflection. Blunk and Prilla [25] enhanced this approach and developed a concept for goal-driven tool-supported collaborative reflection in which different types of prompts address well-defined goals related to the “Computer Supported Reflective Learning” model by Krogstie et al. [26].

Fessler et al. [4] describe three applications evaluated in three different work-related settings on how reflection amplifiers can support reflective learning at work. While [4] focus on the used prompts, the subsequent literature reports on the associated applications. The MoodMap App [27, 28], a mood tracking application, uses reflection amplifiers to motivate call takers in a call centre to contextualise their stated mood points during work. The Medical Quiz [29] used an integrated form of reflection amplifiers during the quiz play to motivate players to reflect about work-related knowledge and to draw connections between their theoretical knowledge and practical work experience. KnowSelf [30, 31] is an application designed to support individual reflective learning on time management and self-organization of knowledge workers during work.

4.2 Journals/ePortfolios/Diaries

Reflective journals, ePortfolios and diaries are predominantly used in formal educational settings. In contrast to a journal, diaries are personal notes not meant to be shared; hence most studies focus on the effect diary writing has on learning e.g. [32]. Journals are used in different training settings (e.g. athletes) [33] and in work-related settings, especially in medical education of nurses [34, 35, 36]. EPortfolios are mostly defined as a collection of information and (physical) artefacts, gathered for specific purposes by a user over time [37], both in educational [38] and work-related settings [39].

4.2.1 Journals/ePortfolios/Diaries in Educational Settings

Tang [32] described the usage of a reflection diary to draw conclusions for practice in a higher education course for teaching, its facilitation and assessment of reflective learning. George [40] investigated the use of a (paper-based) reflection journal for a data structure and algorithm course. The students’ task was to reason their working steps, evaluate the subjective knowledge and consider the benefit of the journal for themselves. Loo and Thorpe [41] introduced a reflective learning journal to improve both individual and team performance during project work in an undergraduate course for management majors. Land and Zembal-Saul [42] defined based on literature three primary scaffolding strategies for keeping an ePortfolio in a project based experience: (a) facilitate ongoing articulation, (b) support explanation building and generating of working hypothesis and (c) structure opportunities to organize, reflect upon and revise. Alexiou et al. [37] wanted to highlight the support of ePortfolios with regard to self-regulated learning including self-reflection on one’s academic and learning career. Clarke [43] did a study in teacher education with journals. Teachers were writing journal entries about internships they did using guided

questions for the journal entries. Additionally they used shared group discussions amongst the associate teachers to test whether this helps to engage in reflection.

4.2.2 Journal/ePortfolios/Diaries in Medical Education

Many reflective journal-writing approaches can be found in medical education; especially in this area reflective practice is seen as a very important strategy [44, 45] for learning. Elango et al. [38] investigated the perspective of medical student's on ePortfolios as learning tool. They had to keep an ePortfolio for four semesters and to report on complete cases, evidence-based reports and individual reflections on softer issues (e.g. moral, social and ethical issues) and on patient management. Chirema [35] examined levels of reflection in a case study on the usefulness of paper-based journal writing in further education settings of nurses. Harris [36] used reflective journal writing also for nurses in further education. They investigated, if and how it is possible to guide reflective writing with given educational structures and methods e.g. critique, scaffolding and socratic questioning. Van Horn and Freed [46] did a study about journaling for nursing students and they compared individual journal writing to pairs working on one journal together. Hashemi and Mirzaei [47] conducted a qualitative study on journal writing in a medical school with first year students. Twice a week they met in a course and were asked to reflect on a topic of their choice and write down their thoughts.

4.2.3 Journal/ePortfolios/Diaries for Affective States

Lindstrom et al. [48] started with the development of the affective diary. This kind of diary uses data captured by a user during a day via a mobile phone to create an "*ambiguous, abstract colourful body shape*" representing body postures and arousal on a timeline. In Stahl et al. [49] the study of the enhanced Affective Diary aimed at whether the affective diary representation has the potential to trigger reflection about the own embodied experiences.

4.3 Visuals for Reflection

Visuals do not only include typical sophisticated visualisations in IT based tool, but also encompass also captured images or videos worth being reflected on.

4.3.1 Tag Clouds and Smart Indicators

Glahn et al. [50, 51, 52] did a series of studies regarding tag clouds. Early trials with one person indicated that tag clouds might stimulate reflection [50]. Based on this they did a study to analyse different approaches on how to design tag clouds in order to better facilitate reflection [51]. They used user-based tag clouds with regard to the user's tag changes, tag development in the user's personal network and tag trends of the whole network as basis for reflection. In Glahn et al. [52] they conducted a qualitative study as follow up of [50, 51] with the goal to (a) investigate if tag-clouds can stimulate meta-cognition of learners and (b) identify design factors for reflection support.

Glahn et al. [53] used graphical indicators of user interaction data to engage and motivate learners to participate and contribute in an open community platform. Two different types of indicators - one for representing user's activity and the other for user's performance in relation to the average user performance - were implemented.

4.3.2 *Video and Images*

Leijen et al. [54] used ICT facilitation in form of video streaming to guide dance students of two classes (choreography and ballet class) through the reflection process. During their courses, students were asked to take videos, select video fragments to conduct reflection assignments together with the teacher and the researcher. Leijen et al. [55] introduced a guided reflection procedure to support experienced and inexperienced student teachers. Supporting the oral reflection resulted in more benefits for the student teachers than doing the reflection alone.

Harper et al. [56] did a study with the Microsoft SenceCam, an action cam hanging from one's neck which is periodically creating pictures throughout the day providing a record of experiences. They identified that the captured images can be used for reflection. Fleck & Fitzpatrick [57] did a follow up study on SenseCam with teachers, tutors and their mentors during teaching a lecture in a classroom setting. Having recorded images of the experiences allows users to return to the experiences more easily and reflect upon them.

4.4 *Miscellaneous*

Freed [58] investigated forum entries, in this paper referred to as “reflective dialogues”, with regard to reflection. The students were enrolled in a leadership graduate program, had to read six predefined articles and discuss them in the forum. Prilla et al. [59] analysed a self-developed tool, called “TalkReflect”, supporting peer exchange amongst nurses and caretakers in care homes to facilitate reflection. The system offered sharing of reflection content as well as specifying outcomes of collaborative reflection. Sanchez et al. [60] developed a tool called “Affective Health”. It aims at stress detection by stimulating reflection providing two different sophisticated visualisations. The system provides a biofeedback loop providing bodily reactions in real-time and supports users to detect positive as well as negative stress patterns. Isaacs et al. [61] developed a technology-mediated reflection tool, which is used for recording everyday activities. It presents prompts to motivate users to explicitly reflect on the recorded events and to repeatedly revisit those reflections in order to improve their individual well-being. Xiao and Carrol [62] did a study with a self-developed tool, which allows students of a project management course to share and work collaboratively on “rationales”. The rationales were used for externalizing reflective thinking processes during the development of these challenges. Mentis et al. [63] developed a tool for sharing experiences through bodily interaction with friends. The tool stores traces of the user experienced in an art exhibition while it plays traces left of friends at the same time. Allan et al. [64] developed an assessment process, for reflective essays of students enrolled to a first year writing course. For developing the assessment process, they first created a common reflective writing environment by using reflection prompts in form of reflective questions about writing and research processes.

5 Categorization and Analysis of the Reflective Learning Tools

We analysed the given body of literature according to four different analytical dimensions to assess the usefulness of each tool for reflection. We created a table covering those dimensions for each literature category, where at least one paper can be assigned to.

5.1 *Analytical Dimension I: Reflection-in-action and Reflection-on-action*

This dimension focuses on the proximity between reflection and action, meaning whether the tool is more useful in reflection-in-action and reflection-on-action. Reflection-in-action is split into “rapid reflection-in-action” and “deliberate reflection-in-action”. The first describes situations in which a decision has to be taken quickly while the second describes situations in which one can take a break from the action for reflection [6]. Combining one of these with reflection-on-action is labelled intertwined reflection.

5.1.1 *Prompts*

Table 1 presents the literature about prompts assigned to the timing dimension of reflection. In educational settings, prompts are often used in exercises or projects, which are performed by students alone or in groups. Prompts often play the role of guiding the user through an activity (activity prompts) or to facilitate reflection ((self-) reflection prompts). In the analysed literature, most prompting approaches can be assigned to deliberate reflection-in-action, because they are shown while doing an activity mostly without time pressure. McNicol et al. [22] describe a system in which student should record so called news flashes within 60 seconds enriched with prompts to highlight certain activity relevant aspects. These prompts support rapid reflection-in-action and act as a scaffold to structure their contributions. The approach of Tabuenca et al. [20] can be assigned to reflection-on-action as they focussed on what students learned during one given day, whose learning phase is finished in the evening.

In workplace settings prompts are mostly used to reflect on working situations, either directly during the work or afterwards. Prilla’s approach [24] can be classified as deliberate reflection-in-action for current patients or reflection-on-action for patients who will not be taken care of by the reflecting nurse anymore. The approach of Fessl et al. [29] can be classified as intertwined reflection. Depending on the quiz type prompts can be rapid reflection-in-action (answer of a prompt in the quiz-against-time), deliberate reflection-in-action (deliberate answer of a prompt in the other quiz types) and reflection-on-action (relate prompt to work situation). Prompts used in Fessl et al. [4] and Rivera [28] with regard to the mood capturing tool are added to the category deliberate reflection-in-action. These prompts occur during the action with the tool, but users have enough time to reflect and mention why they selected which mood status. The prompts used in Fessl et al. [4], Pammer [30], and Pammer et al. [31] are categorized as intertwined reflection. Prompts occurring during the application usage based directly on the actions of the user are categorized as deliberate reflection-in-action. Prompts showing up at a fixed time asking to reflect on past situations during work are referred to as reflection-on-action prompts.

5.1.2 *Journals/ePortfolios/Diaries*

The term “journal” will be used as synonym for ePortfolio, diary and affective diary and we will distinguish the term only where it is relevant. Table 2 presents the corresponding literature about journals assigned to the timing dimension of reflection.

Research for reflective journal writing is mostly conducted in nursing or teacher education contexts and journal entries often focus on exercises or content taught in class. Writing a journal entry about exercises in class can be reflection-on-action since the exercise was already done. On the other hand, it can be also deliberate reflection-in-action where the action consists of a series of similar exercises throughout a semester.

Table 1 Prompts and their assignment to the dimensions

Literature	Reflection Type				Reflection Participants	Reflection Guidance
	rapid reflection-in-action	deliberate reflection-in-action	reflection-on-action	inter-twined reflection		
Prompts in formal learning settings						
Davis [14]		x			I	
Davis [15]		x			I	
Van der Boom et al. [17]		x			I	x
Chen et al. [13]		x			I	x
Furberg [18]		x			I	
Hanlon and Diaz [19]		x			I	
Ifenthaler [16]		x			I	
Tabuenca et al. [20]			x		I	
Kori et al. [11]		x			I	
McNicol et al. [22]	x				I	
Verpoorten et al. [23]		x			I	
Prompts in work-place settings						
Pammer et al. [30]				x	I	
Prilla [24]			x		I / C	
Fessl et al. [29]				x	I	
Fessl et al. [4]		x			I	
Rivera-Pelayo [28]		x			I	
Pammer et al. [31]				x	I	

From the journals used in educational settings Tang [32], and Loo and Thorpe [41] can be clearly labelled as reflection-on-action: Tang [32] used a reflection diary to facilitate and assess reflective learning for teaching purposes and to draw conclusions for practice. Loo and Thorpe [41] used journal writing to reflect on collaborative project work in a management course with the goal to improve individual and team performance. Approaches

Table 2 Journals/ePortfolios/diaries and their assignment to the dimensions

Literature	Reflection Type		Tool	Reflection Participants	Reflection Guidance
	reflection-on-action	inter-twined reflection			
			Journal (J) / ePortfolio (eP)/ Diary (D) / Affective Diary (AD) Affective Tool (AT)	individ.(I)/ collab. (C)	
Journals/ePortfolios/Diaries in Educational Settings					
Tang [32]	x		D	I	
George [40]		x	J	I	
Loo and Thorpe [41]	x		J	C	x
Land and Zembal-Saul [42]			eP	I / C	x
Clarke et al. [43]	x		J	I	
Alexiou et al. [37]		x	eP	I	x
Journals/ePortfolios/Diaries in Medical Education					
Elango et al. [38]	x		eP	I	
Chirema [35]	x		J	I	
Harris [36]	x		J	I	x
Van Horn and Freed [46]		x	J	I / C	x
Hashemi and Mirzaei [47]		x	J	I	
Journals/ePortfolios/Diaries for Bodily Expressiveness					
Lindstrom et al. [48]	x		AD	I	
Stahl et al. [49]	x		AD	I	

in George et al. [40], and Alexiou and Paraskeva [37] are assigned to intertwined reflection. In George et al. [40] students had to submit a reflection journal entry per week about exercises as well as their solution approach within that exercise. Thus the timing depends on when the journal entry was written either during conducting the exercise or afterwards. Alexiou and Paraskeva's [37] approach followed the model of Zimmerman [65]. In the forethought phase, the students had to use their ePortfolios to set a goal and to plan their

work (deliberate reflection-in-action). During the performance phase, they worked on given exercises enriched with self-control and self-observation techniques (deliberate reflection-in-action). In the self-reflection phase, they reflect on the collected information and evaluated their performance (reflection-on-action). Only Clarke [43] can be categorized as deliberate reflection-in-action since the associate teachers wrote their journal during the internship. The provided questions to guide reflection targeted points like what do you want to learn, indicating that teacher could still influence the action.

In medical education, Elango [38], Chirema [35], and Hashemi and Mirzaei [47] can be assigned to reflection-on-action. In all three studies, students had to report via a journal or ePortfolio on interesting cases or critical incidents they dealt with during work or nursing education and to individually reflect about their taken notes. Van Horn and Freed [46] and Harris [36] can be seen as intertwined reflection. Students had to keep a diary, which is clearly assigned to reflection-on-action, but additionally they were guided by reflective questions. These reflective questions cannot influence past actions, but might have influence on future actions.

The affective diary by Lindstrom et al. [48] and Stahl et al. [49] can be assigned to reflection-on-action. In both studies, the bodily experiences captured during a day was the purpose to reflect on and to draw conclusions out of it, afterwards.

5.1.3 Visuals for Reflection

Visuals, consisting of visualisations, can be implemented in learning environments showing or summarizing actions taken in the past, worth being reflected on to influence actions in the future. Recordings in form of videos or images capture past activities to better re-evaluate past situations or experiences. Table 3 presents the overview of research on visuals for reflection.

Both, the different types of tag clouds in Glahn et al. [50, 51, 52] as well as smart indicators described in Glahn et al. [53] are assigned to deliberate reflection-in-action. The tag clouds try to motivate users to reflect on personal focus, shared interests and network trends while using the application. The smart indicators motivate to reflect on past activities and user performance. In both approaches, reflection takes place during the usage of the application in a deliberate way and can influence the current or future actions. The work of Leijen et al. [54, 55] use video recording as basis for reflection, one conducted with dance students, the other with students teachers. Harper et al. [56] and Fleck & Fitzpatrick [57] used screenshots as basis for reflection. All four approaches can be referred to as reflection-on-action because reflection took place after the action.

5.1.4 Miscellaneous

Table 4 summarises the timing of reflection for very diverse tools and approaches. Mentis et al. [63] developed a tool for sharing experiences and directly reflect about them, thus it is assigned to the category of rapid reflection-in-action. In this use case reflection took directly place when starting to feel the experience captured with the tool. Deliberate reflection-in-action is the approach of Freed [58], who investigates “reflective dialogues” in an online course discussion forum. The assessment process of Allan et al. [64] is assigned to deliberate reflection-in-action as well. Students have to write reflective essays on their research, writing process and learning process guided by reflective questions during writing. The approaches in Sanches et al. [60], Isaacs et al. [61], and Prilla et al. [59] can be assigned to intertwined reflection. In the Affective Health tool of Sanches et al. [60] deliberate reflection-in-action

Table 3 Visuals and their assignment to the dimensions

Literature	Reflection Type		Tool	Reflection Participants	Reflection Guidance
	deliberate reflection-in-action	reflection-on-action	Tag Clouds (TC) / Smart Indicators (SI) / Video (V) / Image (I) /	individ.(I)/ collab. (C)	
Tag Clouds and Smart Indicators					
Glahn et al. [50, 51, 52]	x		TC	I	
Glahn et al. [53]	x		SI	I	
Video and Audio					
Leijen et al. [54]		x	V	I/C	x
Leijen et al. [55]		x	V	I/C	x
Harper et al. [56]		x	I	I	
Fleck & Fitzpatrick [57]		x	I	C	

takes place when reflecting on the current own stress level, and reflection-on-action when passing the stress level in review over a longer period of time. In Isaacs et al. [61] reflection took place while consciously capturing an activity, and reflection-on-action took place when reflecting on the activities afterwards. The notes created by nurses and caretakers in Prilla et al. [59] can be labelled as intertwined reflection.

5.2 Analytical Dimension II: Reflection Participants: Individual vs. Collaborative

In the second dimension we analyse whether reflective learning took place individually or collaboratively.

5.2.1 Prompts

Out of 18 use cases dealing with prompting approaches for reflection, only one supports collaborative reflection [24]. The remaining 16 papers support individual reflective learning.

5.2.2 Journals/ePortfolios/Diaries

Similar to prompts, journals mostly support individual reflection. There exist three approaches dealing with collaborative reflection [41, 42, 46] in journals: In Loo and

Thorpe [41] the focus was to reflect on team performance and team work in a management course. In Land and Zembal-Saul [42] students enrolled in a university course for project management worked in pairs, thus reflected together on re-evaluating and improving their project work. Van Horn and Freed [46] directly compared individual journal writing with pairs working on one journal together.

5.2.3 Visuals for Reflection

The literature by Glahn on tag clouds [50, 51, 52] and smart indicators [53] focus on individual reflection, and the same applies to one of the two SenseCam studies done by Harper [56]. In the second SenseCam study by Fleck and Fitzpatrick [57] as well as in both approaches of Leijen et al. [54, 55] individual as well as collaborative reflection was investigated.

Table 4 Miscellaneous tools and their assignment to the dimensions

Literature	Reflection Type			Tools	Reflection Participants	Reflection Guidance
	rapid reflection-in-action	deliberate reflection-in-action	inter-twined reflection			
				Affective Tool (AT)/ Well-being App (WA)/ Assessment Process (AP) / Forum (F)	individ.(I)/ collab. (C)	
Freed 2003 [58]		x		F	I	
Sanches et al. [60]			x	AT	I	
Isaacs et al. [61]			x	WA	I	x
Xiao and Carrol [62]		x		R	C	
Mentis et al. [63]	x			AT	I	
Allan et al. [64]		x		AP	I	x
Prilla et al. [59]			x	F	I / C	

5.2.4 *Miscellaneous*

All but two of the approaches have in common that they focus on individual reflective learning. Xiao and Carrol [62] work on collaborative reflection while students share and work collaboratively on “rationales”. In Prilla et al. [59] nurses and caretakers could choose between keeping entries private or sharing them with their colleagues allowing for collaborative reflection.

5.3 *Analytical Dimension III: Reflection Guidance*

5.3.1 *Prompts*

Because prompts themselves should guide and facilitate reflective learning, only few approaches were enhanced with other types of guidance. In educational settings, Chen et al. [13] and van der Boom et al. [17] inform about peer support or feedback by tutors with regard to the given answers to the prompts. For all other approaches, independently if educational or workplace setting, no further guidance for reflection was reported.

5.3.2 *Journals/ePortfolios/Diaries*

We found two different types to guide reflection during journal writing: guidance with reflective questions and guidance by peer or writer responders. Loo and Thorpe [41], Land and Zembal-Saul [42], and Van Horn and Freed [46] used various reflective questions to guide journal writing. Harris [36] used guidance by critique, scaffolding and socratic questioning by writer responders directly responding to the journal entries, while in Alexiou and Paraskeva [37] peers guide the reflective writing process. No others have applied additional guidance.

5.3.3 *Visuals for Reflection*

In Leijen et al. [54] the collaborative reflection session was guided by questions while in Leijen et al. [55] the three reflection sessions afterwards were planned in more detail. First selecting a relevant positive and negative incident, second reflect on the incidents alone or with a teacher or peer guided by questions and third do a written reflection on the incidents afterwards. For all other approaches, no explicit guidance was available.

5.3.4 *Miscellaneous*

Isaacs et al. [61] and Allan et al. [64] use guidance in form of prompts: In Isaacs et al., the prompts motivate to reflect on past activities and reflections conducted [61]. In Allan et al. the prompts were tailored to reflective essay writing and ask about the writing process, research process and self-evaluation [64]. The remaining approaches did not provide any further guidance to facilitate reflection.

5.4 *Analytical Dimension IV: Success and Results of Reflection*

The fourth analytical dimension focus on the success, achieved results and gained insights with regard to reflective learning.

5.4.1 Prompts

The insights and results gained with prompts in educational settings were very different. Davis [14] and Ifenthaler [16] showed that the success of reflection strongly depends on the type of prompts. Activity prompts or directed prompts give more step-by-step instructions than motivate to reflect, while self-monitoring or generic prompts encourage students to reflect. Davis [15] found that generic prompts help students to produce more coherent ideas than directed prompts although overall there was no significant difference in students' performance. Chen et al. [13] and Van der Boom et al. [17] confirmed both that the guidance provided by peers and teachers significantly influenced reflection in a positive way. Kori et al. [11] stated that prompts can enhance the level of reflection and sending prompts to students via SMS as reported in Tabuenca et al. [20] lead to the gain of insights on different levels. Verpoorten et al. [23] relates a success of reflection amplifiers only as combination of the number of inserted annotations with other reflective enactments, but not on reflection amplifiers alone. Furberg [18] and McNicol et al. [22] found out that without seeing the value of reflection, students only answer prompts in order to receive a positive grade.

In work-related settings, Fessl et al. [27, 29, 4], Rivera-Pelayo [28, 66] and Pammer [30, 31] showed that prompts are able to induce reflective learning on own and other's mood, new gained knowledge in relation to practical experiences and with regard to time management. What emerges in all work-related settings is that especially the timing, when to present the prompts, need to be carefully considered in order to not disturb the user's current work-flow. Concepts of Blunk and Prilla [25], and Prilla [24] try to advance in this area, but haven't included results yet.

5.4.2 Journal/ePortfolio/Diaries

All case studies used in educational settings like [32, 40, 41, 37] showed evidence that reflective learning could be triggered. The topics of reflection encompass current teaching and assessment practice, better understanding of concepts, awareness of the attitude towards learning and team performance. In medical education [38, 35, 47], improvement could be achieved in communication skills, self-directed learning as well as expanding the sense of self and a confidence in their capacity. The reflection achieved with the affective diary on bodily expressiveness [48, 49] strongly depends on how appealing the bodily representation for self-identification was for the individual. From those studies with reflective questions as guidance [41, 42, 46], only Land and Zembal-Saul [42] investigated the usefulness of the provided scaffolds and showed that they were useful for articulation, reflection and revision of explanations. Loo and Thorpe [41] saw improvements with regard to team performance and team management (because this was the purpose of the study) and Van Horn and Freed [46] saw improvements only in paired journal writing instead of individual journal writing. The results of both studies with peer support showed that reflective learning took place; in Alexiou and Paraskeva [37] with regard to enhancing self-regulated learning skills. Harris [36] clearly stated that for good reflective writing, students need "*regular, specific and sensitive critical response from their writer-responder and follow-up supportive contact*".

Additional drawbacks for journal writing are time constraints and stressfulness of keeping it [40, 38, 35] as well as the difficulty of writing it [35]. Additionally some approaches only work, if the participants were experienced enough and understood the potential value reflective learning might have for the individual [42].

5.4.3 *Visuals for Reflection*

Glahn et al. [50, 51, 52] showed during their development of the tag clouds that they can trigger reflective learning on tag activities with regard to self-regulated learning. The smart indicators of Glahn et al. [53] were not directly used for reflective learning, but trying to influence the indicators lead to reflection about the users' social context and activities. The results of Leijen et al. [54] showed that reflecting on videos taken during dancing classes depend on the study of the participants. Leijen et al. [55] showed that only experienced student teachers gained valuable insights for teaching when reflecting on videos on their teaching. Furthermore, they stated that reflecting together with peers resulted in more benefits for the individual than reflecting alone. Both SenseCam studies [56, 57] confirmed, that reflecting on pictures taken during the day help to re-evaluate past experiences and inspire reflection on own behaviours.

5.4.4 *Miscellaneous*

The results of Freed [58] showed that reflection took place in so-called "hot spots", posts with high activities. These posts contained questions and metaphors strongly related to reflective dialogues. Sanches et al. [60] derived three design features necessary for initiating interpretation and reflection with visualisations to for stress detection: (i) available history of prior bodily states, (ii) aliveness in the interface and (iii) fluent visual transitions between states for all variables. Isaacs et al. [61] showed that "Reflecters" on activities perceive benefits of positive experiences and draw positive lessons out of negative events. Xiao and Carrol [62] associate the length of a rational with the depth of reflective thinking. Mentis et al. [63] achieved individual reflective learning on the experience. Allan et al. [64] found out that the reflective essays contained strong reflection statements with regard to their research and writing process. However, it seemed that students did not really know how to cope with reflection about their learning. Prilla et al. [59] showed that it helps increasing chances to reach a reflective outcome in an online discussion when users add their own experiences to collaborative reflection.

6 Discussion

Dimension I: reflection-in-action and reflection-on-action: The literature review showed evidence, that papers using prompting often support deliberate reflection-in-action. Users are still being somehow in the action thus influencing their actions is still possible. At a first glance, it seems that all journals belong to reflection-on-action; but having a closer look at the action and their duration as well as if journal entries are guided by reflective questions led us to the conclusion that some of them can also be aligned to deliberate reflection-in-action. Videos and images are focused on reflection-on-action, while the assignment of work in miscellaneous depends on the investigated tool. Altogether only two papers are dealing with rapid reflection-in-action, which points out a research gap which might worth being explored further. When creating a new tool for reflection, designers have to analyse the nature of the action users should reflect on. For rapid reflection-in-action prompts might help facilitating reflection, though the literature basis on this is very thin with only two studies explicitly stating time pressure. Deliberate reflection-in-action as well as reflection-on-action can be supported by prompts, journals, ePortfolios, or diaries.

Dimension II: reflection participants: individual vs. collaborative Depending on the action, which should be reflected on, designers need to know whether individual or collaborative reflection is desired. All analysed papers show their applicability for individual reflection. There are only few papers supporting collaborative reflection, which indicates that this research area is currently under-represented in literature.

Analytical Dimension III: reflection guidance: Providing meaningful guidance during the reflection process seems to be a challenge worth paying attention to. Participants of [38, 36] explicitly mentioned that guidance for reflection was missing. Prompting approaches reported in [17, 13, 23] were very successful in combination with peer, tutor or teacher support and also [55] confirmed more benefits for guided reflection with teachers. Also journal writing guided with reflective question like in [41, 42, 46] confirmed the usefulness for reflection. The described guidance techniques often use reflective questions (or question prompts). These questions might be shown during the usage of a tool (e.g. in form of pop-ups) or are used during peer-to-peer meetings or group discussions. No other type of guidance could be found in literature. Although only few studies provide reflection guidance, it seems that guidance is one of the most important success criteria for reflective learning. Moreover, a combination of reflective learning tools with peer-to-peer or group discussions seem to be the most promising way for facilitating reflective learning.

Analytical Dimension IV: success and results of reflection: All of the literature reviewed report about their successfulness with regard to reflective learning. However, we were able to derive some crucial challenges, which need to be taken into consideration when facilitating reflective learning.

Independent of the setting, introducing reflective learning is a challenge on its own. First, there needs to be a clear benefit for participants answering the questions “What is in for me?” to make a reflective learning tool successful and beneficial for each individual [4]. Second, participants need to understand the purpose of reflective learning. Otherwise, like reported in [18, 40] students would fill in prompts or journals only for getting a positive grade and prompting approaches like described in [22] will not work. Third, depending on the goal of reflection, participants need to have enough background knowledge about the topic they should reflect upon right from the beginning in order to understand and utilize the provided scaffolds [42].

The timing of automatically presented prompts need to be thoroughly planned to optimize learning in formal education [67]. For workplace learning, the time is of high relevance. Prompts should only be presented, if they do not disrupt the current workflow [29, 4]. For journal writing, which is very time consuming and stressful [40, 38, 35], it needs to be carefully considered if such an approach makes sense in fast-paced and time pressured working environments.

7 Conclusion

In this work, we conducted a literature review on tools supporting and guiding reflective learning. We divided altogether 44 research papers from educational as well as work-related settings into reflective learning approaches including prompts, reflective journals/ePortfolios/Diaries, visuals and miscellaneous and analysed them according to four dimensions. The analysis helped us to derive new insight, guidelines and recommendations for guiding reflective learning. It emerged that reflective learning tools enriched with

guidance by reflective questions in form of prompts and additionally in relation with peer-to-peer or group discussions seem to be the most promising way to achieve reflective learning. While in educational settings, reflection guidance in form of prompts is well investigated, in work-place settings the correct timing is still an open issue in order to avoid disruptions in ongoing work processes. Furthermore, we identified two areas which are currently under-represented in literature and still needs further investigation: support for rapid reflection-in-action as well as tools supporting collaborative reflection, both independent of the setting.

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