The Reflection Object: A Useful Concept when Designing for Reflection

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Abstract

Existing literature talks about what is reflected on in terms of examples, such as reflecting on financial expenditures, lifestyle, professional growth, etc. In this paper, we give a name to this: the reflection object.

This paper develops the name and concept “reflection object” based on activity theory,

reflection theory, and design-oriented theoretical works on technologies for reflection; as well as based on our understanding of designing for reflection from own past, previously published empirical and design-based research.

We develop four themes for design-relevant considerations around the reflection object. The four themes are i) identifying the reflection object, ii) identifying explanatory contextual information about the object, iii) the object's development in time and iv) the object's representation.

The theme of the object's development in time, including what should change, how this would be measurable, and procedural aspects of bringing about this change, points particularly at an opportunity for future research, as it addresses that explicit support for transformation is the weakest point in existing reflection technologies.

For practitioners, we have instantiated the above four themes as four sets of questions, to be iteratively used throughout design.

Keywords: Computer-mediated reflection, reflective informatics, design, reflection, reflective learning, activity theory

Introduction

Information systems can be designed with many goals in mind; often the goal is to support work such that it is carried out more efficiently, or to entertain. By now, the goal to designing systems that support users in reflection has come to the attention of HCI-oriented research (Baumer, 2015; Baumer, 2014; Choe et al., 2014; Fleck & Fitzpatrick, 2010, Isaacs et al., 2013; Li et al., 2010; Li et al., 2011; Malacria et al., 2013; Mamykina et al., 2016; Slovák et al., 2017).

A wide range of tools that cover different domains of usage have already been designed, evaluated and published with this goal in mind. For instance, Echo (Isaacs et al., 2013) lets users describe significant situations and events in their lives textually and with multimedia data, and prompts users later to remember and reflect on them. KnowSelf (Pammer & Bratic, 2013) captures and visualizes application and document usage on computers, and thereby creates a data basis for reflecting on time management. The Mobile Diabetes Detective (Mamykina et al., 2016) enables users to document their blood sugar level, and provides data analytics functionalities in parallel to reflection

scaffolds and prompts. TalkReflect (Prilla, 2015) enables users to describe significant situations textually, to share descriptions with others and to collaboratively and asynchronously reflect on such situations. Narcissus (Kay & Kummerfield, 2011) combines log data from a software code repository, an issue tracking system and a project management wiki to provide an overview and data basis for synchronous and collaborative reflection on progress and collaboration patterns.

All exemplary tools listed above are useful to reflect about something concrete, like personal memories, time management, lifestyle as relevant for Diabetes, difficult conversations, or collaboration in software engineering. All tools represent these reflection objects in some manner, and it is clear from the descriptions, that the designers of these applications have spent significant thought on what is actually reflected on, and how to represent this in their tools. However, neither foundational theoretical works on reflection and reflective learning such as Boud et al. (1985) or Schön (1983), nor design-theoretical works such as Baumer (2014,2015), Fleck & Fitzpatrick (2010), Krogstie et al. (2013), Pammer et al. (2017), or Slovák et al. (2018) have a name for this. Of course the above-mentioned existing design, empirical, and design-theoretical works discuss reflection as being about something. However, no concept of a reflection object as presented in this paper is identified in these works, and therefore these design-theoretical works cannot, and were not intended to, support tool designers in thinking about and deciding on what to represent in a tool.

In the present paper, we give this concept a name: The reflection object. It is that which is reflected on, and at the same time that which changes through reflection. Furthermore, we develop this concept based on activity theory (Kaptelinin & Nardi, 2009; Kuutti, 1996), reflection theory (Boud et al., 1985; Schön, 1983), and design-oriented theoretical works on reflection (Baumer, 2014; Baumer, 2105; Fleck & Fitzpatrick, 2010), Krogstie et al., 2013; Pammer et al. (2017); Slovák et al., 2018) as theoretical underpinning. This work is also based on our understanding of designing for reflection from own past, previously published empirical and design-based research (no references to preserve anonymity). This background enables us subsequently to develop four themes of considerations on the reflection object. These are: i) What is the reflection object? ii) What is relevant contextual information? iii) How does the object develop in time? and iv) How is the object represented?

Background and Related Work

What is Reflection

Reflection means re-thinking existing knowledge, values, behavior and practice with the goal to derive insights on and potentially change aspects of them (cp. especially (Boud et al., 1985; Schön, 1983). Boud et al. (1985) concretely conceptualise reflection as returning to past activities, ideas and feelings, re-evaluating these and drawing new insights on them, including new perspectives and changes for future behaviour. This shows important characteristics of reflection: Firstly, reflection is based on reconstructing or recalling past activities as well as on representing ideas and opinions. Second, in contrast to activities like rumination and venting, or concepts like sensemaking (e.g., Crowston & Kammerer, 1998; Weick et al., 2005), reflection has a clear focus on outcomes, that is, learning and change.

In most literature, reflection is understood as an individual activity and essentially a cognitive process. This view is dominant in the context of reflection as a means of learning, e.g., in (Boud et al., 1985; Schön, 1983); and is also taken in (Daudelin, 1996) in the context of work practice even whilst acknowledging the social context in workplaces. HCI literature also frequently takes this view, for instance in research on quantified self (e.g., Li et al., 2011), adaptive help (Malacria et al., 2013), or when supporting remembrance (e.g., Isaacs, 2013). In collaborative and organizational settings, reflection can also be conceptualized as a collaborative activity and social process (Prilla et al., 2012; Prilla, 2015). Krogstie et al. (2013) and Pammer et al., (2017) finally bring together both perspectives, that of reflection as individual and as collaborative activity, in the context of workplaces.

Design Theories for Computer-Mediated Reflection

Several design-theoretical works theorize about designing for reflection from the *perspective of separating reflection into different phases*. Based on background theory, Baumer (2015) has proposed three principal dimensions along which reflection should be understood by designers, namely breakdown, inquiry, and transformation, based on a literature survey. By breakdown, Baumer understands situations or moments that constitute the starting points for reflection. Breakdowns include elements of surprise,

puzzlement, conflicts or “explicit consideration of that which was previously unconscious and implicit" (ibid, p.6). Inquiry means the process of “generating, testing, revising, and further testing hypotheses" (ibid, p.6), a ``re-examination of things - concepts, ideas, theories" (ibid, p.6). Transformation is a change in understanding, conceptual schemata, values, or decisions in the sense that ``reflective decision making (...) enables decision making that is not subject to (...) biases" (ibid, p.7). Li et al. (2010) investigate reflection in the context of people self-tracking relevant aspects of their lives with the goal to change and improve own behaviour. Based on background theory and own empirical work, the authors have identified as five stages in this process first a preparation stage in which people decide to start self-tracking, and prepare their own method (tools, procedure) to do so. Second, in the collection stage, people are engaged in collecting data, either manually via calendar entries for instance, or automatically such as when analysing phone usage. Third, in an integration stage, people “prepare, combine and transform (data)" (ibid, p.5) Fourth, in the reflection stage, people reflect on data; and fifth, in the action stage, users “choose what they are going to do with their newfound understanding of themselves" (ibid, p.6). Krogstie et al. (2013) and Pammer et al. (2017) investigate reflection in the context of workplace learning. Based on background theory and own empirical and design work, the authors have identified four phases in reflection, such that in a first phase, people “plan and do work". In a second phase, reflection is set-up, which includes goal setting, involving relevant people, and planning the actual reflection. In a third phase, people reflect. In the fourth phase, plans for the future are made (“apply outcome"). This includes planning how to apply insights in future work practice, as well as planning follow-up reflection sessions. One unique notion put forward by the authors is that of triggers, which essentially kick-off the phase of setting-up reflection. Triggers can be internal or external: The first are perceived discrepancies, and provide the motivation and individual or collective rationale to reflect. The second are external impulses for starting to reflect, which essentially constitute impulses to take time and space to reflect, and be it only to reflect briefly on whether there is something worth reflecting on.

Fleck and Fitzpatrick (2010) structure their discussion around *levels of reflection*. Levels of reflection can be understood as the extent to which an activity (or an outcome of an activity) is reflective. The authors' model is based on background literature and own design work. Level zero, revisiting, consists of reporting the past, without adding significant “reflective thought". This level is not understood as

reflective, or would not count as reflection in the authors' understanding. Level one, reflective description, includes “justification or reasons for action or interpretation" (ibid, p.3). In level two, dialogic reflection, “relationships between pieces of experience or knowledge" (ibid, p.3) and generalizable insights are sought. In level three, transformative reflection, “fundamental questions" are asked, and change of future practice is explicitly intended. In level four, critical reflection, “social and ethical issues are taken into consideration" (ibid, p.3).

Slovák et al. (2017) discuss *conditions that help learners to reflect*. Based on background theory and own empirical and design work, the authors identify as one condition for reflection learning that learners are enabled to construct knowledge by themselves in a setting that provides them with the experiences that are real-enough as well as safe-enough to learn from. At the same time, the reflection process should be guided. In contrast to the reflection approaches described above, the authors discuss designing not only technology for reflection but the overarching reflection activity.

Synthesis: Conceptualisations of the Reflection Object in Related Work

The foundational works of Boud et al. (1985) and Schön (1983) talk about experience(s) and practice as that which is reflected on; knowledge, behaviour, or individual perceptions as that which is changed; and future experience(s) and practice as that which is impacted through reflection - in a word, observable change (future experience and practice) is effectuated via the reflective practitioner who learns. In the above discussed design-theoretical works, authors talk about experience, events, actions, knowledge, interpretations, ideas, values, thoughts as being reflected on; as well as about concrete examples such as financial expenditures (Li et al., 2010) or nursing practice (Krogstie et al., 2013). A coherent name is missing, however. Subsequently, a systematic relationship of these exemplary reflection objects to the reflection activity is missing. This is what we propose: To use the name and concept of reflection object to talk and think about what it is that people reflect on during reflection; and thereby to be able to systematically talk and think about reflection, and support for reflection, differs depending on reflection object.

In addition, all design-oriented works discussed agree that a key element in reflection is the derivation of learning outcomes. This is understood to be a key characteristic of reflection, differentiating it from other forms of thinking or learning.

The respective phase is called transformation by Baumer (2015), transformative reflection level by Fleck & Fitzpatrick (2010), reflection stage by Li et al. (2010, 2011), and applying outcomes by Pammer et al. (2017). The implicit understanding that underlies the above cited works follows Boud et al. (1985) and Schön (1983), namely that work practice, experience, or more generally speaking behaviour, is impacted through reflection, and will differ in relevant characteristics from experience, work practice or behaviour before reflection. In addition, also knowledge, perception, attitude, values of those who reflect are understood to change. However, the above works don't clearly bind together that which is reflected on with that which is changed. This conceptual gap makes it difficult to connect design decisions on representing that which is reflected on with design decisions on how to support transformation. This is what we propose: To use the name and concept of reflection object to talk and think at the same time about that which is reflected on, and that which is changed through reflection. We see this as one step towards being able to better support transformation, which is the most challenging phase and level to design for (cp. Baumer, 2015).

Using Activity Theory as Tool in order to Conceptualise the Reflection Object

The core proposition of this paper is to introduce and argue the concept of reflection object. We do so by i) explicitly framing reflection as activity in the sense of activity theory, and ii) subsequently understanding the reflection object as object in the sense of activity theory. We use activity theory as a conceptual tool to think about reflection, and in particular the reflection object. We have chosen activity theory because it is a mature framework, is accepted in HCI (see Kaptelinin & Nardi, 2009) and has at least been put forward in information systems (see Karansios, 2018) as a theory that might be helpful for these fields in framing how to understand human activity for design purposes. In particular, we had started looking at activity theory in-depth as theory on which to base the development of the concept of reflection object, because activity theory understands activities to be inherently oriented towards objects, and all elements of an activity to naturally develop over time. Below we first review activity theory in the briefest of possible ways, and then frame reflection in terms of activity theory.

The Briefest of Introductions to Activity Theory

Activity theory is a philosophical perspective which postulates activities as the smallest relevant units of analysis for understanding human agency. Activities here are overarching endeavours; they are long-term processes that “consist of actions or chains of actions" (Kuutti, 1996, p.30). An activity is the unit of a human actor (=the subject) who manipulates an object and is motivated by that object. Activities are mediated (shaped, influenced) by tools. Tools are “at the same time both enabling and limiting" (ibid, p.27). Tools can be both physical and conceptual, such that a useful formula, concept, or method is as well a tool as a piece of software or a hammer. A single actor is typically involved in many activities, and activities themselves are interlinked and influence each other (ibid, p.30).

An object can be “an object of eating, an object of labor, an object of contemplation, etc." (Leontiev 1981 as translated and cited in (Kaptelinin & Nardi, 2009, p.140). By object one understands both the conceptual target of an activity, and the material object that is manipulated by the activity (Kaptelinin & Nardi, 2009, p.138ff - Objekt versus Predmet. When constructing a statue therefore, the material statue is the physical object of the activity, which is external to the subject. The concept of the statue is the internal object of the activity. Both constitute the dual object that directs the overall activity including related sub-actions such as buying material, hiring workers etc. We understand the object therefore as having a dual meaning, and combining physical, tangible and external as well as conceptual, intangible and internal aspects. An object of an activity is different from basic human needs, and also different from motives that drive human actors, such as the need to earn a living, or the motive to be well-respected or make a career. However, objects satisfy or address actors' needs and motives such that they motivate and give meaning to activities (Kaptelinin & Nardi, 2009, p.143ff - Objects versus motives).

Through and by means of an activity, all entities of the activity change over time: Subjects develop their knowledge and skill through activities, tools and how they are used are created or further developed through activities, and the object of the activity is manipulated and transformed via the activity. In the present work we emphasize the development of the object.

Framing Reflection as Activity}

In this work we conceptualise reflection as activity in the sense of activity theory, such that the subject of the reflection activity is the reflective practitioner or learner; and the *object of the reflection activity is the reflection object*.

Consequently, tools for reflection shape the reflection activity. Examples for tools are concepts about learning and reflection, as well as methods and structures for reflection, and of course also software tools that support reflection. In the present work, we focus on the design of software tools. Considering that tools are both enabling and limiting, a proper understanding of the reflection object as that on which the tool should work is imperative in order to design in a way that enables adequate actions, and limits the wrong ones instead of vice versa. What is an adequate tool for a particular reflection activity hence also depends on the reflection object; the tool needs to help manipulating, transforming the object: it needs to support reflection on this particular object.

Reflection is also linked to other activities in which the subjects participate: In reflection, people pick as reflection object something that appears in other activities. This means that people reflect for instance on tools, the community, community rules, or division of labour of linked activities. Examples are reflecting on a product that is the object of a company's core value creation process, reflecting on knowledge or concepts that are used as tools in other activities, or reflecting in an overarching manner about other activities like a past project. Reflection is therefore linked to other activities via the reflection object.

We note that alternatively, reflection could be conceptualised as action that is subordinate to a wider activity. We don't use this conceptualisation in the present work: Viewing reflection as activity allows us to conceptualise separately tools and the community with its rules and division of labour of the reflection activity; and tools and communities, as well as other constituent entities, of connected activities.

Four Themes: Implications of Using the Concept of Reflection Object

As major contributions of this paper beyond giving the reflection object its name, in order to be able to talk about it, we develop four thematic areas for considerations on

the reflection object. The first three are derived as consequences from conceptualising the reflection object in the sense of activity theory. These are identifying the reflection object, identifying contextual information about the reflection object, and the object in time. The fourth theme discusses the role and desirable characteristics of the object's representation. This theme is tool-oriented, and goes back to the initial motivation for this paper, to develop a theoretical basis for what existing tools for reflection already do, namely represent the reflection object.

What is the Reflection Object? - Something that Motivates Reflection

From framing reflection as activity, we derive firstly that the reflection object is an overarching entity that motivates and directs reflection. The reflection object therefore is not simply a small, isolated something that one thinks about for a minute. It is larger and is more than what is reflected upon in a limited time-frame. Secondly, we derive that the reflection object is also that which changes through reflection. Thirdly we derive that the reflection object is both internal to the subject (=whoever reflects), and external to the subject.

Examples

In this section we discuss an example of what is the reflection object, based on own empirical work. We highlight again that activity theory is an analytical tool. This means, that for any real use case there may be multiple representations of the use case in terms of activity theory. The decision criterion of a good representation is that the representation helps to think about the use case, and fulfils the criteria given by activity theory, namely that the object is an overarching entity that motivates and directs reflection, vague as these criteria may be.

In care-oriented professions such as medical care, “treatment of patient <X>" could be a meaningful reflection object. This framing would be particularly useful where care for every concrete patient is challenging and potentially needs continual monitoring and adjustments. This is the reflection object underlying the tool CaReflect (Müller et al., 2015). Another meaningful reflection object could be “communication with patients and their relatives". This would be helpful in cases where conversations tend to be difficult, as for instance in emergency or palliative departments. This is the reflection object underlying the tool TalkReflect as evaluated in (Prilla, 2015). Both of

these reflection objects are something that medical practitioners typically want to reflect on in line with their professional role, have significant power over, and are therefore typically directly motivated to reflect on.

"Communication with patients and their relatives" might not be experienced as challenging, and hence not so motivating to reflect on for medical staff in a department that deals with less critical medical conditions. In such cases, this might not be the best way to frame the reflection object. In such a case, it may make more sense to frame the reflection object differently such that communication remains only one of multiple aspects of care that might turn out to be relevant or not.

Is it Context? - Additional Information about the Reflection Object

Context is a difficult and yet central concept in human-computer interaction in general (Dourish, 2004). In literature on reflection tools, context appears mostly in the sense of "additional information that helps users to create meaning of that which is represented in tools for reflection". For instance, in (Fessl et al., 2017), the authors describe contextualization components, which are technical tool features that help to contextualise (in the sense of explaining) "main data captured within an application". This had been identified as necessary functionality via user-centred design methods by the authors. Also Li et al. (2010) have found, when exploring which questions people ask of collected data, that context was something that people were looking for; again in the sense of context being something that explains data that is captured in quantified self tools. This understanding aligns with that of Dourish (2004) in understanding context as additional information that is helpful and necessary in order to create meaning in relationship to a particular activity (Dourish, 2004, p.4). Further, such additional information can be understood as communicative context, in the sense of being a prerequisite for reflection as inner conversation with oneself, or as conversation with others in the case of collaborative reflection (Hermann & Kienle, 2008). Hidden behind this is the understanding that what is represented in tools only ever represents parts of all information relevant for reflection.

Synthesizing, we see that any partial representation of the object within a tool may need additional, contextual, explanatory information which helps to explain and describe the reflection object. In tool design, contextual information therefore needs to

be part of the representation of the reflection object. In related work (e.g., Li et al., 2011; Fessl et al., 2017), such contextual information is not always captured upfront, but is sometimes created via the reflection activity. For instance, prompts were used to incite users to give contextual information in (Fessl et al., 2017). after the respective events/experiences. This strengthens the point we made above of seeing this contextual information as constituting communicative context that enables reflection as (inner, or with others) communication. Such contextual information therefore also constitutes visible evidence for reflection, in that it captures changing insights and perceptions.

Furthermore, in all related works, contextual information relates to what we have labelled linked activities in the present paper. This means that contextual information refers to linked activities. In other words: one role of contextual information is to explain and relate the reflection object to linked activities.

Example

In this section we discuss an example of what is contextual information that helps to explain the reflection object. The discussion is based on the example of KnowSelf as described in (Pammer & Bratic, 2013).

Activity log data capture only a partial aspect of time management, albeit a relevant one - actual time use. In order to reflect on time management however, fine granular time use needs to be related to overarching tasks, projects, and activities. In order to reflect on scheduling, time use also needs to be understood in terms of urgency and importance of actions; and interruptions need to be understood in terms of the potential to remove them in the future. Such additional, contextual information helps to explain and understand the activity log data with respect to time management. In the process of explaining data, and questioning own behaviour as visible within such data, reflection may happen; or vice versa, via reflecting, the significance of data and own behaviour with respect to time management may become clearer.

In tools, users may manually label time with relevant labels, or take additional notes in which they describe and reflect on the relationship of executed actions and overarching activities. On the other hand, such contextual information need not be captured within the same tool, or indeed in any tool - it just needs to be available for reflection.

The Object in Time

The notion of change is central to reflection: In reflection theory, reflection is understood to lead to learning, i.e. a change in the learner's knowledge, behaviour and perception (cp. Boud et al., 1985). Both Boud et al. (1985) and Schön (1983) understand that future experience(s) and work practice are impacted through reflection. Also, all design-oriented works discussed above share the understanding that reflection leads to change, or transformation.

From the perspective of activity theory, all constituents of an activity develop over time. In particular, it is understood that through any activity, the subject changes and learns (Kuutti, 1996, p.32; Kaptelinin & Nardi, 2009, p.110). In parallel, it is understood that "the subject is transforming the object" (Kuutti, 1996, p.32). Both the internal and the external reflection object can change. When the internal object changes, this change is at first unobservable from the outside. This captures that subjects change their understanding of and perspective on the reflection object. In particular, subjects may change their understanding about what are relevant aspects of the reflection object to reflect on. As a consequence for design, over time, new and different kinds of contextual information may become necessary to understand and reflect on the reflection object. When the external object changes, this change is immediately observable. Observable changes can be for instance the learner's behaviour, or changes made to artefacts that document the reflection activity, or that document linked activities.

Example

The example we discuss here is that of understanding the “communication with patients and their relatives" as described in (Prilla, 2015).

Here, conversing with relatives and patients serves as reflection object, in the spirit of reflective practice. Such a reflection object can then mean the physician's understanding of the conversation situations, including the situation of patients and relatives, the locations of the conversation and the way the conversations were conducted. This understanding may be questioned through reflection, and may change over time. Internal, subjective aspects on the one hand, and observable aspects of further conversations on the other hand may be different. However, both a change in understanding and a change in further conversations may be observable in the

documentation of the reflection activity (e.g., in a discussion of conversations with a particular person).

Representing the Object

Finally, we delve into the theme that was the starting point of the present paper: In all tools that we know of, and certainly all tools that we cited in the introduction, the reflection object is represented.

Often, the reflection object is represented via automatically or manually tracked data. In addition, textual or multimedia descriptions, metadata such as notes, tags, ratings, and all kinds of communications about the reflection object are used. Indeed, anything that explains or describes the reflection object within a tool can be part of its representation. Of course, as we understand the reflection object to be an overarching entity that exists outside tools for reflection, any such representation is partial.

When discussing the reflection object, we have already above highlighted its dual nature as being both internal and external. The internal reflection object is the representation of the reflection object in the subject's mind, as mental model of that which is reflected on. The external reflection object is the reflection object as exists outside the subject in its own right. The representation of the reflection object now is again something external, but it is only a representation. It also has a specific purpose, namely to support reflection. The overall goal of the reflection object's representation is to come as close to the internal and external reflection object as necessary.

The Role of the Representation

Activity theory allows us to understand that tools shape the interaction of the subject with the object. This means that the representation of the object - whether and how it is represented, how the object can be interacted with - acts as modifier to the reflection activity itself.

From the perspective of reflective learning, we can in addition understand the representation of the reflection object to serve as external trigger (cp. Krogstie et al., 2013; Pammer et al., 2017) for reflection. This means, that one role and function in reflection is that the representation creates awareness of something that is worth being reflected on, and points towards a salient aspect of the reflection object.

From the perspective of communication, the object's representation serves to create communicative context both for inner conversations with oneself, and for conversations with others (Hermann & Kienle, 2008). Thereby, the representation aims to mediate and stimulate critically reflective dialogue. We found it particularly useful to consider the similarity of the role of the reflection object's representation to create communicative context with the role of boundary objects (Star, 1989). Boundary objects are artefacts that are known by different groups of people and for which each group has a different conceptualization or a different practice of dealing with it. Thereby, boundary objects raise different interpretations and thoughts among different people and groups; and overall support articulation and communication in the group. Examples put forward in the literature are maps used and interpreted differently by different people, or work requirements affecting people differently but enabling them to talk about work (Star, 2010). In collaborative reflection there may be no, or only a weak boundary between people in the group, as the reflection object typically constitutes shared concepts, shared practice, etc. Nonetheless, the role of the reflection object's representation is similar: It needs to stimulate the explication of interpretations, thoughts, and ideas for dealing with the issues reflected on within the group in order to stimulate collaborative reflection. Therefore, the representation of the reflection objects needs to include different facets and aspects, and it needs to allow the addition of thoughts and interpretations to, which in turn documents changes in the shared reflection object.

Finally, from prior discussions on contextual information about the object and the object in time, we know that the reflection object's representation in time changes. Such change documents both the ongoing reflection activity and its outcomes. Tools therefore can take up the role to make changes visible. However, this role is not taken by existing tools in related work, as existing tools don't analyse and emphasize the object's development in time.

Desirable Characteristics of the Representation

The different roles of the representation of the reflection object, to mediate and enable reflection, to trigger reflection, and to support the creation of communicative context, lead to a variety of desirable characteristics for the representation.

Firstly, relevant aspects of the reflection object need to be represented. Existing works on data-driven tools for reflection highlight the importance of choosing relevant data that represent multiple facets of the reflection object. In the case of CaReflect for instance, the authors discuss critically that measuring the time spent with residents is only one aspect of care quality: "by putting the focus on one aspect, there is a risk that the others are neglected" (Müller et al., 2015, p.121). We note that the authors refer to "aspects of the reflection object" without explicitly conceptualizing the reflection object as such in their paper. Also Li et al. (2011) note that tools for data collection tend to be specialise on a very limited number of types of data. Designers then need to be aware of the risk that users may choose to switch tools in case they decide that another aspect of the reflection object is more relevant for reflection, and hence need another representation. Choosing relevant aspects also means to consider that the representation serves as trigger for reflection: The representation needs to be able to focus users on something that is meaningful, interesting, relevant to reflection, and not easily obvious to users without the tool.

Secondly, the role of the representation is to support articulation, communication, and to raise and document different interpretations and thoughts. This requires the representation to be elastic (Star, 1989) and offer interpretative flexibility (Star, 2010). By this it is meant that as the reflection object is in the process of being critically re-considered, tool design should allow multiple interpretations; and tool design should leave space for users to adapt the reflection object's representation.

Thirdly, the role of the representation to support communication in collaborative reflection settings of course requires designers to think of issues like sharing, anonymity versus author identification, etc. In particular, we highlight that sometimes the group of people who reflect can change. Such a change in reflecting subjects could happen for instance because new people "bring in new expertise or executive power into the group" (Pammer et al., 2017, p.10). In such cases, it may even be desirable to consider complete transfer of ownership of the object's representation.

Finally, representations of the reflection object could to take up the role to make visible the temporal development of the reflection object in time by visualizing and emphasizing changes to the representation. This is not done in existing tools however.

Examples

In this section, we discuss an example of how a reflection object can be represented, for the case of reflecting on time management. Activity log data about application and document usage is automatically collected. Activity log data captures time management only partially, such that additional contextual information is definitely needed for reflection; however, the data are relevant (cp. Pammer & Bratic, 2013). In particular, one representation within the research prototype (ibid) focuses on representing worktime fragmentation, which is a source of inefficiency and stress. The representation thereby takes the role to trigger reflection on a particular aspect of the reflection object by design. Secondly, the representation within the used research prototype focuses on automatically captured data. Interpretative flexibility and elasticity were implemented via free-text labels, and free text notes in the form of a running diary. In a follow-up study, the authors have also investigated user-directed data analytics to provide additional flexibility (cp. Luzhnica et al., 2016). Communicative context is created both within KnowSelf, in labels and notes, and outside KnowSelf in discussions with peers.

Discussion and Conclusion

Above we have discussed four themes for consideration around the reflection object, based on activity theory, and the observation that many tools for reflection contain representations of the reflection object. In this section, we instantiate the above four themes as concrete questions that could be asked at design. Secondly, we discuss on a meta-level how the concept of reflection object has the potential to help in particular to design for transformation.

Questions for Design Time

Overall, the concept of reflection object has been developed based on literature, and our own understanding of designing for reflection in past, previously published research (references removed to preserve anonymity). In this way, while cited background literature has informed our own designs and empirical studies, these studies now in turn informed the present theoretical discussion.

Below we synthesize our above theoretical questions in the four thematic areas as concrete questions, which are intended to structure thoughts and discussions at design time, and to make related design decisions explicit.

In own past research on designing for reflection, having had the concept of reflection object available from the beginning would have helped us to think clearly about the reflection in all the four thematic areas outlined above in design. We don't think that the design of those tools that we ultimately successfully evaluated in field trials would necessarily have changed so much. However, we could have been more efficient; especially we might have come up good designs in less time, could have used the valuable time of users in a more focussed manner by systematically exploring relevant angles for design. Below we describe in as much details as preservation of anonymity allows us below a few examples of early dead-ends; as well as already existing cases in own discussions where we could gainfully employ the concept.

Note that below we also re-structure the four themes to a sequence that is more suitable for design.

What is the Reflection Object?

It may not be easy to specify the object exactly; and it may also be that as design progresses, the understanding of what is the reflection object changes. However, this question scopes and focuses design. Supportive questions at design time to do this are:

- What do target users want to reflect on?
- What do target users want to change?
- Why are users motivated to reflect on the object? This is to check that the reflection object really is something that motivates the activity of reflection.
- What is valuable about the reflection object? Some aspects of the reflection object may be more valuable in linked activities than others.

One of this paper's authors has been able to constructively comment on a design study published at alt.chi in which ultimately no tool for data collection and reflection had been designed (the comment has been published alongside the alt.chi paper, and is removed to preserve anonymity) in the case of tracking menopause symptoms. Using the concept of reflection object, it could be argued that in this case it is unclear what

would have been the reflection object represented by the collected data, i.e. something meaningful, motivating, and something that could be changed by women in menopause.

The other author has worked on reflection tools to help professionals to understand their interactions with others. Conceptualizing what is such an interaction and what are valuable aspects to reflect upon these interactions took a long time finally resulted in the design of reflection specific prompts to motivate users for reflection, and to frame reflection. Using the concept of the reflection object and the questions above could have led to this path earlier; and might have helped users to create a frame for their reflection.

How should the Reflection Object be Represented?

The reflection object needs to be partially represented in a tool for reflection. This is a major part of tool design. Supporting questions for this decision are:

- Which data and digital artefacts can represent relevant aspects of the reflection object?
- Which aspects of the reflection object are meaningful, interesting, relevant, and not easily obvious to users without the tool?
- Should the change in the reflection object, or the change in the representation of the reflection object, be emphasized in the reflection tool?

In most own designs we did to some degree point out changes in the reflection object, but didn't strongly follow-up on this as design focus (concrete examples and references to own work omitted here to preserve anonymity); nor do we see this in related work. Rather, the change in the reflection object is typically treated as that which is measured for research purposes. This is a very promising direction for further research. As one example, in the case of the abovementioned reflection on interactions with others, we realized very late that self-reported descriptions of interactions may work for individuals as prompt for own memory, but need more elaboaration, achieved for instance via guidance through prompts, to contain enough details for others to understand the overall reflection activity, especially intended and achieved changes of the reflection object.

What Contextual Information about the Reflection Object is Relevant?

The goal of this question is to identify what contextual information about the reflection object is necessary, what is optional but useful, what of this is available, and what needs to be created specifically for the purpose of reflection. Supportive questions at design time to do this are:

- To which activities is the reflection object linked? Which data and informative artefacts are created within these activities? This is to identify available data and information.
- What data formats represent contextual information? Text, photos, videos, or audio files would be standard formats, but one doesn't always need to design for all of them. In parallel, contextual information may be available in other formats as well.

In workplace settings, clearly productive IT systems contain vital information about reflection objects of professionals, such as about clients or patients of reflective practitioners. In one particular case, an organisation's standard presentations and centrally collected information about clients was useful additional information for professionals to reflect on their own consulting practice.

How does the Object Develop in Time?

Supportive questions at design time for considering the representation of the object's development in time are:

- What should change? Overall, the answer needs to be: The reflection object. However, it makes sense to be as clear as possible in identifying whether one can be more specific, and whether any qualities of the desired change can be made explicit.
- Which parts of the change are external and observable, and could help make the reflection activity and outcomes noticeable?
- How is transformation done - is there a particular procedure? There are guidelines and tools for reflection that are more specific and actionable, and often also more domain-specific, than the foundational literature discussed in this paper, such as Kerth's guideline to project retrospectives (Kerth, 2001).

> Overall, designers should think about and actively support the way from reflecting about the object to transforming it with the intention to derive outcomes for future behaviour.

One of the striking findings in our own work was that despite self-reports of users of reflection tools, who stated that they had taken away some learnings from using the tools, little of this learning was documented explicitly in the tools. In contrast, in the case of reflecting on interactions, learning outcomes could only be taken from the development of the collaborative reflection on interactions. This shows how focusing on how the reflection object changes may be more beneficial than focusing on explicit outcomes as implied by many existing theories on reflection.

We also consider this theme to be a promising direction of future research; in particular the point of how to achieve transformation. There is by no means a sufficient body of literature on how to effectively and efficiently scaffold and prompt for reflection, with selected examples being Fessl et al. (2017) who successfully showcase modular reflection guidance in field trials; or Renner et al. (2016) and Ifenthaler (2012) who are able to show that more directed prompts are more successful. Combining the latter statement with an argument by Kirschner et al. (2006), that minimal guidance only works for domain experts, we argue that future research on reflection technology should consider scaffolding reflection much more concretely than many existing designs do, using significant knowledge both of the learning domain and the reflection process in the design of reflection prompts. This goes especially for the fields of quantified self and learning analytics, which seem to mostly do without guidance for reflecting on data.

Designing for Transformation

Finally, we go back to the acknowledgement true transformation is difficult to design for (cp. Baumer, 2015); and discuss how our conceptualisation of the reflection object could help to design more explicitly for transformation. Initially, we have identified a dual gap in existing design-theoretical works: As gap we have identified the lack of a concept like the reflection object, that captures that which is reflected on, as well as that which is changed through reflection. Such a concept has been missing in literature despite actual tools for reflection representing reflection objects, and the change of

relevant aspects of the reflection objects over time.

This coherent conceptualisation allowed us to discuss that one potential role of tools for reflection is to make visible such a transformation, and to explicitly scaffold reflection in order to increase the chances of transformation,.

Key Aspects of Our Contribution

With the present paper, we have given something that designers of reflection tools obviously think about during design, and that foundational and design-oriented thinkers about reflection obviously also think about in their theories, a name – the reflection object. Summarising, key aspects of our contribution are:

- *Theoretical grounding*: The themes have been developed on the basis of reflection theory and activity theory.
- *Methodological contribution*: The present work showcases how a mature theoretical framework within HCI (activity theory) in combination with domain-specific theoretical framework (reflection) can serve to instantiate design considerations for the domain (designing for reflection).
- *Theoretical contribution*: The present work contributes to the field of design-theoretical works on designing for reflection. Our work doesn't challenge existing design-theoretical. However, we extend current theory by the concept of reflection object that we argue to be i) relevant to designers but ii) is not present in design-theoretical works.
- *Practical contribution*: We have instantiated the four themes as four groups of questions to be asked, discussed and answered or decided upon at design time. For designers who don't wish to go into theoretical depths, the core message of this paper is: When designing for reflection, please think about what is the overarching issue (reflection object) that people will reflect on, beyond a specific type of data or artefact - and use the guiding questions from above.

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References

Baumer. E. (2015). “Reflective Informatics: Conceptual Dimensions for Designing Technologies of Reflection”, in *Proc. of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI ’15), pp. 585–594.

Baumer, E., Khovanskaya, V., Matthews, M., Reynolds, L., Sosik, V.S., and Gay, G. (2014). “Reviewing Reflection: On the Use of Reflection in Interactive System Design”, in *Proc. of the 2014 Conference on Designing Interactive Systems (DIS ’14)*, pp. 93–102.

Boud, D., Keogh, R., and Walker, D. (1985), “Promoting Reflection in Learning: a Model”, in *Reflection: Turning Experience into Learning*, Routledge Falmer, New York, pp. 18–40.

Crowston, K., and Kammerer, E. E. (1998), ‘”Coordination and collective mind in software requirements development”, in *IBM Systems Journal*, Vol. 37/2, pp. 227–245.

Daudelin. M.W. (1996), “Learning from experience through reflection”, in *Organizational Dynamics*, Vol 24/3, pp. 36–48.

Dourish, P. (2004), “What We Talk About when We Talk About Context”, in *Personal Ubiquitous Computing*, Vol.8/1, pp. 19–30.

Fessl, A., Wesiak, G., Rivera-Pelayo, V., Feyertag, S. and Pammer, V (2017), “In-app Reflection Guidance: Lessons Learned across Four Field Trials at the Workplace”, in *IEEE Transactions on Learning Technologies*, Vol 10/4, pp 488-501.

Fleck, R. and Fitzpatrick, G. (2010), “Reflecting on Reflection: Framing a Design Landscape”, in *Proc. of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction (OZCHI ’10)*, pp. 216–223.

Herrmann, T. and Kienle, A. (2008), “Context-oriented communication and the design of computer-supported discursive learning”, in *International Journal of Computer-Supported Collaborative Learning*, Vol 3/3.

Ifenthaler, D. (2012), “Determining the effectiveness of prompts for self-regulated learning in problem-solving scenarios”, in *Educational Technology & Society*, Vol 15/1, pp. 38–52.

Isaacs, E., Konrad, A., Walendowski, A., Lennig, T., Hollis, V., and Whittaker, S. (2013), "Echoes from the Past: How Technology Mediated Reflection ImprovesWell-being", in *Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI '13)*, pp. 1071–1080.

Kaptelinin, V. and Nardi, B.A (2009), "Acting with Technology. Activity Theory and Interaction Design", MIT Press.

Karansios, S. (2018), "Toward a unified view of technology and activity", in Information Technology & People, Vol 31/1.

Kay, J. and Kummerfield, B. (2011), "Lifelong learner modeling", in *Adaptive Technologies for Training and Education*, Cambridge University Pres.

Krogstie, B., Prilla, M., and Pammer, V. (2013), "Understanding and Supporting Reflective Learning Processes in the Workplace: The CSRL Model", in *Proc. of the 8th European Conference on Technology Enhanced Learning, (EC-TEL 2013)*, pp. 151–164.

Kuutti, K (1996), "Activity Theory as Potential Framework for Human-Computer Interaction Research. Context and Consciousness - Activity Theory and Human-Computer Interaction", The MIT Press, Chapter 2.

Li, I., Dey, A., and Forlizzi, J. (2010), "A Stage-based Model of Personal Informatics Systems", in *Proc.of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10),* pp. 557–566.

Li, I., Dey, A., and Forlizzi, J. (2011), "Understanding My Data, Myself: Supporting Self-reflection with Ubicomp Technologies", in *Proc. of the 13th International Conference on Ubiquitous Computing (UbiComp '11)*, pp. 405–414.

Luzhnica, G., Fessl, A., Veas, E., Mutlu, B., and Pammer, V. (2016), "Designing Generic Visualisations for Activity Log Data", in *Proc. of the 6th Workshop on Awareness and Reflection in Technology Enhanced Learning*, CEUR WS Proceedings, Vol. 1736, pp. 11-25.

Malacria, S., Scarr, J., Cockburn, A., Gutwin, C., and Gossmann, T. (2013), "Skillometers: Reflective Widgets That Motivate and Help Users to Improve Performance", in *Proc. of the 26th Annual ACM Symposium on User Interface Software and Technology (UIST '13)*, pp. 321–330.

Mamykina, L., Heitkemper, E. M., Smaldone, A. M., Kukafka, R., Cole-Lewis, H., and Davidson, P.G. (2016), "Structured scaffolding for reflection and problem solving in diabetes self-management: qualitative study of mobile diabetes

detective", in *Journal of the American Medical Informatics Association*, Vol 23/1, pp. 129–136.

Müller, L., Divitini, M., Mora, S., Rivera-Pelayo, V., and Stork, W. (2015), "Context Becomes Content: Sensor Data for Computer-Supported Reflective Learning", in *IEEE Transactions on Learning Technologies*, Vol 8/1, pp. 111–123.

Pammer, V. and Bratic, M. (2013), "Surprise, surprise: activity log based time analytics for time management", in *Proc. of ACM SIGCHI Conference on Human Factors in Computing Systems, Extended Abstracts*, pp. 211–216.

Pammer, V., Krogstie, B., and Prilla, M. (2017), "Let's Talk about Reflection at Work", in *International Journal of Technology Enhanced Learning (IJTEL)*, Vol 9/2-3.

Prilla, M (2015), "Supporting Collaborative Reflection at Work: A Socio-Technical Analysis", in *AIS Transactions on Human-Computer Interaction*, Vol 7/1, pp. 1–17.

Prilla, M., Pammer, V., and Balzert. S. (2012), "The Push and Pull of Reflection in Workplace Learning: Designing to Support Transitions Between Individual, Collaborative and Organisational Learning", Proc. of the 7th European Conference of Technology Enhanced Learning (EC-TEL 2012), pp. 278–291.

Renner, B., Prilla, M., Cress, U., and Kimmerle, J., (2016), "Effects of Prompting in Reflective Learning Tools: Findings from Experimental Field, Lab, and Online Studies", in *Frontiers of Psychology*, Vol 7.

Schön, D. A. (1983) - Reprint 2006. "The Reflective Practitioner - How Professionals think in Action" (1 ed.), Ashgate.

Slovák, P., Frauenberger, C. and Fitzpatrick, G. (2017), "Reflective Practicum: A Framework of Sensitising Concepts to Design for Transformative Reflection", in *Proc. of the 2017 CHI Conference on Human Factors in Computing Systems (CHI '17)*. pp. 2696–2707.

Star, S. L. (1989), "The Structure of Ill-structured Solutions: Boundary Objects and Heterogeneous Distributed Problem Solving", in *Distributed Artificial Intelligence*, Vol. 2, pp. 37–54.

Star, S. L. (2010), This is Not a Boundary Object: Reflections on the Origin of a Concept", in *Science, Technology, & Human Values*, Vol 35/5, pp. 601–617.

Upton, K. and Kay, J. (2009), "Narcissus: Group and Individual Models to Support Small Group Work", in *Proc. of the 17th International Conference on User*

Modeling, Adaptation, and Personalization: Formerly UM and AH (UMAP '09), pp. 54–65.

Weick, K.E., Sutcliffe, K.H., and Obstfeld, D. (2005), "Organizing and the process of sensemaking", in *Organization science*, Vol 16/4, pp. 409–421.