MOBILE AND COLLABORATIVE TIMELINES FOR REFLECTION

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ABSTRACT

In this paper we present the design and evaluation of TimeLine, a mobile application to support reflective learning through timelines. The application, running on Android devices, allows users to capture traces of working and learning experiences in a timeline with the aim to provide data that can be used to promote reflection and learning after the experience. The paper presents the design of the application, its evaluation, and identifies challenges connected to the development and deployment of timelines for reflection.

1. INTRODUCTION

Timelines are widely used metaphors for organizing presentation and navigation of information. For example, Facebook has recently introduced a timeline feature for showing the story of the user (http://www.facebook.com/about/timeline). Timelines have two important characteristics. First, the metaphor is widely used and easily understandable. Second, most digital information has a timestamp that makes easy to organize and visualize a variety of information from different sources, e.g. text, photos, data from environmental sensors or from other applications. Recent commercial and research projects have developed different user interaction modalities to create and manipulate timelines, exploiting mobile and tangible technologies. For example the Path app (path.com) available on iOS and Android devices, allows for collecting different aspects of life experiences (including moods and feelings) by providing a user-initiated input mechanisms and enabling sharing contents on social networks. A different interaction approach is built into the Evertale app (evertale.com) which automatically collects pieces of context of daily experiences (from locations to songs listened while doing an activity) on behalf of the user while running in background on an Android smartphone. The goal is to enable the user to reminisce a past experience using pieces of context that characterized it. Aiming at enhancing genealogy research practices and personal production of rich family histories for future generations, the ChronoTape (Bennett et al. 2012) is a wood box interface designed to enable a tangible representation and control of time by annotating, manipulating and reviewing paper timelines mounted on reels. Other examples of use of timelines include clustering and exploring search results (Alonso et al. 2009), summarizing and abstracting information about events in order to identify patterns (Wongsubhasawat 2011), and supporting collaborative planning work among stakeholders (Bohøy et al. 2010).

In this paper we focus on the usage of timelines for organizing information for purposes of reflection. Considering the process of reflective learning as outlined by Boud et al (1985), reflection can be seen as a re-evaluation of experience, involving a return to previous experience as well as the production of reflection outcomes, and with explicit attention to emotions as well as ideas and behaviour Timelines have a potential to support the reflective process by providing a structure for the *re-construction* of experience (e.g. helping learners chronologically order a set of events), and by providing a structure to enable *comparison and evaluation* of experiences. For example, in project teams, individually and collaboratively constructed timelines of project events have been shown to support reflective learning about project work (Derby 2006, Krogstie and Divitini 2009, Krogstie 2009).

Reflection might rely on human memory to reconstruct events, but this is a rather subjective and faulty approach which at times can cause problems. For example, in software development teams, one challenge found to be among the reasons why many organizations choose *not* to conduct retrospective reflection is the lack of adequate data to help participants reconstruct the process (Kavi et al. 2008). There has therefore been a large interest in technologies that support collection and organization of data for supporting reflection, e.g. using tag clouds in (Glahn et al. 2009) or the geo-location of information in (Mora et al. to appear).

In this paper we present a mobile application intended to support individual and collaborative reflective learning with timelines. First, it supports users in collecting traces of their experiences in the form of information that might be useful for reflection on action (Schön 1983), i.e. activities conducted at the end of an experience to rethink the working or learning process with the goal of learning from it. Following Boud et al (1985), the application supports capturing of different types of information, ideas, behaviour, and emotions. Second, using the notion of timelines, the application provides a way to organize and visualize the information. The visualization on a timeline provides a temporal contextualization, and any piece of information is presented together with other relevant information that users might have decided to collect, shedding light on different aspects of an event. Third, the application provides the possibility to build shared timelines, capturing in a coherent representation different perspectives of an event and supporting people in comparing their input with the ones of other group members.

The application has been developed through an iterative process including an expert evaluation and small focus groups. In the paper we present only the latest version of the prototype and its final evaluation. The paper is organized as follows: In Section 2 we provide an overview of the system and in Section 3 describe its implementation. In Section 4 we present some scenarios of usage and in Section 5 the evaluation of the system in one of these scenarios. In Section 6 we draw some implications for design and deployment.

2. THE TIMELINE APPLICATION

The TimeLine application runs on Android devices and has been developed following the Android user interfaces guidelines (see http://developer.android.com/guide/practices/ui_guidelines/index.html). The main menu is available through the dashboard (Figure 1-a), providing access to functionalities for managing timelines, groups, and tags, and for navigating sharing and synchronizing timelines. With the application, a user can capture traces of an experience by annotating a timeline.

2.1 Constructing Timelines

TimeLine provides an empty timeline as starting point to which users can attach different types of annotations (Figure 1-b).
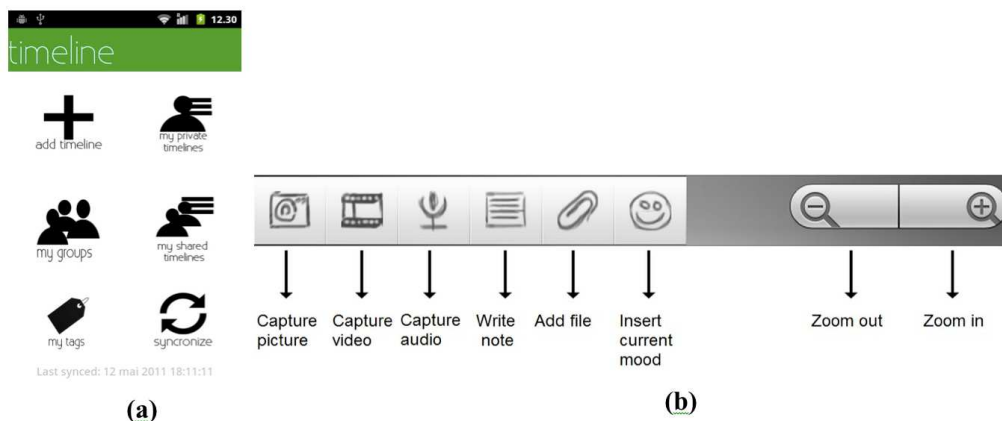

(a) (b)

Figure 1. The timeline dashboard (a) and main annotation types (b)

Users can capture audio or video by using the mobile device, they can write notes, or add files and information available in other applications, e.g. in Gmail, Dropbox, or Facebook. Since one important, often neglected, aspect of an experience is connected to feelings, the application explicitly provides the possibility to add emoticons to the timeline, capturing in a very simple way how one feels at a certain moment. For more details on different design choices, see (Kristiansen and Storlien 2011).

2.2 Collaborating Around Timelines

TimeLine allows cooperation around a shared timeline collecting information about a working experience. Users can create groups and share timelines within groups. By default, information added to a shared timeline is private, but the user can decide at any moment to share it (Figure 2-b). In this way, a timeline can be used at the same time for capturing private and shared information. On a shared timeline, cooperation is supported by: (1) *Commenting of content*, for example adding a comment to a picture or adding a picture to an event recorded by another user (Figure 2-a); (2) *Assessing content*, by adding an emoticon to an event; (3) *Sending reports*, the system can generate and send via email a list with all the items collected in the timeline to provide information also to people without the application; (4) *Calculating mood average*, each user can annotate the timeline with mood represented by one of four emoticons. Emoticons are used to calculate the average mood of the group. This is not intended to capture with precision the mood of the team, but rather to provide an indication of the current mood and its changes.
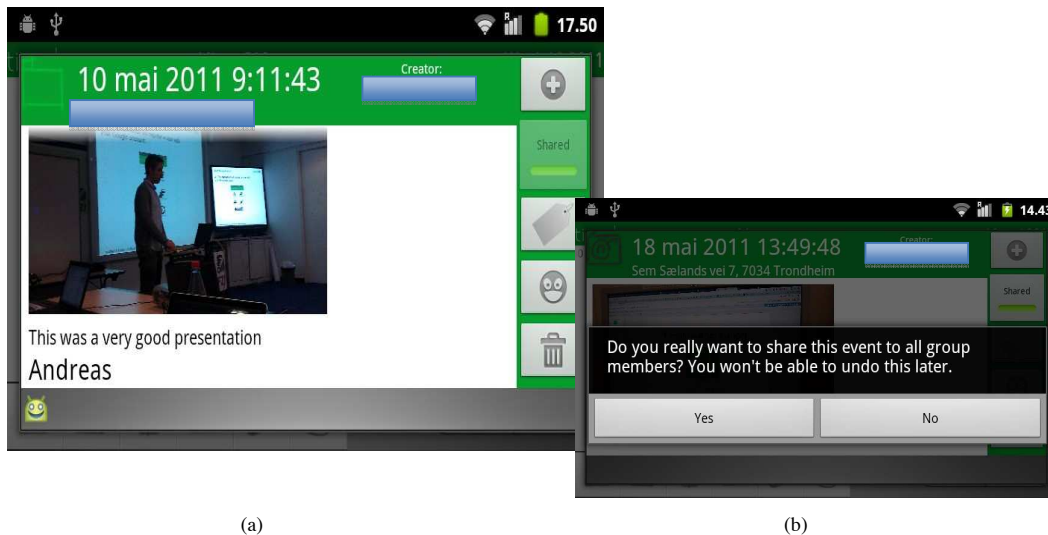

| (a) | (b) |

Figure 2. Sharing information in a group timeline

The application also supports the visualization of the information in a map where elements are presented based on the geographical position at creation.

2.3 Integration with Other Applications

TimeLine can connect with third-party devices and services. At the current stage, we have experimented with multiple visualizations of average moods using three types of technologies: tangible, ambient and social (Figure 3). This integration is mainly intended to demonstrate the possibility to trigger collaborative reflection by provoking discussion through extended visibility. The tangible interface (Figure 3-a), named Nabazmood, runs on a hardware mash-up of two devices: a Nabaztag rabbit (http://www.karotz.com) and a pico-projector. The average mood is visualized through the movement of the ears and colour of the rabbit. This visualization is intended to be provocative and the users can monitor the evolution of the average mood with low cognitive effort. The ambient interface (Figure 3-b) is a projection on the wall of a 2D mood-map based on Russel's Circumplex Model of Affect (Russel 1980), indicating the position of the timeline average

mood by a moving pinpoint displayed on the map. The social visualization builds on social networks by regularly posting the average mood on Twitter (Figure **3**-c). This integration can provoke reflection also within larger communities and users that are not co-located. These interfaces and challenges connected to capturing mood are described in (Mora et al. 2011).
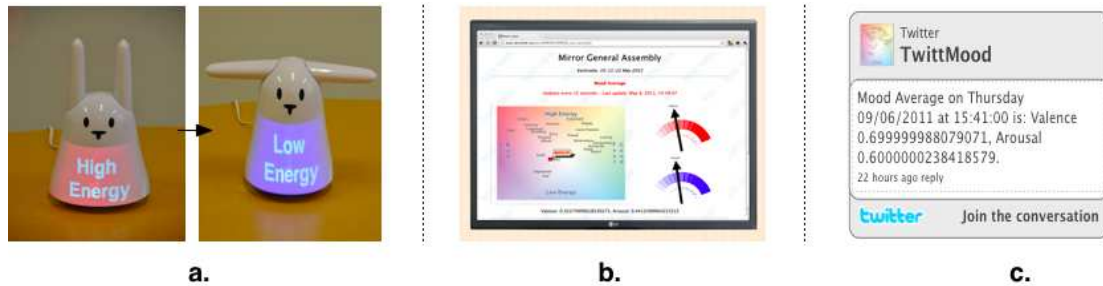

Figure 3. Tangible, ambient and social visualization of the TimeLine (only average mood)

2.4 Implementation

TimeLine is implemented following a client-server paradigm: a mobile application running on android devices acts as a client (TimelineApp) and a cloud service works as a server (TimelineCloud), Figure 4. TimelineApp provides user interaction interfaces, data storage for private timelines as well as functionalities for adding contents to a timeline. It is developed adopting a model-view-adapter (MVA) architecture, frequently used to implementing Android applications because of its flexibility.

TimelineCloud, the server-side, implements collaboration features like synchronizing of shared timelines among clients and the integration with the third-party interfaces described in Section 2.3. Architecture tiers communicate via a RESTful interface using JSON as markup language for data object exchange. The service is exploiting the Google App Engine framework, which also provides web hosting and permanent data storage for the service. In the current prototype, synchronization of contents is manual, i.e. users have to push a button to initiate synchronization between the server and the client. To overcome some of the disadvantages of this solution we did however implement automatic push of timeline contents on-creation, meaning that events, items and moods are immediately pushed to the server. In this way the server always has the updated content, while clients sync on user request to keep updated. The synchronization mechanism also uploads any content generated using the app offline (e.g. using a smartphone in flight mode or without Internet access). TimelineCloud also acts as email gateway for sending timeline reports, an email message listing all the items stored in a timeline (either private or shared).
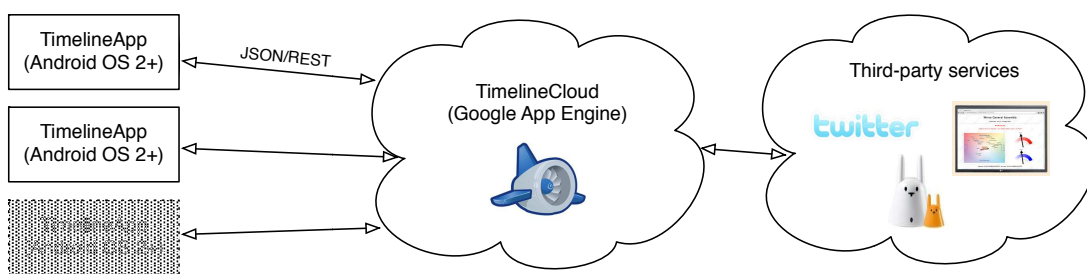

Figure 4. Client/server architecture

3. SCENARIOS OF USE

The application is flexible and can be used in different scenarios. Here we briefly sketch the possible use of TimeLine in three different scenarios.

Meetings. Participants of a meeting can be asked to annotate a shared timeline by indicating their mood or writing down notes about their feelings or ideas. TimeLine is not intended to be a journal, for example to write meeting minutes. Rather, it should be used to write issues that are not necessarily related to the specific topics in the agenda, but more general about the interaction in the team. For example, it might be useful to note that a certain presentation could be improved or that a certain discussion has got too long or distressing. This information would normally not go into the minutes, but can be useful for the team to reflect for example on their communication and cooperation patterns or on the effectiveness of their meetings, with the aim to improve in future instances.

Field trips. A school class can use a shared timeline during a field trip to capture notes of different types and look at them later on to revisit their learning experience. This might help to identify, for example, events that have been particularly interesting, strategies that they have adopted to cooperate during the field trip, and ideas that are worth exploring further. The teacher can look back at the timeline to identify e.g. possible improvement to the scaffolding that is provided to students or moments that students have particularly enjoyed or disliked, and use this information to inform the planning of the next trip.

Development projects. Development projects, for example creating software, are normally involving teams of people with different roles and knowledge. In this case, a shared timeline might be used to record events that members feel are significant, personal impressions of the development, and ideas about how the process could be improved. After the project, TimeLine can be used to revisit the experience, as a stand-alone tool or as an additional source of data, in the context of structured project de-briefing/retrospective (Derby et al. 2006). Individuals might benefit from comparing the traces that they collected with the ones of colleagues to identify different perspectives on the project. Individual timelines might also help individuals re-think e.g., their contribution to the project and their reactions to problems.

4. EVALUATION

The application was evaluated in relation to the meeting scenario, during a three-day meeting of a large European project.

The meeting was attended by 40 persons and included long sessions with discussions and presentations, sessions in smaller groups and a guided tour of the science center in which the meeting took place. All participants were offered the possibility to use the applications on their mobile phones. Additionally, we made available 5 devices (4 mobile phones and one tablet). Before the meeting all the participants were sent an email message with information about the application, a short user guide, and instruction to download the application from the Android Market. All the participants were assigned to a group and a shared timeline was created.

At the meeting a short introduction to the system was provided, and the developers were available for technical help during the meeting. Participants could use TimeLine on the mobile phone to insert any type of supported data, but also to specify their mood using emoticons as well as using a third-party web application. The average mood was also visualized with the services described in Section 2.3. TimeLine was installed on 22 devices, including 10 different types of device from different brands and 4 different version of the operating system (Android 2.1; 2.2; 2.3; 2.3.3). The data collected during the evaluation includes observations and short interviews with the participants, the content of the timeline, and the log of the system.

Usability. Overall, the users were satisfied with the usability of the application, though some directions for improvement have been identified. It should be pointed out that the user experience considerably varied depending on the characteristics of the device. For example, users reported that the application was hard to use on devices with screens smaller than 3.7 inches, which we had used during the development. This is a general challenge to the development of mobile applications, which have to be adopted in a highly dynamic market. Users also lacked the possibility to visualize events in a timeline based on their status, for instance in order to identify more easily events to which new content has been added. Also, some users expressed that it should be easier to see which events belong to which user in a shared timeline.

Mobility. Users in this setting were not highly mobile. It was therefore not clear whether the usage of a mobile device for capturing and visualizing information was perceived as useful. However, users felt it was important to have the possibility to collect data with the application. Few desktop applications support pictures, videos and audio recording as seamlessly as mobile applications thanks to hardware components

available in most mobile phones. This is a strong advantage of using a mobile device for collecting data even when access to a desktop is available. When it comes to visualization, however, in cases like this when there is a shared space, ambient visualizations might be useful because they increase visibility of the timeline and provide a shared visualization of the information, increasing group awareness. Mobile devices might be appropriate for individual navigation after the event.

Usage. Users reported that they felt involved in the process of building the timeline, and that it was fun to see the events that other users shared each other, staying aware of what other users were doing or thinking about. Users added new events to the timeline, but also used the possibility to comment input from others, for example adding a comment to a picture or a smiley to an event. Emoticons were heavily used, with more than 1000 smileys (also including the ones sent in with the third-party web application). There may be different reasons for this. First, an emoticon is the easiest element to add to the timeline, since it is enough to select from 4 alternatives, emoticons are also commonly used in other computer applications (e.g. for instant messaging). Second, the mood was visualized in the room in different ways. This occasionally triggered a playful attitude, with people trying to change the general representation of the mood and in addition, and also put more focus on this type of data. Finally, the heavy use of emoticons might also reflect the perceived relevance of this type of information. However, given the data we have, we cannot make any final statement about this and further investigation is required. During the meeting, notes and pictures were also added to the timeline, but not video and audio.

If we look at the textual notes, we can see that they were used in different ways. In some cases they were used to report bugs in the application, for status updates (e.g. "I am now attending the technical meeting"); for quick exchange of messages; for noting down things that one find relevant. Though it is difficult to assess what might be useful for reflection and what not, it is clear that some notes were clearly intended to record information that might be useful to rethink the process and improve it, e.g.

"Sounds like it is a lot of criticism"

"I think I used too much time for my slides, however, it was interesting"

Investigating the usage of the application, we built a graph of the average mood for each day of the meeting. (Figure **5** provides the graph for the first day.) The graph shows a number of peaks. In order to understand the graph, we overlaid events from the TimeLine application on the particular day, at interesting areas of the graph, e.g. decrease or increase in mood.

Figure 5. Mood change during the first day of meeting (highest line: valence; lowest arousal)

A first peak (positive feeling, but low energy) is around 13:30, when many started to feel the need for a break. After the lunch, a rise in the valence and arousal can be observed. In the same period we can also see a peak in number of events during an hour. Between 14:00 and 15:00, 8 events, with a total of 15 items were collected. This was the highest number of events and items in one hour during our evaluation. This can be

explained by a guided tour to a nearby research facility. Another interesting decrease in valence and arousal can be seen starting at note N2, at approximately15:45. This note was added during the startup of a new session that eventually ended up in an important discussion of one of the main themes in the project. There are 4 events created during this session. Interestingly all the events are commenting the mood, not the discussion, or any specific events leading to the decreasing mood. The only event linking the mood to the discussion is event F4. But it only states that there is a connection between the mood and the current discussion, not explaining it. What we observed being there during this discussion was that the persons involved in the discussion were too engaged in the discussion, and did not have the time to create events or adding their mood using the tool. The persons contributing to the timeline and adding mood were the ones that didn't play an active role during the discussion, and that might have felt a little bored as the session lasted over 2 hours without a break, and wanted to point this out by adding their mood and emphasizing the bad mood using the timeline.

5. IMPLICATIONS FOR DESIGN AND DEPLOYMENT

The evaluation confirmed that a timeline can help to capture information about a shared experience from different perspectives and it is easy to understand. Navigation within a timeline is also straightforward.

Multiple metaphors. A timeline is a simple and widely used metaphor for visualization. A shared timeline can be used to provide a team representation of a shared experience. Alternative metaphors should be considered and possibly integrated for getting different perspectives on the reflection data. For example, for work experiences characterized by a high degree of mobility it might be interesting to look at place as an alternative or complementary metaphor. The design challenge is to identify and support a suitable set of metaphors for visualization of reflection data, providing an easy switch from one to the other so that a user can re-visit a work experience looking from different standpoints. Multiple metaphors might also be useful to make sense of information and consider different types of information. For example, if we look at the average mood during the evaluation (Figure **5**), it is difficult to make sense of it using only the information that is in the timeline. If we take into account that emotion is not only about valence and arousal but also has relational and situational aspects (Barrett et al. 2007), additional information about the situation is useful. By relating the timeline for instance to a process model, in this case simple information about steps in the meeting, it becomes easier to make sense of the information.

Capturing and comparing multiple perspectives on a shared experience. Being able to get multiple perspectives on a shared experience is critical, however our evaluation pointed out that capturing relevant perspectives might be challenging. As discussed in the previous section, during the meeting, at critical points, people with a critical role might not provide input because they are too busy. To address this challenge it is necessary to introduce adequate scaffolding mechanisms, but also provide easy modalities of input and, when relevant, connection with applications used for work that might automatically provide complementary data. In addition, during our evaluation users also pointed out the need for specific support to distinguish better and compare input from different users, especially one´s own vs. that of others. This challenge brings along issues connected to visualization, ownership, and privacy.

Tailoring to different contexts of usage. The timeline is a rather general metaphor for visualization that might be useful in a number of different situations, especially for reflecting on work practices that have a strong temporal element. However, a tailoring of the application might be needed. For example, the usage of photos to annotate the timeline could be problematic for nurses in a nursing home due to privacy constraints. Using the timeline metaphor but with a different interaction device might be more appropriate in some cases, e.g. electronic paper rather than a mobile device. In this way, the application would use a device with affordances more suitable to the specific scenario. The usage of ambient devices for visualizing information (e.g., the mood in Section 2.3) could prove to be an interesting approach for some working contexts. As we have experienced during the evaluation, the shared visualization might be used to provide a quick and non-intrusive overview of the mood in a group of users. Though the informational content is rather limited, the visualization can provide a feeling of connectedness and provoke awareness on different aspects of the collaborative effort. This approach might be particularly suitable in working environments where (1) workers share a physical place that can be enriched with ambient devices (keeping also the esthetical element in place); (2) there are a number of concerns to privacy that might limit the collection and visualization of

information and therefore where it might be more appropriate to provide limited information; and (3) workers have a regular cooperation that supports the emerging in time of a shared meaning for the device.

Scaffolding intended usage. TimeLine has been designed to be very flexible and it does not impose any requirement on the content that is put on the timeline as long as it can be conveyed through one the supported media. During the evaluation it was clear that this flexibility might be a source of problems because individual users might use the timeline in rather different ways. As users reported during the evaluation, they felt unsure about what type of information would be useful. This is also evident looking at the data that populated the timeline, as discussed in the previous section. Users also reported that it is easy to forget to provide input. The challenge is to identify adequate scaffolding mechanisms that can assure the collection of a coherent set of data, but allowing for multiple perspectives and flexibility of the tool for easy adoption.

Assuring reflective learning. TimeLine might be used to support reflection separately or as part of structured de-briefing and retrospective sessions. In the current version, the only support that is provided is in terms of navigation of the information along the timeline. It is up to the user to identify all relevant information. This assures a lightweight tool suitable to different modalities of reflection, counting on the personal knowledge of users about the experience to direct the navigation and selection of relevant elements in the timeline. The challenge is to identify support for assuring that the navigation of the timeline becomes a reflection session leading to learning, but without creating unnecessary constraints on users. In addition, at the deployment level, it might be necessary to define guidelines to integrate TimeLine in the context of structured reflection sessions.

6. CONCLUSION

In this paper we presented an application that allows capturing and sharing of information about an experience on a timeline. The information can be used to reflect on action and learn from experience. The application has been designed to be flexible and usable in different scenarios. The initial evaluation of the application confirmed the potential benefit of the timeline, but also points out challenges for future development and deployment.

As part of future work, we are planning to evaluate the timeline in different contexts of usage to verify its pedagogical value. We are also extending the design of the application to include scaffolding mechanisms to enhance the reflection session. Finally, we are planning to compare the usage of the timeline as a metaphor for visualizing information with respect to other metaphors, e.g. based on space or work processes.

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