Concept, Design and First Evaluation of a Mobile Learning Diary Application with Access to a Learning Record Store

Svenja Neitzel[1], Christoph Rensing[1], and Henrik Bellhäuser[2]

[1] Technische Universität Darmstadt, Multimedia Communications Lab, Darmstadt, Germany, firstname.lastname@kom.tu-darmstadt.de
[2] Johannes Gutenberg-Universität Mainz, Department of Psychology, Mainz, Germany, bellhaeuser@uni-mainz.de

Abstract. Especially in higher and further education, today's learning more and more allows and also requires individual learning strategies. On the one hand, this development is a step towards lifelong learning and a higher personal engagement. On the other hand, many learners struggle with organizing learning processes on their own. Learning diaries were proven to be supportive for self-regulated learning. In this paper, we show the concept and design of a mobile learning diary application, which extends standard functionality like planning, documenting and reflecting learning behavior. Through a distributed architecture with a central learning record store, the application has access to data of all users and all learning applications within the architecture. We also report first insights of collected data during a small field study and some feedback obtained through a questionnaire.

Keywords: learning diary, self-regulated learning, learning analytics, adaptive learning applications

1 Introduction

The rise of E-Learning and the requirement of lifelong and flexible education have paved the way for individually organized learning processes. Although there is a common goal, like a final course exam, learners are able to organize the process of reaching that goal on their own. They can find a plethora of services and materials on the web, which they can use in addition to provided course contents. They can also choose when, where and with whom they want to learn and how they want to cooperate with others. Studies proved that this self-regulated learning can improve the learning outcome as learners experience a higher personal engagement with the learning contents [1]. On the contrary, many learners can not maintain the motivation to work on the course contents regularly without a fixed schedule and regular feedback. Those learners either leave the course early or are not able to meet the course requirements. Learning how to learn self-regulated is nowadays a valuable - personal as well as professional - goal. Learning diaries were proven to be supportive for self-regulated learning through regular

planning, documentation and reflection of one's learning behavior [6]. However, the maintenance of a detailed learning diary can be effortful. In this paper, we propose a new concept for a mobile learning diary application, which is superior to traditional learning diaries in that it is part of a distributed architecture of different learning applications and a central learning record store. Our application is able to send adaptive reminders, list activities from other applications and to show statistics about other course participants. Those functionalities can facilitate the maintenance, motivate for reflection, show a more complete picture of one's learning behavior and enable comparison to learning behavior of others.

In Section 2, we motivate our work by introducing related work in the field of supporting self-regulated learning. Section 3 describes the concept and design of our learning diary application and the architecture which allows for sharing learning activity data. After that, in Section 4, we will discuss the results of an initial evaluation comprising an analysis of data collected during a small field study and feedback obtained through a questionnaire. Finally, we will draw some conclusions from our work and give some insights to our plans for the future.

2 Related Work

Pedagogical psychologists distinguish between three phases of self-regulated learning [7]: In the phase before learning, learners plan their activities, which are documented and evaluated in the phase during learning. Finally, in the phase after learning, learners reflect their progress and adapt goals and behavior if necessary. Learning diaries, whether on paper or electronic, are a common way to strengthen learners' awareness of their learning behavior in each of the phases. Especially in the planning and reflection phase, many electronic tools for supporting learners have been developed: [8] propose a tool for setting goals and reflecting own behavior which is integrated into a learning application. [4] introduce a plugin for a learning management system, allowing to plan the next learning iteration and to reflect own behavior by comparison of own behavior and behavior of peers.

The provision of means for reflection and comparison are also part of the main goals in the research area *Learning Analytics* [2]. In recent years, standardized concepts, like *Experience API* (xAPI) for the formulation of learning activity statements and *Learning Record Stores* (LRSs) for storing those [3], have established, which theoretically enable the collection and analysis of learning data across different learning applications. As a result, learning applications could make use of much more complete data to support learners with visualizations and interventions. However, most tools for supporting learners in self-regulated learning are using data from a single application. We use xAPI and a LRS to build an architecture, which allows learning applications to use the data of all users and all other applications within the architecture. Further, we designed a mobile learning diary application, which can offer innovative functionalities due to that architecture.

3 Concept & Design

The proposed mobile learning diary application includes basic learning diary functionality, which comprises planning learning activities, marking activities as done and visualizing planned and done learning activities for the reflection of own learning behavior. The application is innovative over traditional learning diaries in three additional functionalities:

1) Partially adaptive notifications for better maintenance of the learning diary. In order to reduce the daily effort for planning learning activities, the learning diary application reminds its users to plan learning activities for the upcoming week on Sunday afternoon before the respective week. Because we do not expect learners to know the exact time for every learning activity in the upcoming week, only the module the activity is belonging to, the type of the learning activity, the day of the week and the rough duration of the activity[3] has to be provided. On days of the upcoming week, for which learning activities are planned, learners are reminded in the morning to plan their activities of that day with a concrete time. In the evening they are further reminded of marking activities as done or modifying them if necessary. This step motivates regular reflection and further ensures the validity of the data in the learning diary. The app reminds users in form of notifications. Those notifications are adaptive in that they only occur if learning activities are planned and have not been marked as done for the current day. The notification in the evening also occurs when learning activities from other applications were recognized and no temporally matching learning activity was entered in the learning diary. The learner can then add potentially missing activities, which increases the completeness of the collected data.

2) Integration of learning activities from different learning applications. For the integration of learning activities from different learning applications, there is a need of an architecture, see Figure 1, connecting applications and allowing to share data between them. We make use of the standardized concepts xAPI and a central LRS. To connect learners using different identities in different learning applications, we also use a component for identity management [5], which delivers a unique pseudonym to all applications used by a learner, thereby guaranteeing security and privacy requirements. We currently integrated two learning applications, which are the mobile learning diary application and the learning management system Moodle. The learning activities are transmitted as xAPI statements to a central LRS, where they can then be read by other applications. The learning diary application shares statements about planned and performed learning activities, that are used to calculate course statistics. Moodle shares information about resource access, which are read by the learning diary application and integrated in the list of daily learning activities.

[3] In the current version of the app, we predefined one module and a set of learning activity types.

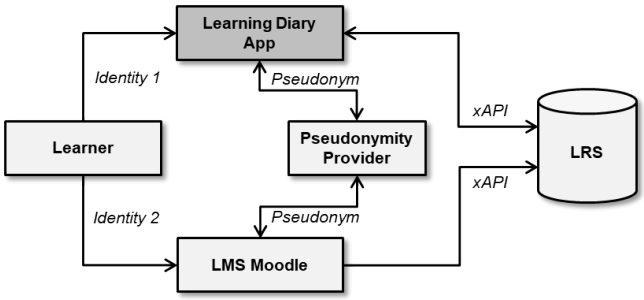

Fig. 1. The proposed architecture, including the learning diary application, Moodle, a central LRS and a component for identity management (*Pseudonymity Provider*).

3) Visualization of learning behavior of peers. As mentioned before, the learning diary application shares the manually entered learning activities with the LRS. In the statements, we distinguish between different states of a learning activity (roughly planned, planned with time, done). The information about done learning activities is used to calculate course statistics to allow for a comparison of own behavior with the behavior of others. Information about activities with other states can be used to analyze planning and app usage behavior, as we will show in the evaluation. In the future those information can also be used to support learners in reaching their current goal, for instance with automatic interventions.

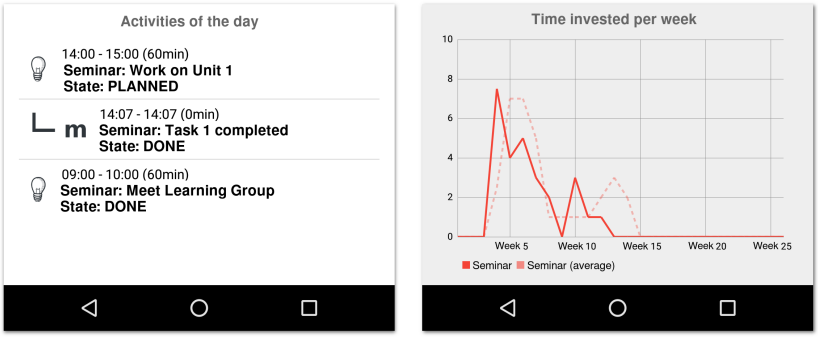

Fig. 2. User-Interface of the learning diary application. The left picture shows the list of learning activities entered into the learning diary application or recognized from Moodle. The right picture shows the visualization of own and peers' weekly invested time in the course.

4 Evaluation

We applied our approach during April 24th and June 17th, 2017 in a seminar offered by the department of psychology at a German university. The seminar, which was on self-regulated learning for prospective teachers, started with a four week phase of autonomously working on the course contents. Participants were asked to document their learning behavior using the app or a traditional learning diary. Due to the limitation that the app was only available on Android phones, and due to some technical problems in the beginning, most of the students decided to use the traditional approach. However, there were some students showing high interest in using the app despite of the technical issues. Unfortunately, only two users used our app over a longer time: Learner A used the app for 44 days and produced 169 statements describing 112 learning activities. Learner B used the app for 50 days, producing 120 statements for 84 learning activities. We analyzed their usage behavior of the app and present the results in the following. We will also give insights to feedback we obtained using a questionnaire.

Evaluation of partially adaptive notifications for better maintenance of the learning diary. Ideally, we would expect a number of three statements per learning activity (one per state: roughly planned, planned with time, done). However, for both learners we only observe roughly 1.5 statements per activity. For Learner A, 46% of activities have been both planned (either roughly or with time) and marked as done, 21% have been only planned, and 32% have been directly entered as done. For Learner B, only 28% of activities have been both planned and marked as done, while 11% have been only planned and 61% have been directly entered as done. We conclude that it is difficult for learners to adhere to the three phases of self-regulated learning even with reminders. We further suggested learners to plan their learning activities for the upcoming week on Sundays. Learner B seems to follow this suggestion, as 42% of planned activities were created on Sundays. Learner A planned the majority (29 %) of activities on Sundays, too. However, he or she also often created planned activities on Tuesdays (26%) and Fridays (24%). We further analyzed how long learners plan their activities in advance (*lead time*, i.e., the time the activity was first planned until the time the activity was planned for) as well as how long after a learning activity learners mark it as done (*follow-up time*, i.e., the time the activity was planned for until the time the activity was marked as done). Figure 3 visualizes the results for Learner A. We can observe a pattern in the lead time indicating a step by step planning of learning activities for upcoming days of the week. In contrast, the follow-up time remains relatively constant, meaning that performed learning activities are marked as such soon after execution. In the feedback questionnaire, learners state they wish to configure if and when reminders are shown. Some also wish a better design and more intuitiveness and also more adaptive functionality, like visually highlighting important and urgent activities. They also propose acquiring more data sources like exam dates or the phone's calendar.

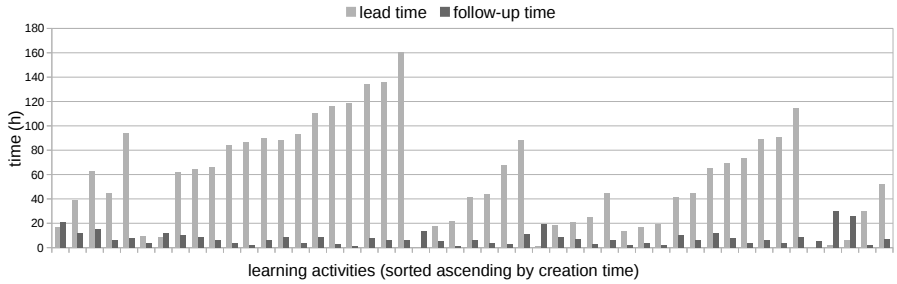

Fig. 3. Visualization of Learner A's lead and follow up time for learning activities.

Evaluation of integration of learning activities from different learning applications. For this part, we analyze learning activities, that were marked as done in the learning diary application together with activities from Moodle. Only one of the two learners (Learner B) used the identity management component for sharing a unique pseudonym between different learning applications. Learner B marked 75 learning activities as done in the learning diary application. Moodle activities were only present within the time of five of those learning activities. Within those five activities, 117 activity statements from Moodle are present in the LRS. In total the learner produced 296 activity statements in Moodle, meaning that 179 statements happened outside of activities that were marked as done in the learning diary. This observation can be interpreted in two ways: First, many learning activities happen without access to Moodle. Probably learners download course material beforehand but work on it outside of Moodle. This stresses the importance for including more applications to our architecture to capture more information on actually performed learning activities. Second, including Moodle activities in the learning diary leads to more complete information about learners' behavior, which stresses the importance of our proposed architecture. Even from the questionnaire, we obtained encouraging feedback for the integration of Moodle activities within the learning diary application.

Evaluation of visualizing peer's learning behavior. The visualization of peers' learning behavior was also rated positively in the feedback questionnaire. Unfortunately, we have not enough users to get further insights on this aspect using data analysis.

5 Conclusion

In this paper, we proposed a mobile learning diary application which is innovative over traditional learning diaries in that it is able to send adaptive reminders, list activities from other applications and show statistics about other course participants. The analysis of data collected during a small field study

revealed that, even with reminders, learners show another behavior for organizing their activities than proposed by the learning diary application. It also showed that collecting data from Moodle is useful to provide a more extensive overview about learning behavior. Further, we obtained encouraging feedback for the functionalities of showing Moodle activities and course statistics from the questionnaire.

We acknowledge the limitation of having too few users for making significant statements about the usefulness of our approach. We consider this initial evaluation as a proof of concept implementation and there will be follow-up evaluations with more participants in the near future. We further want to work on minimizing the effort for maintenance of the learning diary, for instance by recognizing learning activities autonomously using sensor data collected by the mobile phone. We also want to make the step from offering planning, reflection and awareness functionality towards changing learning behavior actively by sending interventions that correspond to the learners current learning goals and actual behavior.

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