

User-Centric Approach to the Design of a Mobile Learning Companion

Haeseon Yun¹, Johann Habakuk Israel¹, Albrecht Fortenbacher¹, Helena Rott², Delia Metzler¹

Hochschule für Technik und Wirtschaft Berlin¹
DAYONE GmbH²

Abstract

In the LISA project, a mobile device (SmartMonitor) to support learners will be developed. SmartMonitor serves as a learning companion, receiving a learner's sensor data, connecting to a learning analytics system and interacting with a learner without distracting from learning. This paper is about design considerations and first prototypical work for a SmartMonitor device.

1 Introduction

Learning Analytics for Sensor-Based Adaptive Learning (LISA) is the name of a research project funded by BMBF (German Ministry of Education and Research) which is consisted of 3 scientific partners (Hochschule für Technik und Wirtschaft Berlin, Humboldt-Universität zu Berlin, and Leibniz Institute für Wissensmedien) and 3 industrial partners (NEOCOSMO, Serious Games Solutions and SGM Educational Solutions). The aim of the project is to provide support to a learner by analyzing learning activities in various learning contexts together with detecting learning-relevant information unobtrusively using sensors and providing adaptive feedback to a learner [5]. The aim is to achieve this by means of a mobile device (SmartMonitor) which serves as a learning companion.

In this paper, we focus on the design of the SmartMonitor, which receives data from a sensor device, e.g. a wristband, processes data, and interacts with a learner by providing feedback. In this regard, we present a user interface for mobile learning companion, a user centric approach that includes a focus group, design study, workshop, and a heuristic evaluation and discussion of findings, implementations and outlook.

2 User Interface for a mobile learning companion

The SmartMonitor device serves as a hub and a bridge where sensor signals are received and sent to the LISA learning analytics engine for processing. The processed data then returns to the device to be projected to a learner. For the ideal communication between a learner and a SmartMonitor, a mobile learning companion concept has been adopted. A mobile learning companion emphasizes non-authoritative, communicative, co-learner-like and pedagogical

characteristics to support learners to manage and control their learning [1]. Unlike a regular learning companion which can be in various forms, a mobile learning companion concerns mobile, contextual and ubiquitous aspects where it emphasizes the contextual information of a learning activities and environment. To design a mobile learning companion, a general design consideration was discussed and the detection of learning activities and context using sensors were explored [9]. The findings show that a mobile learning companion needs to be designed as a co-learner with an instructional benefit including emotional support. Furthermore, a mobile learning companion should have a simple visual user interface that initiates communication with a learner by focusing on both the relationship with a learner and the learning task. Finally, the interaction experience that a learner feels with a learning companion should be enjoyable and should result in a positive learning experience.

To realize a concept of learning companion in a design of a SmartMonitor, the human computer interface design processes were adhered as stated in the next section.

3 HCI Concept for SmartMonitor and Focus Group

With the scientific research questions and requirements set by the project's outline in mind, a user-centered design process was initiated parallel to the technical investigations and research related to sensors (cf. [2], [3]). The aim was to examine the user requirements and develop design variants for a mobile learning companion. In the following, we describe the first two iterations of the design process and present an outlook to the next steps.

3.1 First Iteration

After the initial frame of the project was set, a focus group was conducted in order to access the acceptance threshold, requirements and demands of the intended target users regarding a mobile learning companion. The focus group with ten computer science undergraduate students was moderated by two people and lasted 1.5 hours. In the beginning, all participants were asked to reflect upon their personal learning habits and possible usages of other digital companions (e.g. smart watches or fitness trackers). Once the discussion was started, the topic on how the environment can distract students from learning was discussed. Prevention strategies from distraction, such as turning off mobile phones and internet or learning in the library, were mentioned by some participants. Additionally, others revealed that they need a space to walk around in order to memorize learning contents.

In the next phase, the stimulus question ("Imagine a djinn who could assist you during learning; what should this djinn be able to do?") was presented by the moderators to spark ideas on how learning could be supported by external means. Participants mentioned the need of motivational statements when the learner is to stop learning, rewards for learning, punishment for not learning, reminding learners of long-term aims, suggesting learning topics and strategies, monitoring the health conditions of learners and providing warnings if certain conditions fall below acceptable thresholds, logging and analyzing learning activities, and visualizing learning progress. Regarding possible distractions, many participants mentioned a

mute-all function, which should turn off all unnecessary electronic devices (smartphones, tablets etc.).

At the end of the focus group, the participants were asked to reflect upon the discussion and identify those functions and requirements, which seemed most important to them. The results were written onto presentation cards and clustered in a joint discussion process (Table 1).

Table 1. Requirements defined during the focus group

Category	Requirement
Learning diary	Logging function, learning milestones, dialogue partner about learning aims and strategies
Content-related hints	Suggestions/Recommendations (e. g. "Learners who learned this topic also learned that topic."), further examples related to the current topic
Time management	Creation of timetables and milestones, reminders for upcoming deadlines, support in time management
Analysis	Report learning achievements, time-based reports of learning activities and learning achievements, comparison between learners, stats about individual learning progresses
Learning methods	Constructive critique, suggesting new learning methods, providing aids to concentrate, showing consequences of not learning
Distraction	Pinging in case of distraction, mute-all function, filter incoming e-mails, messages and phone calls
Health assistant	Remind learners to drink
Real-time feedback	Positive feedback when a learning target was fulfilled, warning statements when something is going wrong, displaying learners' current state to concentrate, encourage the learner

The result proposed the core functions that a SmartMonitor should play as a learning companion. A SmartMonitor should enable learners to plan their learning (Learning diary, Time Management), see the status on learning progress (Analysis), gain instructional and health benefits (Content-related hints, Learning methods, Real-time feedback, Distraction Health assistant).

3.1.1 Design study

Based on the results of the focus group, a design brief was formulated to create the first non-functional prototype of a learning companion. Different design thinking techniques such as

user journeys and scenarios were utilized to turn the design brief and thereby the insights of the focus group into concrete user experience and user interface concepts. By drafting different user journeys and scenarios, user's behaviors, pain points and the magic moments of the application in the different phases of use [6] were identified. The main pain point considered in the design study was to set up the SmartMonitor to be quick, intuitive, automated and simple.

The ideation phase considered and defined the data and options needed in the application. Based on the specified functions, the interface was divided into three screens: *learning*, *statistics*, and *detail* screen. To provide a seamless adoption, the screens should automatically be activated if certain users behaviors or other relevant information are detected. For example, when a user wears a sensor device, the *learning screen* should be shown which charts data from all sensors and deduces recommendations/feedback from the learning analytics engine. The feedback should be highlighted on screen with a signal color so that the user can notice it easily (see figure 1) [8]. The design of the learning screen tries to find the right balance between showing that the SmartMonitor is working without providing any distractions. Thus, the display was designed to dim and only light up when showing recommendations. When a user is not wearing a sensor device, the SmartMonitor should prompt a *statistics screen* which shows an overview of sensor data from past learning sessions in chronological order, including recommendation (figure 1).



Figure 1. Feedback in a learning screen

One of the biggest design challenges was to make the system look like a learning companion, not like a medical equipment. Therefore, the visual language of the first design study was modern, flat, and minimal, with playful icons and a legible, playful font (see figure 2). The color schema combined burned orange (signal color) and icy blue with different shades of anthracite-grey and white. The classic traffic light colors red and green were avoided because red is typically associated with mistake and might discourage the learner [4].



Figure 2. Look and feel of the design study

3.1.2 Software Prototype of SmartMonitor

Based on the result of the first design study, a software prototype was developed (figure 3). The visualization of the graphs was implemented using the JavaScript library d3.js. A time-axis, a home button (at the top left corner), alerts, and navigating buttons were added to the spiral graph screen. In addition to the initial concept, a welcome screen, which allows users to control all functions, and a login screen, which allows for multiple users to use a single device were added.

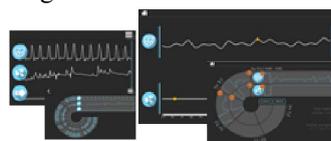


Figure 3. Design study (left), Software prototype (right)

3.2 Second Iteration of HCI Design

During the first iteration, a concept for a functionally and visually consistent prototype of a mobile learning companion was developed. However, various aspects such as the utility and feasibility of the learning history, the dialogue and communication concept (i.e. the type of recommendations), and details of the system control remained open. Thus a second iteration was performed, including a design workshop and an empirical evaluation.

3.2.1 HCI workshop on SmartMonitor design

To address the communication style of the learning companion, a HCI workshop was conducted. It comprised four stimulus talks respectively on HCI, the design study, the software prototype, and mobile learning companions. After the talks, the participants were separated into 3 groups of 3-4 people. Each group was assigned with a particular theme (*usability, user experience, and ethics & privacy*) to focus on during the design process. The usability group focused on functionalities of the SmartMonitor, whereas the user experience group focused on how to make an interaction fun and exciting. The ethics & privacy group was concerned with the question how to make the interaction with the SmartMonitor ethical and safe. This group proposed an opt in or out options for learners to choose which data to collect, store and transfer. The usability group suggested a welcome screen, a calibration screen, and options to choose various types of visualization and data collection. Improvements of the statistical view were discussed, in particular the spiral visualization. A pause/resume button was suggested to give users the freedom to control the data being tracked. To allow users to reflect upon their personal learning behaviors, the possibility to enter notes was proposed. The user experience group recommended the visualization of raw data by adopting a circle with spikes around. It represented an abstract and artistic form of visualization which could be zoomed in and out. Furthermore, it included an auditory component which should convert the learning data to sounds for play back and sharing. Another idea included the visualization of learning achievement within a digital aquarium.

3.2.2 Heuristic Evaluation

The results from the HCI workshop were delineated into a paper prototype (figure 4). It was presented to seven people, mostly computer science students, 20-40 years old, all familiar with technical development; however not all of them were experts in usability. The heuristic used in the evaluation was adopted from Nielsen & Molich [7]. A few suggestions from the HCI workshop were omitted in the paper prototype (i.e. user notes, aquarium, and auditory conversion). The empirical test results were summarized into the three categories discussed in the HCI workshop.

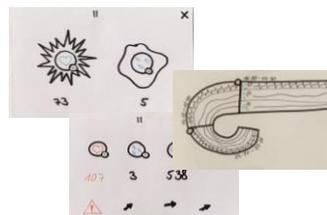


Figure 4. Live and statistical view

Usability: The initial setup screen which includes the welcome, calibration, sensor selection and visualization types selection (i.e. showing raw signal or interpreted signal based on the pre-set threshold) was evaluated as too technical and incomprehensible. A quick tutorial or a visual guide was recommended to explain it. The implemented pause/play button was perceived as not intuitive, some testers found it unnecessary since it requires additional actions. Instead, pausing automatically when the sensor device is away from the SmartMonitor and resuming when they are both in communicative range was suggested.

User experience: The circular view of physiological data (figure 4) was not considered insightful to one tester. The number under each sensor view was evaluated as neither intuitive nor informative. All testers were unsatisfied with the spiral view; they did not understand what to do with it. One tester questioned why her day should be viewed in a curved form.

Ethics & Privacy: Regarding the initial screen, which provides control over data collection, storage and visualization, one tester found the used terms (EDA, ECG etc.) too difficult.

3.3 Discussion

The second iteration of the design process yielded into a novel concept of the SmartMonitor, oriented towards user experience. As general interaction and visualization principles were adopted from the first prototype, the new concept allows to further personalize the system and add individual information to the sensor data. These concepts were partly incorporated into a paper prototype and tested by means of a heuristic evaluation. This evaluation revealed various issues to be resolved in further iterations.

The challenge to design a mobile learning companion in manifold. In this paper we described a user-centered approach which addressed the visualization of sensor data, techniques to interact with these visualizations, the physical layout of the SmartMonitor device, approaches to enhance the user experience, and strategies for the dialogue between the SmartMonitor and the user (i.e. recommendations etc.). We assume that satisfactory solutions were developed through focus group, HCI workshop, software development and heuristic evaluation as a work-in progress result. However, the results from the heuristic evaluation imply challenges in creating a system which transcends technical solution. Our future work within the project will focus on answering the questions how to enhance the user experience and make the SmartMonitor a real learning companion in addition to the technical system development.

Acknowledgement: This work has been funded by the BMBF project LISA (16SV7534K).

References

- [1] Azevedo, R., & Cromley, J. G. (2004). Does Training on Self-Regulated Learning Facilitate Students' Learning With Hypermedia? *Journal of Educational Psychology*, 96(3), 523–535.
- [2] Brovko, V., Fortenbacher, A., Israel, J. H., & Yun, H. (2017) A Mobile Sensor Device for Learning Support: Design Considerations. *Proc. Informatics. Culture. Technology*. Odessa, 30-31.
- [3] A. Fortenbacher, N. Pinkwart, & H. Yun (2017), [LISA] learning analytics for sensor-based adaptive learning. *Proc. 7th Int. Learning Analytics & Knowledge Conf. LAK '17*, 592–593.
- [4] Elliot, A. J., Maier, M. A., Moller, A. C., Friedman, R., & Meinhardt, J. (2007). Color and psychological functioning: the effect of red on performance attainment. *J. exp. psych.*, 136(1), 154..
- [5] Fortenbacher, A., Pinkwart, N., & Yun, H. (2017). [LISA] learning analytics for sensor-based adaptive learning. In *ACM International Conference Proceeding Series* (Vol. Part F1267).
- [6] Hanington, B. & Martin, B. (2012). *Universal methods of design*. Rockport Publishers.
- [7] Nielsen, J., & Molich, R. (1990, March). Heuristic evaluation of user interfaces. In *Proceedings of the SIGCHI conference on Human factors in computing systems*, 249-256. ACM.
- [8] Wang, K. (2014). *Infographics & Data Visualizations*. Design Media Publishing Limited.
- [9] Yun, H., Fortenbacher, A. & Pinkwart, N. (2017) Improving a mobile learning companion for self-regulated learning using sensors. *Proc. 9th Int. Conf. Comp. Supported Education CSEDU*, 531-536.