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*Personalized Mobile Learning Via An Adaptive Engine**

Richard A.W. Tortorella
School of Computing and Information Systems
Athabasca University
Edmonton, Canada

Sabine Graf
School of Computing and Information Systems
Athabasca University
Edmonton, Canada
sabineg@athabascau.ca

***Abstract*— Using mobile devices for learning gets more and more popular. However, in order to provide learners with suitable learning materials in such mobile settings, the learners' characteristics and context should be considered. In this paper, we propose an approach for providing personalized course content in mobile settings, considering a combination of students' learning styles and context. The proposed system aims at supporting students by presenting them with learning materials that are appropriate with respect to the students' current contexts and based on their preferred learning styles.**

Mobile learning, ubiquitous learning, context awareness, learning styles, adaptive learning

I. INTRODUCTION

Due to the recent advances in mobile technologies, learning is able to take place anytime and anywhere. Such mobile and ubiquitous learning has many benefits, such as allowing more authentic learning experiences as well as more flexibility in when and where a user can learn. However, in such mobile settings, additional factors can influence the learning processes and experiences. Therefore, when aiming at providing adaptivity and personalization for learners in such mobile settings, both the learners' characteristics as well as their context should be considered.

In this paper, we propose an approach to provide adaptivity and personalization in mobile and ubiquitous settings based on a combination of a learner's characteristics, in particular their learning styles, as well as their context.

The consideration of learning styles has been demonstrated to have various advantages for learners in desktop-based settings [1, 2, 3], such as increasing their learning satisfaction, improving their grades and helping them to learn faster. However, there is only little research on considering learning styles in mobile learning. Furthermore, while there are several adaptive systems in mobile settings that consider different aspects of a learner's context [4, 5], only very few research exists on considering learners' characteristics and context in combination.

The aim of this research is to provide adaptivity in mobile settings based on learners' characteristics and their context. We propose a framework of an application that determines the learning style of the user and then provides information in a suitable manner and fashion through mobile technology. Furthermore, context information about the user's environment is considered when providing suitable learning materials.

II. ARCHITECTURE OF THE SYSTEM

A. Elements

The system architecture consists of several elements:

1) Mobile Device – ILS Component: This component on the mobile device is responsible for administering the Index of Learning Style (ILS) questionnaire [6], and scoring the results for each user; the results being stored locally as well as on the server's user profile. The ILS questionnaire is a series of 44 questions created by Felder and Soloman to identify a user's learning styles based on the Felder-Silverman Learning Style Model [7].

2) Mobile Device – Context Modelling Component: This component is responsible for gathering contextual information via the devices' various sensors. The raw data from the sensors are processed by the context modelling component, and the results are stored on the mobile device and used in the adaptive engine.

3) Mobile Device – Adaptive Engine: The device is also responsible for the personalization of the courses by calculating the optimal delivery mode for course content. This calculation involves the users' learning styles, as determined in the ILS component as well as their current context, detected by the Context Modelling Component. Once the appropriate delivery mode has been calculated, the adaptive engine contacts the server in order to obtain the required content and then present the respective content to the user.

4) Server: The server allows for the central storage of user accounts and profiles, system logging as well as storing course content. The server provides the mobile device with the appropriate course content when requested.

5) User Types: The system supports three main user types: *User/Learner, Teacher, and Administrator.*

6) Course Material: A course is divided into sections, and each section into a series of lectures. These lectures are further divided into smaller blocks. The material of each of these blocks is recorded in four different modes:

- Video of the lecture (MPEG-4)
- Audio recording of the lecture (MP3)
- Written/Text transcript of the lecture (PDF)
- PowerPoint-style graphical presentation (PPT)

The course material is stored electronically in various appropriate file formats on the server, and presented via the

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mobile device. These blocks must be numerous and short enough to allow for a dynamic personalization by changing the delivery mode as required, while maintaining content continuity.

B. Sensors: Implementing Context Awareness

Sensors on a mobile device are used to gather context information about the students/users and their environment. Generic attributes are gathered in order to help identify the student's motion, location, activity and needs. In the following, we present how data from various sensors in a smart phone can trigger recommendations for a different mode of content delivery.

Proximity Sensor: The proximity sensor is used to detect how close the device is to the student. If for example, the device is held close to the face then the audio recording format would be favoured.

Accelerometers: The acceleterometers on the device detect the overall motion of the device. An increase in the device's motion is considered as less favourable towards a printed media format.

Ambient Light Sensor: The ambient light sensor detects the amount of ambient light in which the device is located. For example, with a very bright or dark local environment, the audio recording format is favoured.

GPS Sensor: With the ability to set pre-determined locations, a student is able to manually set a particular delivery mode for a given location. For example in a library, the course material may be defaulted to always present in a written format. The student may add/edit/delete these locations and their respective delivery mode at any time. Once a location is added, the GPS coordinates are stored, together with a student-defined radius for the location.

C. Combining Learning Styles and Context Information for Calculating the Content Delivery Mode

The appropriate mode of presentation for the student is selected depending on the student's learning style and current context. The student's learning style is based on the Felder and Silverman Learning Style Model [7], using the following learning style dimensions: Active/Reflective, Sensing/Intuitive, Visual/Verbal, Sequential/Global.

The student's learning style dimensions are obtained by administering the ILS questionnaire from the device upon account creation. The adaptive engine uses the resulting score from the ILS questionnaire to determine the default delivery mode for the student. In addition to a student's ILS score, context awareness from the device's sensors is considered when selecting the appropriate delivery mode. In a case where the default mode is unfavourable with respect to the context (e.g., presenting text in a dark room, presenting video while the student is running/walking, etc.), the adaptive engine provides the user with a recommendation for a more suitable delivery mode, considering again the students' learning styles and their context.

The adaptive engine presents the course sections, block by block, calculating each subsequent block's delivery mode in a real-time basis in preparation for the next block's content delivery. Therefore, the same student can have the same course presented in different fashions depending on their location and activities, all while strongly favouring their particular learning style.

With the exception of pre-determined locations, a student's learning style plays a very strong role in the determination of the mode of content delivery. However, internal context awareness additionally affects the presentation mode.

III. CONCLUSIONS

In this paper, we presented an approach for considering students' learning styles and context information in order to provide them with personalized content in mobile settings. The proposed approach contributes towards adaptive mobile systems in two ways: First, it aims to demonstrate how information from students' characteristics can be combined with students' current context for providing adaptivity in mobile learning systems. Second, the proposed approach facilitates more detailed investigations on how learners with particular learning styles and in particular contexts use mobile technologies for learning. Such findings have the potential to significantly improve research on adaptive mobile systems and can lead to more comprehensive adaptive features of mobile systems.

Our future work will deal with implementing the proposed approach, evaluating it within an adaptive mobile system and utilize this system to further investigate students' behaviour and performance in adaptive mobile learning systems.

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