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Implementing and Validating a Mobile Learning Scenario Using Contextualized Learning Objects

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Abstract: Substantial research in the field of mobile learning has explored aspects related to contextualized learning scenarios. Nevertheless, the current context of a mobile learner has been often limited to his/her current position, neglecting the possibilities offered by modern mobile devices of providing a much richer representation of the current learner´s context. In this paper, we show that a detailed contextualization of the learner may provide benefits in mobile learning scenarios. In order to validate this claim, we implemented a mobile learning scenario based on an approach that allows for a very rich and detailed contextualization of the mobile learner. The scenario that we implemented allowed exchange students to be guided at Linnaeus University in Växjö, Sweden in order to get familiar with the campus and prominent institutions on it. We carried out a study including two groups; one that performed learning activities with contextualization support and one other without it. The results of our evaluation showed significantly better results for the contextualized approach, especially with respect to the acceptance of the Perceived Ease of Use.

Keywords: mobile learning scenarios; learning objects; contextualization; cross-platform development

1. Introduction

With the growing population of mobile devices, especially smartphones and tablet PCs', also their usage in mobile learning scenarios increased tremendously. A significant amount of research has been conducted in recent years, providing both, new technological approaches and pedagogical scenarios to support learning. According to O'Malley et al., (2003) mobile learning can be defined as "any kind of learning when the learner is not at a static or fixed location, or when the learner takes advantage of mobile technologies". For the purpose of this study, we understand mobile learning as learning that occurs outside of a traditional classroom and when the learner uses a mobile device in order to perform some tasks in the context of the learning activity. The context of the learner may include different contextual information about the environment, device, user's needs and interests. Mobile learning scenarios that take into account the learning context are called contextual mobile learning (Chuantao, Bertrand, & Rene, 2009). The mobile device allows collecting user's current context information, e.g., by collecting data from various sensors, to provide a convenient and easy way of learning independent of time and space (anywhere and anytime).

In order to investigate whether a richer contextualization model, as described in (Sotsenko, Jansen & Milrad, 2013a; Sotsenko, Jansen & Milrad, 2013b) really provides benefits to mobile learning scenarios, we developed a guided tour activity at our university, both with and without contextualization support. The objective of this study was to understand if the implementation including contextualization support provides significant differences with regard to an implementation without that support. The results of these efforts are described in this contribution.

The rest of the paper is organised as follows: next section provides a short overview about the current state of the art. Afterwards, a description of the implementation of our scenario is provided,

followed by the presentation of the results of our evaluation. In the last section, we conclude by discussing our results and providing some ideas for future lines of research.

2. State of the art

The experiment carried out by Hung et al., (2014) shows that using multimedia content of Learning Objects (LO) is more convenient and satisfactorily than just LOs in textual form. Approaches utilizing multimedia LOs can be used in mobile learning scenarios, e.g., for data collection in science education (Vogel, 2013), for quizzes with access to learning content (Geisler & Jansen, 2011) and/or field trips (Giemza A. , Bollen, Jansen, & Hoppe, 2013). in which mobile devices assist the learners in a convenient and efficient way. For instance, Wang et al., (2012) have developed a context-aware mobile application for navigating university campus maps in which personalized maps show important and relevant buildings, e.g., providing services to students. The results of this experiment indicate that a contextualized approach could improve its usefulness and navigation efficiency. Unfortunately, in this research contextual support only consisted of GPS location information and the user needed to specify the type of buildings/services he/she have been interested in. Moreover, no indoor navigation support was provided and the application was implemented only for the iOS platform. Another multimedia based mobile application is the Mytilene E-guide (Kenteris & Economou, 2011), implemented as a tourist guide allowing users to select certain content and to download an application for an appropriate mobile platform. The advantage of this app is its ability to also work in an offline mode while, at the same time; a disadvantage is that it was not implemented as a cross-platform application. In the work discussed in this paper, we present a cross-platform mobile app with contextualization support for which a much richer context model was used not just relying on the current user´s location. The scenario that we implemented allowed exchange students to be guided at the Linnaeus University (LNU) in Växjö, Sweden in order to get familiar with the campus and prominent institutions on it. Therefore, the app provides relevant information about the university, its campus, cafes and other facilities. Here, the mobile app provides different activities, subdivided in to different tasks that allow foreign exchange students to get familiar with their new university.

3. Implementation

This section describes the implementation of a mobile application utilizing the contextualization approach described in (Sotsenko, Jansen, & Milrad, 2013a), implementing a three dimensional (environment, device and personal context) vector space model in which LOs' are represented. The context data is collected by: a) accelerometer, to define the movement (e.g. moving, sitting/standing) of the user; b) GPS location, to define the current place by using Google Places API; c) GPS location, to define the current weather condition; d) battery service, to define the battery status; e) screen size (width, height); f) camera, to confirm user location by scanning QR codes (e.g., for indoor navigation); and g) the user profile in a corresponding Learning Management System (LMS), to define users with similar interests. All LOs' to be used are stored in different media formats (.pdf, .html, .mp3, .mp4) in a standard LMS (Moodle) in order to make them accessible to the app.

The implementation of the app was done in a platform independent way (Sotsenko, Jansen, & Milrad, 2013b), for allowing a cross-platform deployment. The server-side implementation was done in Node JS for the main functionality of the mobile app. The client side is implemented by using the jQuery Mobile framework, allowing for the creation of user-friendly mobile interfaces. For persistency, a MongoDB database was used in order to natively store JSON objects, used for the complete communication in the system. Additionally, to collect the information about the current context of the user we used additional Web Services: a) Free Weather API provides the current weather condition for the location of the user; b) Google Places API provides the information (e.g. name, type, image, etc.) of current place of the user. These two types of data have been necessary in order to provide an appropriate description in the rich context model; c) Moodle Web Service extension (Piguillem, et al., 2012) allowing access to the LOs' that we provided to users as main learning content in the app; and d) a QR code service used for reading QR codes in order to identify the current location of the user in an indoor scenario.

3.1 Description of LnuGuide mobile application

The following sub-section describes the main functionality of the LnuGuide mobile app. At the login view, the user should login with a username and password from the LMS. The main view (Figure 1) is responsible for helping users to navigate in the activities. The Google Maps API v3 along with the Google Places API are used in order to provide an easy and convenient navigation. For inside navigation, the QR code service was used in order to determine the current position of the user.

Figure 1. Screenshots of *login* and *main* view in LnuGuide app

The activity lists the tasks that a user can choose within his/her current station. Based on the user´s current location the application will provide different tasks that are retrieved from a database. The task view shows the learning material in an appropriate format, according to the current context of the user. The profile view allows filling and saving the users' profile, e.g., with data like a picture by taking a photo, the study program of the learner, interests and hobbies. In order to facilitate collaboration between students the real-time chat is provided by application. The application determines other users with similar interests that are of the database and applies a filter to just show which users are currently online.

3.2 Description of the Learning Scenario

Mobile learning scenarios can be designed for guiding mobile learners to gain information about their current learning environment and how to work in it. For instance, students can learn about how to use the different services at the university library (e.g. registration in the library, usage library card, etc.) if he/she is inside the university library. Another example might be that students can be guided to learn how to print and scan papers by using universities printing system. The scenario described in this paper was designed for allowing international exchange students to familiarise with LNU and to learn about the different facilities and services available on campus. The Student Guide activity contains three stations (e.g. University Library, Administration Building and a café on campus) where students can get useful information to facilitate his/her "student life" (e.g. obtain the library or student card, to be able scan and print at Library, etc.). Each station provides a number of tasks, where, e.g., the app will provide information on how to scan documents at the library including instructions that the user should easily be able to perform. In this scenario, the LOs represent learning materials describing certain tasks that need to be carried out by the students.

4. Evaluation

An evaluation was performed to address the following research question: does the contextualized version of the LnuGuide provide benefits compared to the implementation of the LnuGuide app without contextualization support? In order to investigate this, we carried out a study including two groups of students; one group performed the scenario with contextualization support (Group№1) and a control group without contextualization support (Group№2).

4.1 Participants

The participants of the study were 25 exchange master students arriving to LNU on January 17th 2014 and invited via a Facebook event to participate in the Student Guide Activity during the universities' orientation week. The participants were divided into two groups where the Group№1 had fourteenth students and Group№2 eleven students.

4.2 Description of Study

The participants were enrolled in the course in our Moodle system manually with username and password. Before the Student Guide Activity started, a Samsung Galaxy S3 mobile device with the installed LnuGuide app and headphones has been provided to each one of the participants.

The Group№1 with contextualization support performed the different tasks of the activity in 45 min.. Below, we provide a short example of the type of contextualization support provided by the app. For example, the task "How to use the library card in order to be able to gain access to computer facilities at the university and enter universities buildings at any time?" Considering the current context of the user: user is walking near the university library and the weather condition is cloudy with the temperature -4C and his/her mobile device charged with 90% and with 3G connection. The learning material would be provided in audio format because light conditions are too bad for video and during movement it is probably not convenient to consume a text-based format. Considering a different context of the user: user is standing inside the university library and his/her mobile device charged with 40% and with Wi-Fi connection, the learning material would be presented in text format due to the low battery load, the different lightning conditions and the user not moving.
The Group№2 without contextualization support performed the activity also in 45 min. Here, different tasks provided the material only in text format and without taking into account the current context of the user. After the activity finished, participants from both groups were provided with the questionnaires including additional open feedback text questions.

4.3 Limitations

According to a previously performed pilot test with a few students, we defined that 45 min should enough to complete all tasks that were part of the university guide scenario. Still, in our final study, the external students complained that 45 min was not enough to perform all tasks. The overall number of students (*N=25*) resulted from the fact that we implemented the first prototype of the LnuGuide application in order to validate our approach, test and improve the application before running a larger study. At the end, the different number of students in the groups did not significantly influence the results of the quantitative analysis.

4.4 Study Results

The evaluation was conducted using questionnaires according to the Davis' Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989). From this set of questionnaires, we haven chosen two that fit well with our aims: the Perceived Usefulness (PU) and the Perceived Easy of Use (PEU). A seven-point likert scale (Likert, 1932) was applied for each question. The questions have been adapted (Giemza A. , Bollen, Jansen, & Hoppe, 2013) to our study. In order to determine whether or not the increased contextualization support provides some statistically relevant improvement, we deeply analyzed the gathered data from the questionnaires. First of all, we calculated the total average for the Perceived Usefulness to 4.83 in Group№1 and 4.69 in Group№2. For the Perceived Ease of Use the total average is 5.03 for Group№1 and 4.2 for Group№2. In order to test these results for significance, we conducted an independent-samples t-test for the PU and for the PEU. The results for PU indicate a not significant difference with regard to the total scores in Group№2. Still, the results for PEU show differences in question 2.2, 2.5 and 2.6 regarding the total scores in Group№2. So, we decided to conduct a t-test comparing the mean scores of questions 2.2, 2.5 and 2.6 in Group№1 and Group№2. Since we had a relatively small group of participants (*N=25*), we decided to calculate the

effect size offered by (Cohen, 1988). This test shows a significant difference in the question 2.5 *(M=2.79, SD=1.67)* for Group№1 and *(M=4.82, SD=2.32)* for Group№2; *t (13)=4.55, p=0.001, d=1.0.* In the question 2.6 *(M=3.15,SD=1.7)* for Group№1 significantly less then *(M=4.63, SD=2.1)* in Group№2; *t (13)=3.29, p=0.006, d=0.7.* Results for question 2.2 indicates non-significant difference for Group№1 *(M=3.57, SD=1.5)* and *(M=4.63, SD=2.01)* for Group№2; *t (13)=1.73, p=0.106, d=0.59.* All statistical tests have been conducted with an alpha level of 0.01.

4.5 Discussion of Results

The results for the Perceived Usefulness show almost no difference between the two groups, which is not surprising since the scenario and the provided learning content was the same for both groups. Figure 2, shows the average values both for the group using the contextualization approach (Group№1) and the control group (Group№2). From the t-test results we found that there are not significant differences for question 2.2. Furthermore, the corresponding Cohen's effect size (Morgan, 2002) value (*d = .59*) suggests a high significance. Still, significant differences could be found in question 2.5 indicating that using the LnuGuide mobile app with contextualized approach is less exhausting than the LnuGuide mobile app without contextualization. Here, the corresponding Cohen's effect size value (*d = 1.0*) also suggests a high significance. Furthermore, the results from question 2.6 show that with rich contextualization support, it was easer for the students to remember how to perform certain tasks within the provided scenario. Last but not least, here, the corresponding Cohen's effect size value (*d = 0.7*) suggested medium significance. Therefore, it could be said that the implementation based on the rich contextualization support is easier to use.

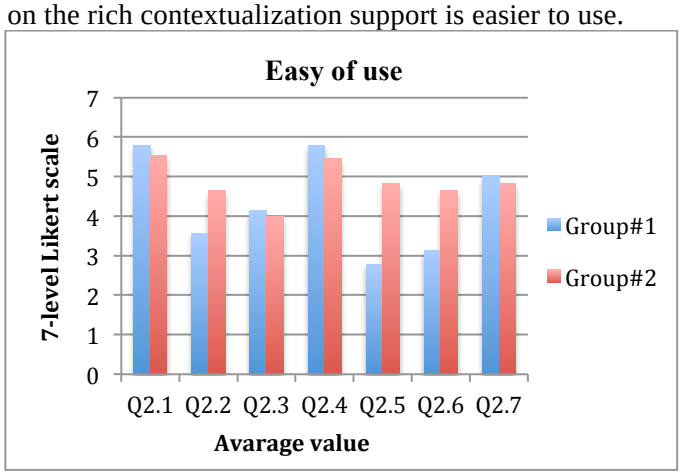

Figure 2. Average rating for PEU questionnaire

5. Conclusions and Future Work

The mobile learning scenario to guide exchange students at Linnaeus University was designed to identify the possible benefits of a rich contextualization support in a mobile learning scenario. The cross-platform LnuGuide mobile application was developed using jQuery Mobile, Node JS and Web Services, providing a stable and reliable technology stack for the development of cross-platform apps. Positive comments and feedback from the students showed that the LnuGuide app with contextualization support is more convenient to use and beneficial in order to achieve their goals (or to perform the tasks) easily. The evaluation also showed significantly better results for the contextualized approach, especially with respect to the acceptance of the Perceived Ease of Use. The results of the study provide some new insights with regard to the usage of the multi dimensional vector space model for modeling user's context for a mobile context based recommender system. The contextualization allows adaptation of the LO's format and the delivery of the LO's to mobile devices according to the user's context in order to keep learner's concentration and convenient study in anywhere and anytime. Our next research steps include a modification of the contextualization support to expand it to mobile health scenarios, where the usage of contextual information provided an important opportunity to create new personalized mobile healthcare applications. Additionally, we

plan to refine our approach on how to provide LOs' in different multimedia formats and to further improve the contextualization mechanisms.

References

Chuantao, Y., Bertrand, D., & Rene, C. (2009). Use your mobile computing devices to learn-Contextual mobile learning system design and case studies. *Computer Science and Information Technology 2nd IEEE International Conference*, Beijing , 440-444.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New Jersey.

Davis, F. D., Bagozzi, R., & Warshaw, P. R. (1989). User acceptance of computer technology: a comparison of two theoretical models. *Management Science , 35*, 982-1003.

Florence, M., & Ertzberger, J. (2013). Here and now mobile learning: An experimental study on the use of mobile technology. *Computers & Education* (68), 76-85.

Geisler, S., & Jansen, M. (2011). Getting Serious About a Platform Independent Application for the Usage of Mobile Moodle Quizzes: A Case Study. *DeLFI Workshop* .

Giemza, A., Bollen, L., Jansen, M., & Hoppe, H. U. (2013). A flexible unified architecture to support heterogeneous multi-device learning environments. *Int. J. of Mobile Learning and Organisation , 7* (3/4), 210-223.

Giemza, A., Bollen, L., Seydel, P., Overhagen, A., & Hoppe, H. (2010). LEMONADE: A Flexible Authoring Tool for Integrated Mobile Learning Scenarios. *6th IEEE International Conference Wireless, Mobile and Ubiquitous Technologies in Education*, 73-80.

Hung, I.C., Yang, X.J., Fang, W.C., Hwang, G.J., & Chen, N.S. (2014). A context-aware video prompt approach to improving students' in-field reflection levels. Computers & Educations , 70(1), 80-91.

Kenteris, G., & Economou, D. (2011). Mytilene E-guide: a multiplatform mobile application tourist guide exemplar. *Multimedia Tools and Applications , 54* (2), 241-262.

Milrad, Marcelo; Wong, Lung-Hsiang; Sharples, Mike ; Hwang, Gwo-Jen; Looi, Chee-Kit and Ogata, Hiroaki (2013). Seamless learning: an international perspective on next-generation technology-enhanced learning. In: Berge, Zane L. and Muilenburg, Lin Y. eds. Handbook of Mobile Learning. Abingdon: Routledge, pp. 95–108

Morgan, S. E., Reichert, T., & Harrison, T. R. (2002). From numbers to words: Reporting statistical results for the social sciences. Allyn and Bacon.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology , 140*, 1-55.

O'Malley, C., Vavoula, G., Glew, J., Taylor, J., Sharples, M., & Lefrere, P. (2003). *MOBIlearn WP4-Guidelines for learning/teaching/tutoring in a mobile environment.* -: MOBIlearn/UoN.

Piguillem, J., Alier, M., Casany, M. J., Mayol, E., Galanis, N., García Peñalvo, F. J., et al. (2012). Moodbile: a Moodle web services extension for mobile applications. *1th Moodle Research Conference*, Heraklion, 148-156 .

Sotsenko, A., Jansen, M., & Milrad, M. (2013a). About the Contextualization of Learning Objects in Mobile Learning Scenario. *mLearn, 11*, Qatar, 67-70.

Sotsenko, A., Jansen, M., & Milrad, M. (2013b). Supporting Content Contextualization in Web Based Applications. *9th International Conference on Web Information Systems and Technologies*, Aachen, 501-504.

Vogel, B. (2013). Towards open architecture system. 9th Joint Meeting on Foundations of Software Engineering. New York, 731-734.

Wang, T. S.-H., Tjondronegoro, D. W., Docherty, M., & Song, W. (2012). Uninav : a context-aware mobile application for university campus maps. *Internet of Things Workshop*.