Integration of Mobile Devices in a Collaborative Learning System

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Abstract

Mobile devices influence our daily routine. The demand of mobile applications and the use of collaborative web systems (e.g. wikis, social networks) are growing. This rapid development of new technologies leads to influences on learning systems, as well. Generally speaking, new technologies imply new learning activities and paradigms. This paper deals with the implementation of a collaborative learning system at the example of the project CUAS 2.0 (Collaborative Ubiquitous Assistance Service through Mobile Apps, Web 2.0 and Location-Based Services). CUAS 2.0 is a Bachelor project of the Carinthia University of Applied Sciences. The result of the project is a prototype solution for collaborative learning activities using mobile devices. The research question in this context is to which extent are mobile devices applicable (and useful) in teaching and learning activities? Among others, the project will focus on the investigation and applicability of Web 2.0 techniques that support collaborative learning activities on mobile location-based services, including. Another focus of this paper is the implementation of the mobile application of CUAS 2.0.

1 Introduction

Implementing a collaborative learning system using mobile devices requires technical and cognitive knowledge. Developers have to consider the usability of the mobile application and the collaborative environment to ensure effective learning activities. To support effective learning activities, Web 2.0 technologies show a remarkable potential in education especially in the context of mobile learning. Web 2.0 technologies that are useful in this field are geo-tagging and micro-blogging (HOLOTESCU & GROSSECK 2011). Thus, mobile learning (m-learning) is getting “more attractive” for educators and researchers (MADEIRA et al. 2009).

In this context, a big technical and conceptual challenge arises when combining these technologies in order to create a collaborative learning system. How can mobile applications efficiently support students in learning activities? The Bachelor project CUAS 2.0 deals with the implementation of a Collaborative Ubiquitous Assistance Service through Mobile Apps, Web 2.0 and Location-Based Services. Based on the following scenario, the project’s scope will be explained. Students participate in an excursion and communicate via mobile devices. It should be possible to view predefined geo-referenced points of interest and also to add new ones. Here, a Point of Interest is a wiki page with information about a specific location, including its geodata, textual information, related images, and videos. The prototype software solution of CUAS 2.0 considers two roles, namely the teacher and the student roles. The teacher plans the excursion and the student follows it. This scenario can also be
adapted to other fields, e.g. tourist guides or mountaineers can use such an application to plan and document their excursion or mountain tour with multimedia data. The integration of geo-tagging and micro-blogging to the mobile application should help to make learning more attractive and efficient.

The research question in this context is, to which extent are mobile devices applicable (and useful) in teaching and learning activities. This paper compares mobile solutions in education (see section 2), analyzes the advantages and requirements of mobile learning (section 3) and explains the method of solution (section 4). Results of the literature research and the analysis of mobile learning activities are guidelines describing the must-have requirements of the prototype solution (section 5). Another result is the implementation of a prototype solution of the mobile application of CUAS 2.0.

2 Comparing Mobile Learning Solutions

This section describes the literature review for this paper. It is based on existing learning activities and does not offer new ones. It combines existing technologies with the requirements of the mobile application of CUAS 2.0. The developments of mobile devices and net books have become more attractive in the field of education, especially in the field of mobile learning. This demand on mobile devices is supported by the International Telecommunication Union (SANJAY 2008). Today, mobile devices are equipped with internet access, cameras, and other multimedia features. Mobile devices for learning activities show a tendency of Web 2.0 integration and location-based services. Geo-tagging and micro-blogging are keywords in this field (SAFRAN et al. 2009). Mobile learning focuses on the aspect of “learning anytime and anywhere”. Whereas e-learning focuses on learning in classrooms or on computers, mobile learning emphasizes learning activities outside the classroom. KORUCU & ALKAN (2011) describe in their paper the differences between mobile learning and e-learning.

New technologies introduce new learning methods in schools and universities. The development of mobile applications supports learning and teaching activities for different age groups and fields. Mobile learning is a new model for learning activities which follows e-learning. The idea of implementing a collaborative learning system using mobile devices is based on TUGeoWiki. Students of the Graz University of Technology implemented such a system by integrating geo-tagging and micro-blogging to build a wiki. This idea has been adapted to the implementation of the Bachelor project CUAS 2.0. Mobile devices support projects and excursions (SAFRAN et al. 2009). It is possible to gather information during a school field trip by using mobile devices. This school field trip can be for example an excursion to a museum (CABRERA et al. 2005). A collaborative system can integrate evaluation tools to create reports or to identify failures (VAVOULA et al. 2009). The advantage of mobile and web-based student learning systems is that tutorials for students, a set of exercises with specific questions and interactive animations, can be integrated (MADEIRA et al. 2009). Mobile learning can be supported by micro-blogging. Micro-blogging combines usability, collaboration, and personality. Therefore, Web-blogs can be an effective feature in a mobile application (EBNER et al. 2008). A wiki is used as a desktop application because it is easy to use and easy to manage the content (FUCHS et al. 2004). Well-known applications that have helped spread Web 2.0 are blogs, wiki and image/video sharing sites; they
have dramatically increased sharing and participation among web users. It is possible to build knowledge using tools that can help analyze users’ behavior (BUFFA et al. 2007). One example is Wikipedia. A so called Geo-Wiki is used to provide an online platform for improving global land cover (FRITZ et al. 2012).

This section documents the state of the art in the context of mobile learning. Furthermore, related work is discussed to compare the mobile application of CUAS 2.0 with other existing solutions.

3 Mobile Learning with CUAS 2.0

This section describes the advantages of mobile devices for learning activities, the necessary requirements of a collaborative mobile application, and the design of a wiki, which supports collaborative learning. To answer the research question, the advantages and requirements of mobile devices have to be analyzed. One part of CUAS 2.0 is the collaborative effect of mobile learning, therefore, the question arose, of how to implement an effective collaborative system. In this context it is necessary to mention the advantages of a mobile device for learning activities.

The four advantages of using mobile devices for learning according to SEIBU & BIJU (2008) are:

- Easy access to free available knowledge to collected information and the immediate access to leaning materials anywhere.
- Self-study options that is, the flexibility of mobile learning allows learning anytime and anywhere. Mobile devices mean more freedom of interaction, in contrast to using a desktop computer.
- Evaluation and feedback, which makes it possible to include evaluation tools to control the student’s progress and furthermore, to create reports. Students can repeat their gathered information and that helps improving their learning activities.
- Access to diverse online materials that is, a mobile learning system permits a continuous interaction between the students and the teacher; students can access online materials during an excursion, which helps to solve tasks and exams.

SEIBU & BIJU (2008) demonstrate that mobile devices are applicable in the field of higher education. They further described advantages in the field of mobile learning and their impacts. Using mobile devices to communicate and interact together displaces the social interaction from the classroom to other outdoor places.

3.1 Defining a Collaborative Learning Activity

A collaborative learning environment should increase the participation and interaction of students. Collaborative means interacting to reach a common goal. As mentioned, the designed collaborative scenario of CUAS 2.0 has two roles, namely the student’s role and the teacher’s role. Therefore, both desktop and mobile applications should have two different access possibilities, one for the student and one for the teacher. It should be possible that students participate in predefined excursions. Here, a teacher has the role of a moderator. The teacher creates the excursion and defines context specific Points of Interest. The teach-
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er selects different student groups, who have to solve a specific task. The number of students in a group should not exceed six (COOPER 1996). Students should have the possibility to participate in these excursions and to visit the Points of Interest. Through sending information to the wiki the content of the network grows and it is possible to discuss and review the entered information. Therefore, micro-blogging could be a solution for sending information via the mobile device. To motivate students to interact, furthermore, geo-tagging could be integrated. A mobile device in the context of collaborative learning supports a touch screen, has internet access (including a browser), and an integrated GPS receiver. These are three minimum requirements.

In addition to the mobile application, CUAS 2.0 includes a desktop application. For the desktop application a wiki system was chosen. In this context the wiki is a geographical wiki, because it stores a geo-referenced content, so called Points of Interest (POI). A desktop application is useful to ensure collaborative learning activities (THENG et al. 2007). The teacher creates a lecture based excursion in the wiki. The excursion contains contextual Points of Interest, which have to be visited during the excursion by the students. Points of Interest are stored as a special page and include general information, the geographic coordinates on a Google Map, images, and videos about them. To ensure collaborative activities via the wiki it is possible to update the Points of Interest after an excursion. Furthermore, it is possible to edit the content of the Points of Interest during an excursion, but the number of changes is limited (TERANISHI et al. 2006).

Summing up, this section described the advantages of using a mobile device in the context of education. The requirements of a collaborative learning activity were analyzed, to facilitate the implementation of the CUAS 2.0 mobile application. Finally the design of a collaborative wiki was illustrated. The wiki is the desktop application of CUAS 2.0 and handles the preparation and maintenance of the excursion and their related Points of Interest.

4 Results

This section documents the strategy to implement a collaborative environment for mobile learning activities.

The implementation and the design of a mobile application are difficult, because the application has to foster student’s collaborative learning. Due to the literature survey it is possible to find comparable implementations of collaborative learning systems. Collaborative learning should increase the participation of the students in classes (SAFRAN et al. 2009, DILLENOBURG 1999). At the beginning of this paper, existing projects in the context of collaborative mobile learning have been studied and compared with the requirements of CUAS 2.0 (see Section 2). Next, the analysis of the advantages and requirements of a collaborative mobile application were studied (see Section 3). Furthermore, the design of a desktop application has to be evaluated. To implement the mobile application, a suitable developer environment has to be chosen. According to similar studies, Android, Google’s new framework, is the most versatile smartphone operating system. Android was chosen due to the fact that the Android platform is open-source and that the implementation language is Java. The next step was to define user requirements. These user requirements have to be classified in must-haves, nice-to-haves, and decorative requirements. However, the first prototype of the mobile application of CUAS 2.0 has to fulfill the must-have require-
ments. The requirements arose due to the literature review, the analysis of the use of mobile devices, and the requirements of a collaborative learning activity. The must-have requirements in this context are integrated in the implementation of a collaborative mobile application, which allows students to participate in predefined excursions. Due to the integrated Global Positioning System receiver of the mobile device it is possible to obtain location-based information and to display the POIs on a map. Another requirement is the integration of a Google Map, which visualizes the Points of Interest and their corresponding wiki-content. A database helps to manage and create this information. To find a convenient collaborative environment, a technical analysis of content management systems and wiki systems has been conducted. The result of the technical analysis was that MediaWiki is the most suitable answer of a collaborative desktop application. To simplify the implementation, scenarios of the requirements and Mock-Ups can be useful. At the beginning of the implementation different prototypes were defined. This kind of development is called Rapid Prototyping.

The CUAS 2.0 system basically comprises two core elements on the client side. This is on one hand the mobile platform containing a mobile application for the conduction of real-time excursion in the field and a desktop platform for the information management. The mobile application utilizes the internal GPS receiver of the mobile device to retrieve the coordinates of the user’s current position. For Android applications the Location Manager which corresponds to an internal Android interface for Location Bases Services (LBS) is used to communicate with the GPS receiver of the device. The desktop application can be accessed with a regular Web Browser via the Hypertext Transfer Protocol (HTTP). On the server side operates a Web Server and a decentralized database server. The web server handles requests from client referring to the mobile or desktop application and communicates with the distributed database on the database server. The request of the mobile application processes an implemented Representational State Transfer Service (REST-Service). The client-request is sent to REST-Service via the HTTP network protocol and then forwarded to the database via Open Database Connectivity (ODBC). ODBC is a common framework for accessing and altering the contents of databases. The transferred data is transmitted in JavaScript Object Notation (JSON) format which is a lightweight data-interchange format.

The desktop application is based on a wiki implementation written in Hypertext Preprocessor (PHP) which operates on the web server. The wiki system incorporates various extensions inter alia for the integration of geospatial information. The application can be accessed with a regular web browser. Similar to the REST-Service of the mobile application, the wiki system establishes the connection to the database via ODBC.

Summing up this section documented the method of implementing a collaborative mobile application. The solutions for the communication of the different components of CUAS 2.0 are presented. Based on the mentioned requirements it was possible to elaborate design principles to implement the prototype solution for CUAS 2.0 (see section 5).

5 Result

This section illustrates the main requirements to implement the prototype solution of a collaborative mobile application and the implementation itself. The analysis of the ad-
vantages of using mobile devices for learning activities and the evaluation of the main requirements of a mobile application resulted in a list of must-have requirements. These requirements are essential for implementing a flexible interaction system in CUAS 2.0. Section 5.1 displays the prototype solution of the mobile application of CUAS 2.0. The following requirements have to be integrated into the mobile application of CUAS 2.0, to ensure effective teaching and learning activities:

- The user should have the possibility to log in via his/her username and password.
- The content of the active excursion, including the Points of Interest should be in a simple, clear, and direct language.
- The application menu should be clear and user-friendly. There should be a back-button and a close-button. A tab view should ensure a clear navigation of the application.
- A map (here, a Google Map) should be integrated with the prototype solution to provide some geographical reference to the Points of Interest and the user’s current location.
- The content of the Points of Interest should be viewed and edited. The wiki is thus growing and the network can be established.
- The multimedia section of the application should be the decorative part. It should motivate users to interact and to upload new images and videos.
- A collaborative desktop application should support student’s learning activities. Here the desktop application is a wiki, based on MediaWiki.

Further results of the evaluation include examples for which collaborative learning is useful or effective. One finding of the literature research was the variety of group composition in the context of collaborative learning. There are different of assigning groups of users. DILLENBOURG et al. (2002) presented scripts, containing rules of how to form user groups. JOHNSON & JOHNSON (1999) suggest that teacher-selected groups often result in the best mix because teachers are better able than students to form optimal combinations. Characteristics of the formed groups are:

- Members of the group should be able to work in a team
- Members should be motivated to interact together to solve an exercise
- Members should be open-minded to new learning technologies
- Members should not depend on the teacher, rather they should show self-initiative and responsibility
- Members should be motivated to share their knowledge with other members

Concluding, it can be said that the group composition depends on the purpose of the collaboration, the age of the members, the task features, and the communication media. However, there are many conditions, which interact with each other in such a complex way that it is not always possible to guarantee learning effects (DILLENBOURG et al. 1995).

5.1 Mobile Solution of CUAS 2.0

The mobile application of CUAS 2.0 is implemented using Android. The IDE which is used is Eclipse Indigo. The project is an Android project – Google API 2.1 (API Level 7). To test the application, an emulator and a mobile device were used (using the API Level 7 as well).
To develop the mobile application the Eclipse IDE, the FileZilla FTP Client, PHPMyAdmin and MediaWiki are used. The database connection from the mobile application to the database is established by an implemented REST-service which serves as an adapter between the mobile application and the database.

This adapter-based approach is inevitable since Android does specify an interface which enables direct access to an external database. The basic idea of this approach is to utilize the REST architecture style where the interaction between the communicating entities corresponds to synchronous request-response messages.

The client, in our case the mobile application, sends an HTTP-request to the web server by specifying parameters like the URI of the appropriate script on the web server which processes the request or passed values for the database query (see Figure 1).

On the web server side multiple PHP-Scripts receive requests from the client and forward it to the database. Each request is associated with the appropriate PHP-Script. The PHP-Script handles the data which was passed with the request and transfers the received data in form of a Structured Query Language (SQL) query to the database. For MediaWiki, multiple consecutive SQL-statements have to be specified in order to retrieve the desired datasets since MediaWiki holds a complex interlinked table structure within the database. Figure 2 displays the prototype solution of the mobile application.

```
HttpClient httpclient = new DefaultHttpClient();
HttpPost httppost = new HttpPost("http://geoweb08.cti.ac.at/CUASGeoWiki/coordinates.php");
httppost.setEntity(new UrlEncodedFormEntity(userValuePair));
HttpResponse response = httpclient.execute(httppost);
HttpEntity entity = response.getEntity();
input = entity.getContentType();
```

**Fig. 1:** An extract of a Client request written in Java for Android

**Fig. 2:** The Excursion class and the TabView of the mobile application
The existing prototype starts with an overview of the existing and active excursions. The excursions are displayed in a ListView and at a click they are loaded. A TabView handles the menu of the application. The TabView is displaying the map, an overview and an imprint. At first the tab of the map is displayed. It zooms to the POI at the first index. To connect the POIs a route is displayed. The map is a Google Map, which displays the POIs and the route as overlays.

As mentioned, the POIs have been added to the map as overlay items. Each overlay item corresponds to a Geo Point. The Geo Point is part of the Android Google Map API. If the user selects an active excursion, the name of the excursion is send to the committed PHP-Script via an http-request. Due to queries in the PHP-script the excursion can be loaded. These queries request the coordinates of the excursion.

If the user wants to display a wiki content, another PHP-script is called. The coordinates of the Point of Interest are requested and the content to the Point of Interest is displayed in a Text View.

The second tap, named info, gives an overview of the excursion. It contains the title of the excursion, the description and the list of POIs that have to be visited. It is possible to click at the list and to get the wiki content it.

The third tab is the imprint. The imprint contains among others the team members, project key facts, the contact and the project information.

6 Conclusion

With the implementation of the Bachelor project CUAS 2.0 a new collaborative learning system has been realized. This paper describes the prototype solution for the mobile application of CUAS 2.0. The realization of the application contained a sophisticated literature research. This includes the analysis of mobile learning activities and requirements. The results of this analysis are “must-haves” for CUAS 2.0. According to this analysis the mobile application of CUAS 2.0 was implemented. Summing up it can be said that the result of the project CUAS 2.0 is a collaborative system, which supports mobile learning. It is possible to get location-based information and to participate in a predefined excursion. The combination of a wiki system and an Android application are combined to create an interactive mobile learning tool. The advantage of the application is that it can easily be used in study courses to create a lecture based wiki. Students can access the wiki and gather information about the lecture and also can add information. One the one hand they learned by entering information to the wiki and on the other hand it is possible to create reports and exercises in a simple way.

Critical open issues in this context are the missing usability evaluation of the desktop and mobile application. A usability evaluation could expose the limitations of the existing prototype solution. Addressing such limitations would result in a more user friendly solution. However, the effectiveness of the learning success does not fully rely on technologies, but it can be supported by them. Collaborative learning activities have also some negative aspects. For example, individual group members assume the teacher’s role and control the excursion while other group members are inactive and let other members do the work. Therefore, the teacher has to find the balance for the group dynamic.
References


