Systematic Design of Context Awareness Mobile Learning Environment

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Abstract

As mobile technologies are getting smarter using various environmental awareness technologies, so too are the mobile learning environment harnesses of smart technologies. Instead of the learner and mobile device being at a fixed and predetermined location, a mobile learning environment fosters free movement while connected to a server with a wireless network. Therefore, in addition to traditional user information, the learning environment needs to provide adequate location based learning materials to the learner. In this paper, how such smart learning technologies can be integrated into a learning system to compose a smart educational agent that utilizes location awareness technology such as GPS and dialogue-based feedback systems in order to provide real-life situated learning environments to users will be introduced.

Keywords: *Mobile learning, Smart technology, Location based information, Educational agent*

1. Introduction

Most of the current smart phones can access the Web at high speeds due to the growth of 3G data networks and Wi-Fi deployments. Such smart handsets provide not only easy and effective access to the Internet, but also ensure the capabilities of location awareness and context awareness of users using environment-sensing capabilities and application software installed on the machines. Harnessing the various environment-awareness technologies which are equipped on such machines, the possibility of applying said technologies into mobile learning, or M-learning, environments attract the interest of educators. Such technology may provide an easy way for collaboration and learning opportunities especially in reference to learning through outdoor activities [1, 2].

One of the main issues in applying those technologies in creating new models of mobile learning is not technical, but social because of insufficient understanding of pedagogical application outside the classroom [3].

The most significant difference from that of traditional e-learning, where user and device are fixed to certain physical settings and connected to the Internet, mobile learning is where the learner continuously moves not only in location, but also their activity in different contexts.

2. Context Awareness and Reflected on Educational Program

Considering how to reflect learner and mobile device motilities in mobile learning

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environments, instead of being at fixed and predetermined locations of traditional e-learning situations, the mobile learning environment needs to provide learning materials to learners which adapt to location changes. Compared to traditional e-learning environments where learners usually receive learning materials that do not adapt to the learners' current environment, new mobile learning environments require effective integration of context – physical and learner's continuous changing cognitive interests.

2.1 Context Awareness in Mobile Learning Environments

Brown, et al. defined the context as "the formal or informal setting in which a situation occurs; it can include many aspects or dimensions, such as environment, social activity, goals or tasks of groups and individuals; time (year/month/day) [4]. The diversity of context meaning can be summarized as in Table 1.

Table 1. Various Meanings of Context According to Situation.

Situation	Detailed classification of situations
Learner	Personal (Identification, Name)
	Bodily (Pulse rate, Blood pressure, Temperature, Voice)
Physical	Spatial (Position, Orientation, Velocity)
	Temporal (Date, Time, Season)
	Environment (Temperature, Humidity, Brightness, Noises)
	Activities (Neighboring people, Action, Schedule)
Computing system in learning environment	Available resources (Battery, Display, Internet, System)
	Available situation (Resources, Facilities, Equipment)
	Access situation (User, Permission information, Proximity)

Among the many situations of "context," it is necessary to ascertain what the essential situations are that learners may be situated in, in regards to their learning environment stage. Furthermore, not only the technical limitations, but also not all of the situations need to be considered in the learning process.

2.2 Dialogue Feedback for Question and Answering from Location as Context

One of the most requested functions in environmental and location based systems is the ability to answer questions from learners. As the context in a learning process is a kind of dynamic process with historical dependencies [5] according to locations, learners who are outside of the classroom may ask questions frequently either to the teacher or systems. Therefore, it is inevitable that a mandate to provide Q&A functions for effective teaching-learning process will come to fruition. Handling many learners at the same time is not possible and mobile learning environment systems need to equip such functions.

From these requirements the mobile learning content for a biology class has been designed using case diagram in the Unified Modeling Language (UML). The use case diagram is a behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present

a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases.

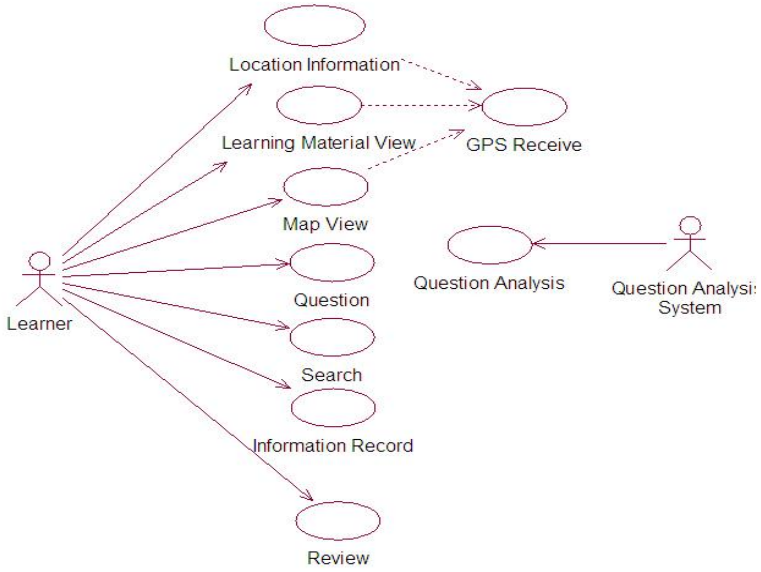

Figure 1. Use Case Diagram of Designed Mobile Learning Content

Since there exists highly dynamic environmental aspects and context-awareness characteristics of Smartphone-based mobile learning, it is necessary to define the dynamic interactions between user and contents. The interactions between learner and content in traditional e-learning do not consider the environmental aspects. However, utilizing the Use-case analysis, it is possible to clearly identify interactions which happen in the outside classroom.

The designed system has 7 use cases as found in Figure 1. Each use case can be explained using detailed actions performed by user, system components, or contents as shown in Figure 2.

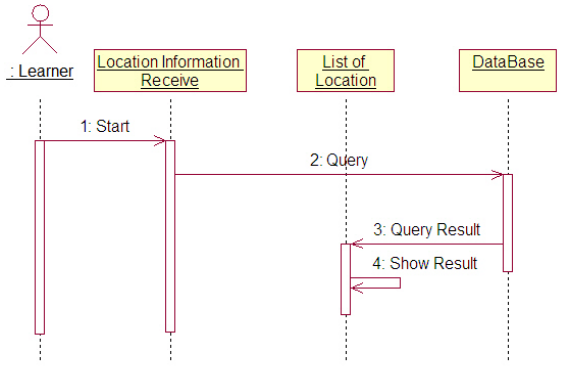

Figure 2. The UML Diagram of Location Information Menu.

The use case of the Question and Answer function is shown in Figure 3. As previously stated, questions stemming from the field participants are directly sent to the server of the dialogue feedback system, and answers are subsequently delivered to learners.

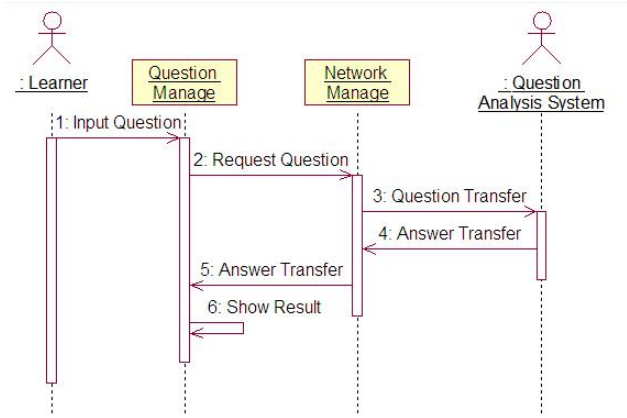

Figure 3. The Use Case of the Question and Answer Function.

The Question and Answer function needs to be sensitive to a learner's learning context, including location, study subjects, and activities. Since the developed system targets a biology classroom of 5th graders, the Question and Answer module needs to have the domain knowledge present.

To foster a successful test of the pilot system, the contents related to the environment were first developed. Next, the collection of the domain information into the Question and Answer module which would analyze the potential questions from the learners, and prepare the answers was created. It is inevitable to limit the possible questions generated by learners at a particular developed stage, but the system may be augmented with additional questions and possible answers gradually.

The system has Review and Quiz functions to encompass the classroom activities that may happen in indoor classrooms. Even though, the outside classroom may provide a more explorative learning environment, the mobile learning environment also secures the target learning objectives, and one of the checking methods to meet the goal is to give Quiz and Review functions for remedial corrections.

Snapshots of the developed system are given in Figure 4.

Figure 4. Snapshots of the developed mobile learning environment (Left: Learning goal, Center: Supplementary information, Right: Question and Answer screen).

3. Usability Test of the Developed System

After implementing the design, the usability test has been performed by the 10 elementary school teachers with Likert scale 1-5. Test items are the appropriateness of visual information, the usefulness of trouble shooting information, the easiness of learning, and feedback of learning process. The response characteristics of the usability are summarized in the Table 2.

As it is shown in the Table 2, the users' response to the usefulness of trouble shooting information is lowest as Mean value 3.70, and Standard deviation 1.18 among tested items. The sub elements of the usefulness of trouble shooting information are 'the possibility of activating menus ' and 'the usefulness of trouble shooting messages.' Especially, the response to the usefulness of trouble shooting messages was very low (Mean value 3.50), and it means that users are sensitive not only the content itself but also providing how to use systems appropriately. In mobile learning environments, most of the learning processes are initiated by the learner, and their easy use of the facilities is one of the key factors to implement mobile learning environment successfully.

Table 2. The Usability Test Results.

Items	Mean	S.D.
The appropriateness of visual information	4.71	0.47
The error frequency	3.70	1.18
The easiness of learning	4.56	0.60
Feedback	4.30	0.67

4. Conclusions

With the highly dynamic characteristics of outdoor activities or outside classes present, the mobile learning environment needs to answer learners' questions in a real-time basis. One of the solutions to ensure such adaptability to smart devices is via an integrating Question and Answer system to a learning system in use for mobile learning environments.

Even though the potential contexts which stem from the outdoor classroom are very complicated, the cognitive domain's context needs to be considered first for reducing the complexity by using physical domain information first. This indicates that allowing full context awareness needs to be scaled down at least in reference to the cognitive domain in reality.

Therefore, a systematic mobile learning content development strategy considering a 5^{th} grade biology subject which will be performed via outdoor activities has been proposed. The usability tests with implemented system target to the elementary school teachers who are teaching the subject show that the trouble shooting materials also needs to be designed carefully for effective learning environment.

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