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A Mobile Learning Support System for Ubiquitous Learning Environments

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Abstract

This paper proposes a Mobile Learning Support System (MLSS) which enables students to access learning materials by utilizing 2D barcodes and GPS technology. As the pilot system of ubiquitous learning, we used camera-equipped mobile phones and 2D barcode tags to obtain learning information from online websites. By installing the MLSS on to their mobile phones, students can scan the tag attached to the corresponding object to display related multimedia materials on the screen of mobile phones. Furthermore, MLSS also applies GPS technology to develop a location-aware environment for students. GPS technology is used to detect the students' location and identify which 2D barcode tags are in their proximity. Therefore, this paper provides the opportunity to develop for developers create ubiquitous learning environments that combine real-world and digital world resources.

Keywords: Local-aware learning; Mobile learning; Ubiquitous learning; 2D barcodes; GPS technology

Nomenclature

A	Ubiquitous Learning
B	E-Learning and the Contribution of Information Organizations

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1. Introduction

The rapid development of wireless and mobile technologies has attracted the attention of researchers from various educational disciplines. Many studies have investigated the use of mobile learning (m-learning) as a complementary teaching technique to reduce both time and location constraints within the learning environment [1], [2]. For example, students engaged in outdoor learning activities with the support of handheld devices could access digital learning resources via wireless communications. Their outdoor learning process was improved by the mobility and portability of these devices. Students could also use handheld devices to interpret and organize their personal knowledge while in the field. Therefore, learning with handheld devices can facilitate the use of multimedia in m-learning, which supports students by combining both real and digital learning resources [3][4].

Recent advancements in mobile hardware technologies have created many new and cutting edge methods to realize ubiquitous learning (u-learning) [5]. U-learning is an innovational concept that helps students gain information on demand, accessible anytime and anywhere [6], [7]. Most studies have used mobile and context-aware technologies to achieve a u-learning environment [2], [8], [9]. Ken and Noboru have developed a project containing ubiquitous computing technologies, called TRON. The project embeds Radio Frequency Identifications (RFIDs) onto foods and serves to increase the intelligibility of total food chains [9]. Students can learn relevant information about foods they will consume if they are interested. Similarly, Huang et al. have developed a mobile plant learning system (MPLS) which facilitates student engagement in outdoor learning courses [3]. In this case, the team installed MPLS onto handheld PDAs which allows students to obtain information about different plants according to the students' position. In addition, Ogata and Yano developed a "Tag Added learNinG Objects (TANGO)" system, which uses the location of a learner to detect various real-world objects associated with RFID tags in order to provide educational information [8]. Hwang and his colleagues found that proper learning tools and appropriate feedback mechanisms should be provided in a technology-enhanced learning environment in order to support students in organizing and refining their knowledge [10].

U-learning applications are usually developed on mobile device platforms, such as personal digital assistants (PDAs) or smart phones as this supports teaching techniques and learning activities [3], [10]. However, mobile devices have demonstrated several disadvantages that have rendered them unfit for some outdoor educational activities. For example, the limited computer memory and the restricted broadband transmission of PDAs prevent this mobile tool from running many computer-assisted u-learning programs. In addition, the small touchscreen interface has posed a major challenge in text typing and editing capabilities [11]. Huang and his colleagues have indicated that the m-learning or u-learning performance on such mobile devices could be disappointing, because students do not have effective tools to help them organize their knowledge in the field [3].

This study proposes a Mobile Learning Support System (MLSS) which enables students to access learning materials by utilizing 2D barcodes and Global Positioning System (GPS) technologies. As the pilot system of ubiquitous learning, we used camera-equipped mobile phones and 2D barcode tags to obtain information from online websites. By installing the MLSS on to their mobile phones, students can scan tags attached to corresponding objects and display related multimedia materials on the screen of mobile phones. MLSS also applies GPS technology to develop a location-aware environment for students. Furthermore, GPS technology is used to detect the students' location and identify which 2D barcode tags are in their proximity.

By using the above technologies, the MLSS can overcome the difficulties of mobile learning that exist in traditional text input methods. This study aims to establish a novel mobile learning system in which students can fully integrate themselves into the ubiquitous learning environment. Combining outdoor learning activities with MLSS can allow students to gain knowledge through interactions with their environment. Our study provides the opportunity for developers to create ubiquitous learning environments that bring together real-world resources and digital world information.

The rest of the paper is organized as follows: Section 2 gives the theoretical aspects of this study. Section 3 introduces the overview of the MLSS used in this study. The importance of local-aware environment is described in Section 4 and the importance of 2D barcodes is provided in section 5. Finally, some concluding remarks and future works are discussed in Section 6.

2. Related Works

2.1. Ubiquitous learning

Many m-learning researchers have noted that the quick progression of mobile technologies and wireless communication directly impacts learning. These advancements have spurred various novel issues in u-learning and m-learning, which are now being studied more in depth. U-learning and m-learning have some similarities to each other, including: permanency, accessibility, immediacy and interactivity [3]. However, several significant characteristics of u-learning differentiate it from m-learning. For instance, u-learning includes seamless learning, context-aware computing and adaptive services [12], [13]. Specifically, context-aware computing is regarded as a very important technology that enables students to learn anytime and anywhere.

In an ideal u-learning environment, computer communication and sensory devices are embedded and integrated into daily real life items, allowing students to immerse themselves fully into different learning situations [13]. Based on the above concept, Yang proposed a u-learning environment, which uses context-aware technologies to provide intuitive ways for collaborators to choose appropriate learning resources according to the situation and location [14]. Ogata and Yano also provided a context-aware language learning support system for overseas students to learn polite Japanese expressions suitable for their particular situation, or based on their personal information [8].

In essence, the context-aware feature of u-learning enables the entire to better understand and adapt to students' behaviors and adjust for environmental parameters present in the real-world [15]. Of the various environmental parameters, it is clear that the location should be the fundamental parameter for recognizing and describing students' context [16]. In this study, the MLSS has integrated GPS technologies to develop a location-aware environment for deciphering a students' physical position, and further describe the related data around the learners. We believe that the MLSS can provide additional adaptive learning activities in a variety of outdoor and indoor settings.

2.2. 2D barcode technologies in education

In recent years, several researchers have investigated various ways of applying tiny computer devices for educational applications [8]. Examples of tiny computer devices include RFIDs, contactless smart cards, barcode tags and sensor network nodes. These devices can be used in the u-learning environment for providing active and adaptive support to students in real-world learning and training. Among such tiny computer devices, the 2D barcode technology is most suitable for scanning and encoding large amounts of data, such as URLs, text, or numerical characters, etc [11].

The application of 2D barcode technologies in an educational context has only recently been investigated [17]. Law and So conducted a recent literature review of educational applications using QR codes, and introduced several related learning systems [17]. They also carried out experiments which applied QR code technologies in elementary schools for proving QR codes have great potential in education. Chen and Choi utilized 2D barcode technologies to integrate online mapping services with a content management platform for supporting the history curriculum in high schools [18]. Ozcelik and Acarturk used mobile phones with the 2D barcode technology which allowed students to combine online information and printed course materials together [11].

However, the use of 2D barcode technologies in an educational context is still in its infancy and lacking adequate long term studies within this novel research domain. Thus, the relevant aspect of applying 2D barcode technology for improving learning is used in this study. By using Wi-Fi/3G-enabled, camera-equipped mobile phones and the MLSS, students are able to scan 2D barcode tags and gain immediate access to various online materials, eliminating the need for inputting text.

3. Overview of the MLSS

Portability and mobility are usually regarded as indispensable factors for u-learning environments. Thus, we use handheld devices enabled wireless technology for the MLSS to achieve portability and mobility. The MLSA used in this study was designed and built for the HTC Desire S mobile phone and can be used on any Android 2.3 Operation System. In order to provide cross-platform capabilities, the MLSS was developed on the Android Software Development Kit (Android SDK) development environment using Java technology. Moreover, this study has created a MySQL Community Server which has become a web space for students, where they can download multimedia materials and use this information on their mobile phones. As shown in Fig. 1, the MLSS has designed to provide three functions: (1) database connection function, (2) content learning function, and (3) tags searching function.

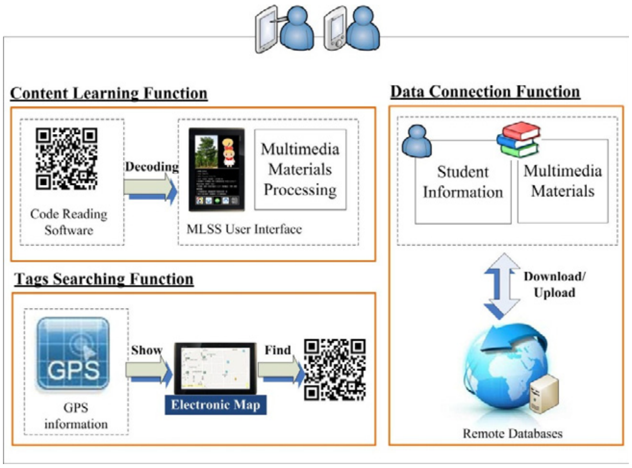

Fig. 1. The system architecture of the MLSS.

3.1. Database connection function

The database connection function was designed to provide students with a u-learning environment. In order to achieve learning anytime and anywhere, the MLSS has developed two remote databases on Internet, which one was used to record students' information and other was applied to keep multimedia materials. The student information database enables the MLSS to maintain students' profiles and learning feedbacks via a network service. When students login the MLSS through their mobile devices, the database connection function will automatically download students' profiles from the information database. This function can also upload students' learning tracks to the information database, while students have finished their learning activities.

Moreover, the multimedia materials database features the management of teaching materials and the maintenance of tags' location information. When students use mobile devices to scan tags, the database connection function will access corresponding teaching materials including text content and multimedia objects from the materials database. Besides, this database also records the location information of all tags in actual learning circumstances, which can be used to support the evolution of the tags searching function. In other words, both databases were used to make a built-in web server for students to easily access information in outdoor settings.

3.2. Content learning function

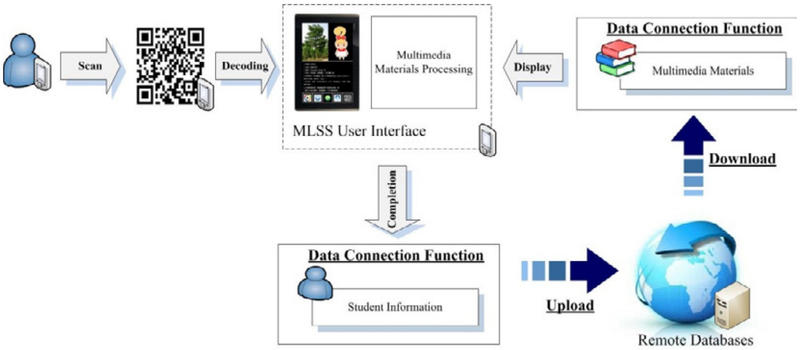

Fig. 2. Diagram of the content learning function.

As shown in Fig. 2, the content learning function enables students to learn teaching materials on mobile devices, and control the learning paces themselves. When students use mobile devices that have installed the MLSS to scan 2D barcode tags, the content learning function will decode the internal information of tags. Then, this function will require the database connection function to download corresponding teaching materials according to that internal information. Teaching materials was processes and displays on the screen of mobile devices of students. The content learning function can also direct the database connection function to upload students' learning tracks after learning tasks are completed.

Furthermore, a control panel was designed to display a set of buttons on the user interface of MLSS for students to operate multimedia materials (see Fig. 3). For example, students can use the "back button", the "next button" and "replay button" to control and interact with the MLSS. Students can also press the "video play button" that was used to display the video of teaching materials on the screen of mobile devices. The content learning function can be regarded as the user interface of MLSS.

Fig. 3. The example process of the content learning.

3.3. Tags searching function

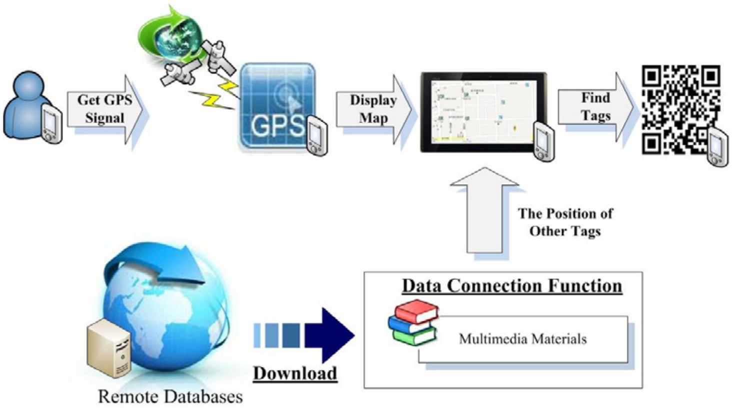

Fig 4. Diagram of the tags searching function.

The design of tags searching function was based on the foundation of u-learning. This function was designed to provide a location-aware learning environment for students. As shown in Fig. 4, this study adopted the GPS technology that accesses location and time information by connecting with satellites for developing the tags searching function of the MLSS. In order to gain the position of students, the function will calculate the longitude, latitude and position dilution of precision from the satellite's signals. When the function gets the position value of students, it will also access the position of other tags around students in their learning circumstances. After all values are collected, these data are integrated into an electronic map to provide more prompt information for students.

In essence, the tags searching function enables students to discover 2D barcode tags that are in their proximity. For example, if students want to find other tags which have the related connection with current learning tag, they can use the "QR(Quick Response) code button" to display the electronic map, which locates proximity to tags in the map area on the screen of mobile devices (see Fig. 5). Through the local-aware application, students can fully integrate themselves into the u-learning environment

Fig. 5. The example process of using QR code button for search tags.

4. The Importance of Local-Aware Learning Environment

An important ubiquitous learning concept is to provide a location-aware learning environment. In this environment, students' learning no longer is restricted to a fixed location that includes indoor and outdoor settings, and they also can notice the features of problem situations by using location-aware computing technology. Therefore, this study created a location-aware learning environment based on GPS technologies. The goal is to deploy a ubiquitous learning environment that identifies physical location automatically and to provide location-aware information services. That is, the MLSS not only detects the position of students, but also supports students to find out other learning tags that have related to current learning materials or around them in the real-world. In this study, we consider that learning at everywhere in our real-world is an importance issue in educational domains. Thus, we need the support of information and communication technologies to extend the classroom learning activities into other informal learning environment with suitable information.

5. The Importance of 2D Barcodes

The 2D barcode technology in education usually is placed in the context of m-learning. Such technology is applied to automatically share or summarize the key information for students, thus they can connect to the learning resource quickly and easily. In our study, the MLSS has integrated the 2D barcode technology to help students download multimedia materials and search meaningful learning contents. The low technical barrier of reading 2D barcode tags also enables students to incorporate these tags into their real-world learning environment. In other words, the MLSS can support students to obtain knowledge from the real objects or places, and allow them to learn in their daily living environment. Through 2D barcode technologies, the MLSS can be regarded as an ideal educational tool for teaching and learning, and further facilitate the development of u-learning environments.

6. Conclusion and Future Works

This study has described a learning tool called the Mobile Learning Support System (MLSS) that facilitate students learning in outdoor settings. The MLSS was designed and implemented to resolve problems that could be cause students hardly to combine real-world resources and digital world information together. Thus, the MLSS was developed to support students acquire multimedia teaching materials through three functions: the content learning function, the tags searching function and the database connection function. This study has used GPS and 2D barcode technologies to increase the effectiveness of the MLSS, which can enable students to organize information by interacting with their environment. With this level of technological support, students can easily combine their knowledge into outdoor learning activities.

Currently, this study has a few of short-term works to facilitate the development of the MLSS. First, we will design an authoring tool that can be used to enable teachers with domain knowledge to create and edit multimedia materials. When teachers work finished, the authoring tool can also automatically generate 2D barcode tags and define the relation between tags. Second, a material sharing website will be designed to provide an internet platform where students can gain access to multimedia materials and share their learning experiences with peers and teachers. Another work is to plan and conduct a formal evaluation in Taiwan schools, such as high schools or colleges, etc. All data from the quantitative and qualitative analysis will be collected to investigate the usability of the MLSS. These works are currently under development.

The long-term future direction of this study is to develop a suitable cooperative function for students to team up with peers. Another future goal is to increase the flexibly of design that allows MLSS is used in a variety of applications or environments without the need to redesign the architecture. We believe that the MLSS can support students to develop the knowledge and skills required for our rapidly changing global society.

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