British Journal of Educational Technology *Vol 44 No 2 2013* E57–E62
doi:10.1111/j.1467-8535.2012.01343.x

Colloquium

The implementation of mobile learning in outdoor education: Application of QR codes

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Introduction

Smith (1987) contends that outdoor education is important for various academic subjects, such as geography, history, anthropology and natural sciences. Outdoor education is provided to impart knowledge to students, who also gain experience from these learning activities (Rickinson, 2001). Outdoor education has a long tradition in Finland (Kuronen, 1997). It has been found to be an effective way of learning (Bogner, 1998; Palmberg & Kuru, 1998). Teaching and learning that takes place outside the classroom, especially outside the school building, has other values and qualities compared with the more traditional form of education inside the classroom (Pia, Eila, Sirpa & Marja, 2011). In outdoor education, to create a dynamic education environment, teachers must engage in constant exploration to gain experience in delivering courses (Pleasants, 2007; Thorburn & Allison, 2010). Knapp (1996) mentions that the main purpose of "outdoor education" is to provide meaningful contextual experiences—in both natural and constructed environments—that complement and expand classroom instruction, which tends to be dominated by print and electronic media.

Greenaway (2004) mentions many aspects of outdoor education (camp cooking, map reading, weather forecasting, first aid and many environmental education topics) so we learn that mapping is one of the fundamental tools utilized in outdoor teaching, especially in the cases of geography, environment and natural sciences. Green maps (GMs) are a product of the emerging trends in promoting nature, sustainability, the ecosystem and environmental friendliness. These maps use a globally unified icon to show the relationship between humans and the environment. GMs are easy to comprehend, simple and effective tools commonly used by communities and schools for environment exploration and education ((Green map activity guide, 2005). Youth-driven GMs have gained in popularity throughout the global GM network. Highlighting the ecologic and cultural resources that intersect with our daily life is an essential step toward healthier, more beautiful and more sustainable communities. Seeing these resources and our local environments through the eyes of our young people can be an enlightening and educational experience. GMs have extensive applications in outdoor education Green Maps by youth worldwide, n.d.). Zuber (1999), and Green and Swanitz (1991) stated that GMs are a relatively new topic for students; thus, they better stimulate learning motivation and appreciation.

Even GMs have limitations in presenting time-related information and as well as space limitations in presenting data; information technology (IT) is a great solution to these problems. The emergence of wireless Internet access, smart phones and the availability of tablet computers have overcome time and space constraints on communication. Similarly, we are no longer inhibited by conventional learning environments. Web-based learning has also evolved from a traditional

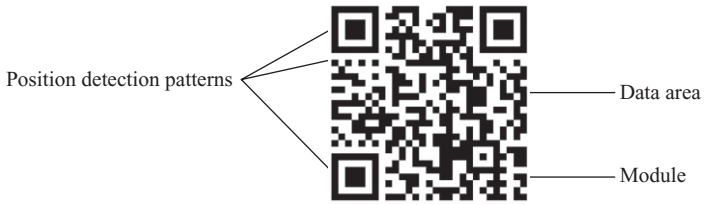

Figure 1: Quick Response code

approach into a modern wireless approach. The advancement of ubiquitous computing technologies has enabled teaching to be provided in unlimited locations, creating an ubiquitous m-learning environment. m-learning integrates e-learning, wireless Internet access and mobile technologies, and enables learners to acquire learning materials, or interact and communicate with teacher(s) or fellow learners via mobile devices and wireless Internet access (Hsi, 2003). The congruent trend in the development of education worldwide involves equipping every person with the basic knowledge and skills to use IT (Hiltz & Turoff, 2005; Lim & Kim, 2003). Mayer (2001) argued that "multimedia messages designed according to people's mental processes are more likely to result in meaningful learning compared to those not based on people's mental processes." Adopting this approach, employing multimedia tools in the learning environment and regarding multimedia tools as the preferred teaching mediums, these types of information systems are highly likely to increase students' learning effectiveness (Elliot, 2009).

To overcome the shortcomings of a map, we choose Quick Response codes (QR codes) as the intermedia to display additional data on a GM. QR codes are two-dimensional barcodes with a storage capacity of up to 1000 characters, which can be used to store relevant information, such as images and markers. The color and size of the QR codes are not specified. Additionally, providing that no more than 30% of the icon area is damaged, the decoding process will be unaffected. QR codes have been employed globally for many years. Using a digital camera on mobile devices to scan QR codes, the recognition software installed in the device can interpret the data in the code and then present the data in the form of multimedia messages. Quinn (2000) defined m-learning as learning using mobile devices, and it is independent of location in time or space. It will also include some interactive practice activities that allow the learner to practice and to provide some personalized feedback. From Quinn's comment, we see that ubiquitous m-learning information systems are ideal for use in education.

Figure 1 shows an example of a QR code. According to the Japan official QR code (http://www.denso-wave.com/qrcode/index-e.html), the square blocks in the three corners of the squared icon enable the software to locate and recognize the icon; thus, users are not required to aim at the icon carefully for the software to detect and read the QR code. In this study, we designed a service (equipment) based on the concept of QR codes. The design is not restricted by time or space, and can provide digital information and materials to learners, enabling them to acquire knowledge. Our design adopts nonsynchronous mobile learning (Chen, Kao & Shen, 2003) as the core concept and incorporates the use of the Internet. Through the website address encoded in the two-dimensional barcode, users are redirected swiftly and accurately to relevant websites to obtain additional multimedia messages and information.

Integrated QR Code Learning System in outdoor education

This study developed an innovative tool for diverse outdoor learning environments that can enable teachers to use and apply ubiquitous teaching tools. We developed an outdoor education information system that combines natural and cultural environment GMs using QR codes. The result is a GM information system that contains QR codes. The QR codes on the maps were

employed as mediums and used to install wireless Internet access. We also collated information on the scenic spots highlighted in the original maps, transformed the information into audiovisual teaching materials and then stored the materials on a digital information platform. By using mobile devices with decoding software to scan QR codes, users can be redirected over the Internet to the digital information platform that contains audiovisual material and audio guides. The framework of our m-learning tool is shown in Figure 2.

The system design flow is further explained later.

1. The GM was designed according to the participants' collective perception, with GM professionals, tutors and the community development association participated in the design process.
2. Information on the scenic spots highlighted in the original maps was transformed into audiovisual teaching material.
3. The developed audiovisual teaching materials were stored on a multimedia learning platform server, and the corresponding QR code were generated.
4. The generated QR codes were printed and placed in the suitable positions on the GM.
5. The Integrated QR Codes Learning System with GM was completed.

System usage procedure:

1. The user uses the camera function and decoding software in the mobile device to decode the QR code on the GM.
2. The mobile device decodes the OR code, obtains the Web address of the corresponding e-learning website and links to the specific learning content.
3. Within the specific learning content destination, the user can navigate through the interface using audiovisual material or audio guides. The interface is also provided in different languages.
4. The specific learning content destination contains questions the teacher has selected for the students to explore and answer. Group discussions, presentations and learning evaluations can be conducted using this system. Before lessons, the teacher can update the questions for the students online.

An Integrated QR Code Learning System scenario

One teacher participated in a practical workshop providing training on how to use the system, gaining in-depth knowledge of the system, which they could incorporate into their outdoor education. The teacher gained a unique perspective and experience applying QR code information systems. Subsequently, the teacher designed a learning course entitled "Fun Group Exploration Activities" and took students on an outdoor education trip to a location with wireless Internet access facilities. The students were equipped with the maps with the QR codes and mobile devices with QR code decoding software. On location, small groups of students were instructed to select a plant they wanted to study from the designated parameters. Through exploratory navigational learning using audiovisual materials and audio guides, the students gained relevant knowledge, such as whether the plant was indigenous and during which months the plant flowers. Group learning, group sharing and the questions posted on the system were provided not only for students to learn the answers to questions but also to demonstrate the convenience of mobile learning in diverse locations. The teacher recognized the usefulness of the system and the diverse learning applications it offers, and expressed significant willingness to adopt the system for outdoor education.

Discussion

To evaluate the QR code information system, this study employed the technology acceptance model (TAM) to assess the feasibility and applicability of the system. The evaluation tool used was a questionnaire we developed based on the TAM questionnaire designed by Davis (1989).

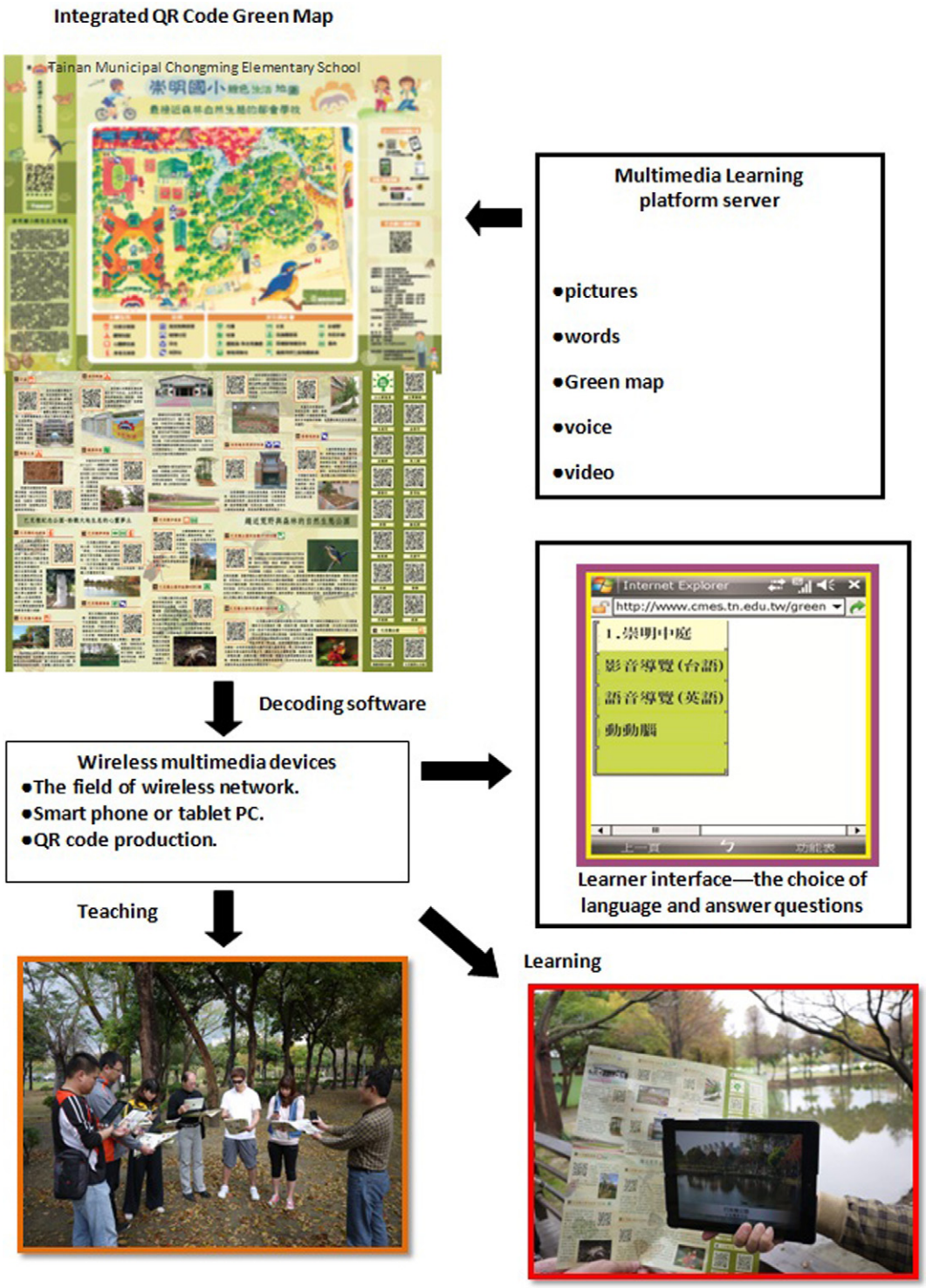

Figure 2: Integrated Quick Response (QR) Code Learning System architecture

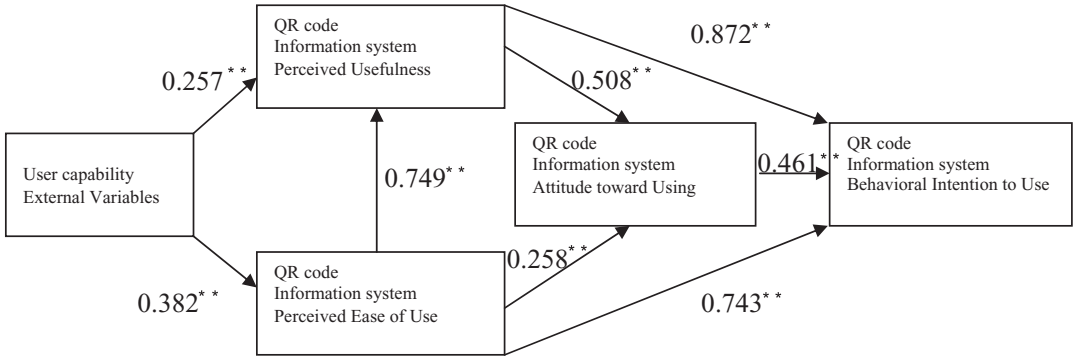

Figure 3: Technology acceptance model for Integrated Quick Response (Q-R) Code Learning System

Questionnaires were distributed among 160 elementary teachers. These teachers first participated in a 2-hour workshop on the Integrated QR Code Learning System to learn the design concepts and functions of the QR code information system GM. We provided the teachers with mobile devices to experience the system in outdoor settings. Then, the teachers were instructed to complete the questionnaires. The main points for analysis (the variables) were the aspects of "user capability," "usefulness," "ease of use" and "attitudes and willingness to adopt." We used multiple regressions to develop a path for teacher willingness to adopt the QR code information system; the analysis results are shown in Figure 3.

The analysis results indicated that the various paths in the TAM model were significant. The correlation coefficient of the effect of the ease of using the QR code information system on the QR code information system usefulness was 0.749. This indicates that the higher the perceived ease of using the QR code system a teacher displays, the more positive their attitudes toward the perceived usefulness of the QR code system are. The correlation coefficient of the effect of the QR code information system usefulness on the teachers' willingness to adopt the QR code information system was also high at 0.872. This indicates that the higher the perceived usefulness of the QR code system, the higher the teachers' willingness to adopt the QR code information system. In the path analysis, the correlation coefficient of the effect of the ease of using the QR code information system on teachers' willingness to adopt the QR code information system is 0.743. This indicates that the greater the perceived ease of using the QR code information system, the higher teachers' willingness to adopt the QR code information system. This finding differs from that reported by Davis (1989) using the TAM model. The results of this study show that both the ease of use and the usefulness of the system have a significant positive correlation with teachers' willingness to adopt the system in the future.

Summary

This study presents an m-learning method that incorporates QR codes. This learning method not only achieves the objectives of outdoor education, but it also increases applications of Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2001) in m-learning for practical use in a diverse range of outdoor locations. When implementing and using the system, we received feedback and suggestions from elementary teachers who participated in this study. These teachers expressed significant interest in using the Integrated QR Code Learning System to conduct outdoor educational activities. They also stated that the m-learning devices and system developed in this study achieved the planned learning outcomes, provided additional opportunities for interaction and facilitated teaching in a diverse range of locations. The system can be used as learning material or an experimental tool to investigate students' learning performance. With the revision of global

education methods, new message and communication technologies are being developed, which are set to alter how this "information" generation learns. Our study shows that the design of educational courses and lessons should be adjusted to include new learning methods that integrate technology with the life experience of the new generation in outdoor education. The results showed that the Integrated QR Code Learning System is highly acceptable for teaching to evaluate the learning acceptance is required in the future study.

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