Embedding mobile technology to outdoor natural science learning based on the 7E learning cycle *

Kuan-Jhen Huang
Institute of Graduate Institute of Learning & Instruction, National Central University
Taiwan
961207007@cc.ncu.edu.tw

Tzu-Chien Liu
Institute of Graduate Institute of Learning & Instruction, National Central University
Taiwan
ltc@cc.ncu.edu.tw

Sabine Graf
Institute of Graduate Institute of Learning & Instruction, National Central University
Taiwan
sabine.graf@ieee.org

Yi-Chun Lin
Institute of Graduate Institute of Learning & Instruction, National Central University
Taiwan
961407001@cc.ncu.edu.tw

Abstract: Outdoor learning in areas such as natural science has high potential to enhance learning by giving students a real experience of what they shall learn. However, traditional outdoor learning faces several problems. One of the major problems is that students lack instant guidance so that they often can not get suitable feedback. In the long run, students' learning achievements are limited. Many researches have been conducted in the area of mobile and ubiquitous learning, using mobile technology to create ubiquitous learning environments. In this paper, we investigate the usage of mobile technologies for overcoming problems of traditional outdoor learning and propose a concept for outdoor learning in the area of natural science in elementary schools. To provide students with a pedagogically grounded instructional design, we applied the 7E learning cycle for technology enhanced outdoor learning, aiming at providing students with a ubiquitous learning environment where they can experience natural science.

Introduction

The subject of natural science is a good example for the potential and benefits of outdoor learning. In learning natural science, the text books just provide text description or few pictures. For example, the introduction of flowers in books just gives the readers a picture of the flower and some introduction. However, for getting a comprehensive understanding of flowers, it is necessary to go out and see real flowers. To provide students with real experiences, teachers can take students out of classroom to practice outdoor learning.

* The authors would like to thank the National Science Council of the Republic of China, Taiwan, for financially supporting this research under Contract No. NSC 097-2811-S-008-001- ,Contract No. NSC 96-2520-S-008 -007 -MY2 and Contract No. NSC 96-2524-S-008-002-.

However, some researchers mentioned that there exists some difficulties in conducting effective outdoor learning dealing mainly with the students' lack of guidance from experts (e.g., Tan, Liu, & Chang, 2007; Lai, Yang, Liang, & Chan, 2005). In outdoor learning, students typically scatter to different areas of the school or park in groups or in individual, which makes teachers to supervise and instruct students difficultly. Therefore, in traditional outdoor learning, students can not get instant aids, and they may also do not focus on what they should learn.

Recently, mobile and ubiquitous learning has become a popular trend in education (e.g., Chen, Kao, & Sheu, 2003; Chen, Kao, & Sheu, 2005; Tan, Liu, & Chang, 2007). According to some researchers (Hwang 2006; Chen *et al*., 2003), a ubiquitous learning environment has the following features:

1) Context awareness: Sensors allow detecting the environment where the learner is currently located and enables the mobile devices to react respectively.

2) Access information: Learners can use wireless LAN to connect to the internet and communicate with experts and colleagues, accessing information even when they are outdoor.

3) Ability of adaptation: In ubiquitous learning, the mobile device (e.g., PDA, Tablet PC, and mobile phone) can present the learning materials with respect to students' characteristics and needs. For example, by incorporating students' cognitive abilities, the mobile devices can present learning materials in a way that avoids cognitive overload.

4) Instant aids: According to the needs of learners, in ubiquitous learning environments teachers can provide some aids instantly by using mobile devices.

This paper demonstrates how ubiquitous learning can help in overcoming the abovementioned problems of traditional outdoor learning, including the lack of guidance and of engagement in the learning material for students and the difficulties for teachers to supervise their students. As an application area, natural science in elementary schools was chosen, which can be considered as one of the most suitable subjects for outdoor learning. In ubiquitous Nature Science Learning, students use mobile devices to get assistance in learning. By doing so, students can get instant information. When they approach a learning target like *Koelreuteria formosana*, the mobile device can detect the target and show key information to students. Besides, teacher also can provide scaffolding by using communication functions of the mobile devices.

In this paper, we propose an approach for ubiquitous outdoor learning in the domain of natural science. From a pedagogical point of view, we base the design of the outdoor learning activities on the 7E learning cycle (Eisenkraft, 2003), using mobile devices to support the whole learning process. In the following section, the 7E learning cycle is described in more detail. Subsequently, we propose a concept for using the 7E learning cycle in outdoor learning, showing how ubiquitous learning can support elementary school students in learning about plants. The last section concludes the paper and presents future work.

7E Learning Cycle

The 7E Learning Cycle (Eisenkraft, 2003) is an instructional design model, which was developed from the 5E learning cycle (Bybee et al., 2006). The 5E learning cycle describes the learning process in 5 phases: Engage, Explore, Explain, Elaborate, and Evaluate. Based on the 5E learning cycle, the 7E learning cycle additionally emphasizes the activation of prior knowledge and the transfer of learning. For this reason, the 7E learning cycle was extended by two new phases, namely Elicit and Extend. In the following paragraphs, the seven phases of the 7E learning cycle are described in more detail.

1) Elicit: When learning new things, the prior knowledge serves as background information. The learners usually use the original experience to recognize new information. If the new material fits their original

knowledge structure, they are able to assimilate the information, otherwise they have to reorganize or change their schema. The Elicit phase focuses on making learners retrieve existing experience that is associated with the new knowledge. Balci, Cakiroglu, and Tekkaya (2006) give a good example for the Elicit phase by asking students about photosynthesis and respiration. The students might know the concept about photosynthesis and respiration before, and by asking them questions the teacher want students to remember this prior knowledge.

2) Engage: In the Engage phases the instructor tries to motivate learners and make them engaged in the learning activity. As an example, many natural science and math teachers use misconception to motivate students to think about problems. Besides, watching some videos also has high potential to motivate students.

3) Explore: This phase is about using prior knowledge to experiment with the new knowledge. The teachers provide some guidance to learners as well as let learners explore the new knowledge and solve questions by themselves. Learners are not just passive receptors; they also have the chances to inquire knowledge actively. For example, a teacher demonstrates several chemicals in a course and students have the chances to perform some experiments. If the result of the chemical reaction is wrong, students need to find what the problems were (e.g., wrong process or wrong chemical).

4) Explain: In this phase, there is more interaction between instructor and learners. After exploring, students explain what they found and encountered in the previous phase, and generate a concept. By explaining what they know, teachers can understand how to guide students to modify and enhance their concepts. For example, students practice some experiment to explore some phenomenon, and they try to explain the data they got.

5) Elaborate: In the Elaborate phase, teachers provide more complicate questions to make learners reflect about their gained knowledge. Besides, in order to elaborate the learned concepts, teachers aim at finding out where learners have difficulties and provide aids to overcome these difficulties. Therefore, formative assessment methods can be used.

6) Extend: The Extend phase deals with the retention of the learned concepts and the transfer of learning. To remember knowledge is the first purpose, but use it to solve problems in other situation is what this phase really aims at.

7) Evaluate: The teachers do summative assessment of the students and test whether the students achieved the learning goals. Moreover, the teachers also get feedbacks from the students' outcome and can modify their teaching strategies for the next course.

A concept for using the 7E learning cycle in outdoor mobile learning of natural science education

In Taiwan, elementary schools see environmental education as an important issue. So, it is very common to find many ecological gardens, such as butterfly gardens and plant gardens in schools. In this research, we design a ubiquitous learning environment for learning about plants, using the 7E learning cycle and apply it for facilitating outdoor learning. By developing a curriculum based on the 7E learning cycle and ubiquitous learning, teachers can integrate the both features to create a more real and motivating learning experience for students. This relation is presented in Figure 1.

In order to prepare the ubiquitous course, information about plants in the school has to be collected and stored in a database representing the environment of the school. Furthermore, technical equipment has to be set up in the school, such as wireless LAN connection and context-aware facilities. Wireless LAN allows students to access the internet everywhere in the school and connect to other students and teachers.

Context-awareness allows students to get instant response as soon as they come close to a learning target, so that it is easy to get information about it.

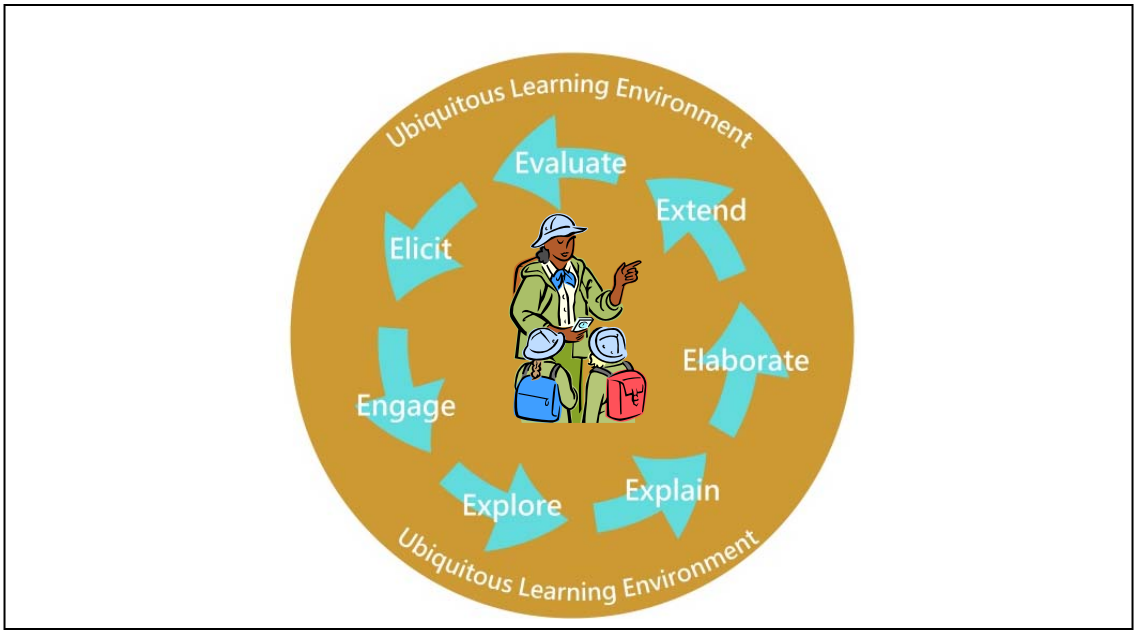

Figure 1: Ubiquitous learning environment and it's relationships to the 7E Learning Cycle

In the following paragraphs, we introduce a course design based on the seven phases of the 7E learning cycle, applied to outdoor learning of plants at school. For each of the seven phases, the planned learning activities are described and examples are provided.

1) Elicit: The teacher prepares materials such as video and pictures for mobile devices. The materials might have been learned by students before, or students know it but are careless about it. For example, a teacher can set multiply choice questions in mobile devices to remind students about the difference between dicotyledon and monocotyledon.

2) Engage: The teacher divides students into several groups and let students conduct a competition activity like treasure hunting. The teacher sets many paths on a map showing the school plants and asks students to find the plants. Through context-aware facilities students' devices are informed when they approach a target in their path.

3) Explore: When students arrive the target, their own mobile device provides some clues such as the name of the plant, the size of the leaves, or the color of its flower. Moreover, the clues are presented in the form of a concept map, so that students can read the information more effectively. Students could choose the clues they are interested in, and use this information to explore the plant in detail. The mobile device is able to adapt the learning material to the students' interests. Furthermore, the device provides students with some tasks in order to encourage them to do some hands-on experience. If they have any questions, they can use their mobile devices to connect with the teacher who can provide some comments.

4) Explain: The mobile devices show some questions to promote students to think and explain what they have explored and learned in the previous phase. An example might be used to ask why the seeds in some plants are so small. Students need to find a good answer by team work.

5) Elaborate: In this phase, the mobile devices continue giving information to students. For example, regarding seed issue, the devices can give several seed pictures, showing various shape of seeds. So the

students can observe more seeds and try to find some pattern.

6) Extend: In this phase, students are provided with tasks were they have to remember what they have learned so far and apply it in different situations. Continuing with the issue of seeds as an example, students are provided with some situations about how the plant spread their seeds. For example, the mobile devices show a map which includes many different places. Students can use the seed information they just got to find the original place the plants grow. This map allows checking whether students can use the property of seeds to infer the location where the plants grow.

7) Evaluate: In the last phase, the teacher collects the information about the learning process of the students from a central computer, which received data from each mobile device. In order to evaluate the students' learning achievement, peer assessment can be used.

Conclusion

This paper introduces a concept for using mobile and ubiquitous technologies in order to enhance outdoor learning. In particular, we propose a course design for facilitating learning about plants at elementary schools. This course design is based on the 7E learning cycle, a well-grounded instructional design model.

By using mobile and ubiquitous technologies in outdoor learning, teachers can have more control in the learning process and students can be provided with instant guidance. Both of these issues were identified as major problems in traditional outdoor learning.

Future work will deal with implementing the course in practice at an elementary school and evaluating our concept in terms of demonstrating that mobile and ubiquitous technologies can overcome the weaknesses of traditional outdoor learning and make outdoor learning more effective.

References

Balci, S., Cakiroglu, J., & Tekkaya, C. (2006). Engagement exploration, explanation, extension, and, evaluation (5E) learning cycle and conceptual change text as learning tools. *Biochemistry and Molecular Biology Education, 34*(3), 199-203.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A., Landes N. (2006). The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications. Colorado Springs: BSCS.

Chen, Y. S., Kao, T. C., & Sheu, J. P. (2003). A mobile learning system for scaffolding bird watching learning. *Journal of Computer Assisted Learning, 19*(3), 347-359.

Chen, Y., Kao, T., & Sheu, J. P. (2005). Realizing outdoor independent learning with a butterfly-watching mobile learning system. *Journal of Educational Computing Research, 33*(4), 395-417.

Eisenkraft, A. (2003). Expanding the 5E model. *Science Teacher, 70*(6), 56-59.

Hwang, G. J. (2006). *Criteria and strategies of ubiquitous learning*. Proceedings of the IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing-Vol 2-Workshops-Volume 02, 72-77.

Lai, C. H., Yang, J. C., Liang, J. S., & Chan, T. W. (2005). *Mobile learning supported by learning passport.* Proceedings of the Fifth IEEE International Conference on Advanced Learning Technologies (ICALT), 595-599.

Tan, T. H., Liu, T. Y., & Chang, C. C. (2007). Development and evaluation of an RFID-based ubiquitous learning environment for outdoor learning. *Interactive Learning* Environments, *15*(3), 253 - 269.