An Adaptive Navigation Support System for Conducting Context-Aware Ubiquitous Learning in Museums

Abstract

In context-aware ubiquitous learning, students are guided to learn in the real world with personalized supports from the learning system. As the learning resources are realistic objects in the real world, certain physical constraints, such as the limitation of stream of people who visit the same learning object, the time for moving from one object to another, and the environmental parameters, need to be taken into account. Moreover, the values of these context-dependent parameters are likely to change swiftly during the learning process, which makes it a challenging and important issue to find a navigation support mechanism for suggesting learning paths for individual students in real time. In this paper, the navigation support problem for context-aware ubiquitous learning is formulated and two navigation support algorithms are proposed by taking learning efficacy and navigation efficiency into consideration. From the simulation results of learning in a butterfly museum setting, it is concluded that the innovative approach is helpful to the students to more effectively and efficiently utilize the learning resources and achieve better learning efficacy.

Keywords:

situated learning; authentic learning; ubiquitous learning; context awareness; navigation support

1. Introduction

In recent years, the innovation and advance of mobile computing and wireless communication technologies have led to a new research issue in education, that is, to develop a novel learning environment so that the students can learn in any place at any time (Sakamura,& Koshizuka, 2005). Furthermore, with the help of sensor technology, the learning system is able to detect the learning behaviors of students in the real world, and hence more active and adaptive learning activities can be

In a context-aware ubiquitous learning (u-learning) environment, individual students are guided to learn in a real-world situation with supports or instructions from a computer system or using a mobile device to access the digital content via wireless communications, where the learning system is able to detect and record the learning behaviors of the students in both the real-world and the virtual world with the help of the sensor technology (Ogata & Yano, 2004; Hwang, Tsai, & Yang, 2008).

In traditional web-based learning environments, navigation support is an important issue. Researchers have given considerable attentions on flexible curriculum sequencing control to provide adaptable personalized learning programs. Zhao and Wan (2006) described relationships between knowledge units in a graph structure and proposed an algorithm to select the shortest learning path. Chen (2008) proposed a genetic-based personalized learning path generation scheme for individual students to support personalized web-based learning. Researchers found that, an inappropriate navigation support in web-based learning tends to lead disorientation during learning processes, thus reduce learning efficacy. When the paradigm shifts to the context-aware u-learning environments, navigation supports becomes even more important as the student is learning around the real space rather than cyberspace (Chu, Hwang, Huang, & Wu, 2007). In web-based learning environment, all the learning contents in a curriculum are sequenced by hyper links, but there is no concrete sequence in authentic world without navigation support.

In the u-learning environment, there are many target objects for students to observe and learn about. It is difficult for the students to determine what to visit without any guidance. They might fail to understand the relationships among those target objects. That is, they are likely to be disorientated in the learning process. In

gardens or classrooms, researchers have found that the learning quality might be significantly affected if too many people attempt to visit or learn about the same target object simultaneously (Chang, Chang & Heh, 2007; Din, 2009; Limongelli, Sciarrone, Vaste, & Temperini, 2008; Hwang, Kuo, Yin, & Chuang, 2010). Thus, it is necessary to guide them adequately to visit a target object at the proper time, so that the learning quality for each target object can be better.

There are several concerns while designing an adaptive navigation support system for u-learning activities.

(1) *Capacity limitation*: The learning targets in the learning environment are real-world objects; that is, the number of simultaneous visitors needs to be controlled. The capacity limitation of a learning object will affect the learning quality. For instance, when a crowd of students surround the learning objects in the same time, it is quite possible that most students are not able to clearly observe the learning objects; consequently, the learning quality could be significantly affected.

(2) *Dynamic configuration*: The contexts in a u-learning environment usually change frequently owing to the movements of the students (e.g., number of students in an area and the location of an individual student) and the variant of environment conditions (e.g., temperature, moisture and noise), and hence the learning path need to be scheduled dynamically based on the changes of the personal and environmental contexts (Hwang, Tsai,, & Yang, 2008).

(3) *Immediate response*: As the students are guided to learn in the real world, the learning guidance needs to be provided immediately. When a student finishes his/her learning about one learning objects, he/she should receive further instructions immediately.

(4) *Time constraint*: Most u-learning activities have their time constraints. Students must finish their learning in a pre-given period of time. In most cases, it is difficult to learn all the learning objects exhaustively in time. To obtain a best learning efficacy in a u-learning activity, it is reasonable to learn the most important learning objects first.

It can be said that the adaptive navigation support problem for u-learning is challenging since it is not only an optimization problem, but also a real-time guidance problem. So far, few literatures have discussed the problem. In practical applications, usually a fixed learning path is provided for all of the students without considering personal and environmental situations.

In this paper, we attempt to explore the unique characteristics of navigation support mechanisms for context-aware u-learning and find out the major factors that affect the learning efficacy in such an environment. Moreover, two navigation-supporting algorithms, the Maximized Objective Navigation Support algorithm (MONS) and the GEnetic Navigation Support algorithm (GENS), are proposed to cope with the problem. For fitting the variance of the situations, several experiments were simulated. By comparing the performance of MONS, GENS and Random Assignment with a set of data, it is found that MONS outperforms the others in most of the cases. Moreover, a practical application has shown the benefits of the innovative approach in helping the students to more effectively and efficiently utilize the learning resources and achieve better learning efficacy.