Delivering Location-awareness Navigation Questions According to Learning Performance in Mobile Learning Environment

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ABSTRACT

The popularization of mobile devices is changing e-learning environments into mobile learning environments. How to lead students learn in the mobile learning environment becomes an important task. Students should have learning guidance to learn concepts they needed in mobile learning environment. This research purposes a learning navigation system in mobile learning environment based on learning performance and student's location. Students can study learning objects they need and follow guidance to next learning spot.

INTRODUCTION

With the development and popularization of mobile device and e-Learning environment, mobile learning becomes a new trend [3][9]. The wireless technology allows users learning at anytime and anywhere. There are many researches about e-learning platforms and frameworks [8][9][11]. Goh and Kinshuk (2004) purposed four research domains in m-learning system: (1) content, (2) user model, (3) device, (4) connectivity, and (5) coordination [2].

There is exam system in Goh and Kinshuk's research which is used to estimate students' learning effects and guide students during learning. In this research, we purpose a learning guidance system based on navigation questions. The system gives questions to students according to their learning states and locations; system gives questions to students to lead students to next learning spot according to their answers. In this research, learning concepts stores in knowledge map and uses information theory to calculate students' answers and give guidance questions.

In this paper, Section 2 talks about research backgrounds and the knowledge structure used in this research. Section 3 designs the strategy of learning navigation. Section 4 describes the system design and Section 5 is experiment and discussion. Conclusions and future works are discussed in Section 6.

REARCH BACKGROUNDS

The concept map has proposed by Joseph D. Novak in 1960s, is a graphical tool for organizing and visualizing knowledge. Concept map is composed by concept nodes (to represent concepts) and linking phrases (to represent the relations among concepts) [5]. Hierarchical concept map uses hierarchical way to present the relations among concepts. The concepts in higher levels are abstract and general concepts; on the other hand, specific and concrete concepts are in the lower levels. Concept map can help students to organize and integrate the concepts they have already known. and furthermore, to learn new concepts. In traditional education, teachers often use the concept map to diagnose students' learning achievement and mental models [10].

In cognitive psychology, a schema is used to identify the real world knowledge and store the knowledge attributes. A schema is a high-level knowledge representation formalism integrated with nature, events and text. [1][6]. Kuo et al. (2002) have adopted the knowledge map, which combines the concept map and the concept schema to represent knowledge [4]. The knowledge map has two benefits: (1) it denotes the relationships between concepts clearly, similar to the concept map; (2) it represents the concept attributes and stores the attributes in concept schema. A Knowledge Map example is shown in Figure 1.

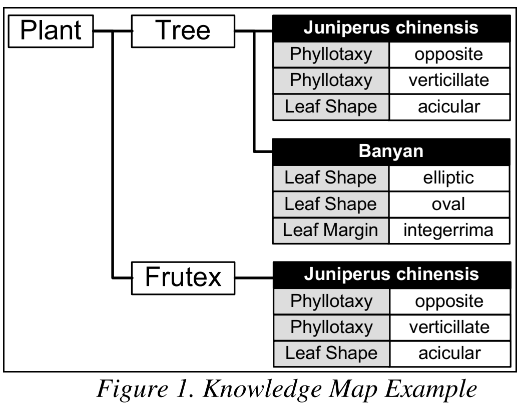

Figure 1. Knowledge Map Example

Information theory is used to measure that wether data is useful or not according to probability [7]. The data with higher information means more important and significant. The information of an learning object (o_i) comes from the probability of the learning object appears in events. The equation would be

$$I(o_i) = \log_2(\frac{1}{p_{o_i}}) \quad (1)$$

This research uses information to decide where student should go and which object should learn. There are two measures can be used to deciding navigating objectives: Learning Object Information $I(o_i)$ and Characteristic Information $I(c_j^{type})$.

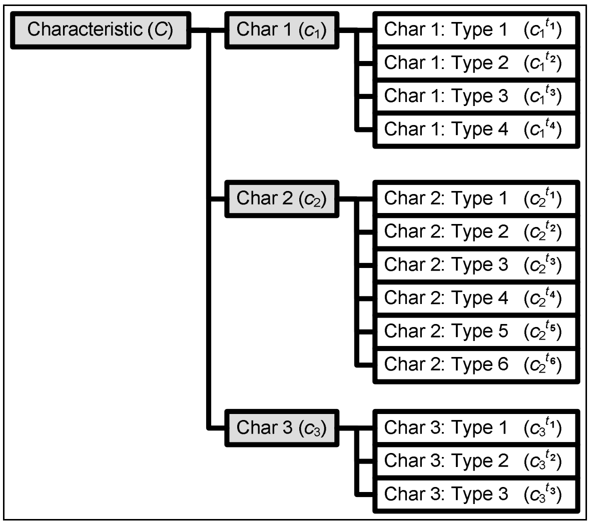

Figure 2. Example of Characteristic Hierarchy

The characteristic hierarchy in Figure 2 represents all characteristics and characteristic types of object. The information of characteristic types is only related to the probability of characteristic type. In this research, we assume all of the probabilities of characteristic types are equal. For example, in Figure 2, the probability of $c_1^{t_3}$ is (1/3)*(1/4) = (1/12). Therefore, the information of $c_1^{t_3}$ is:

$$I(c_1^{t_3}) = \log_2(\frac{1}{1/12}) = 3.5850\,.$$

The information for all characteristics is $I(c^{type})$ in Figure 2 is [3.5859, 4.1699, 3.1699]. The information of learning object is the total information of its characteristics.

$$I(o_i) = \sum I(c_j^{t_k}), \quad \forall c_j \in o_i \text{ and } t_k \in c_j \quad (2)$$

An example of learning objects and its characteristics is shown in Figure 3. According to the Eq.(2), we can find the information for each learning object. The information of learning objects in Figure 3 are:

$$I(o_1) = 3.5859 + 3.5859 + 4.1699 = 11.3417$$

$$I(o_2) = 4.1699 + 4.1699 + 3.1699 = 11.5097$$

$$I(o_3) = 3.5859 + 4.1699 + 4.1699 + 3.1699 = 15.0996$$

The learning object with highest information is picked as the first learning object.

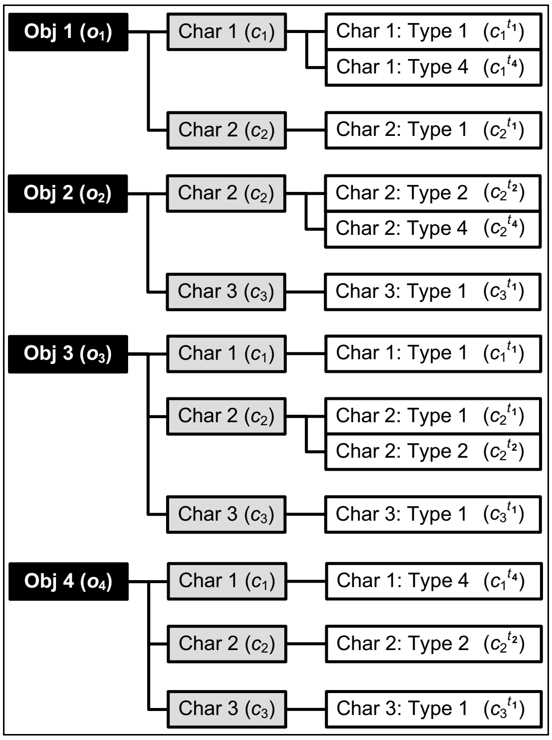

Figure 3. An example of Learning Objects and its Characteristics

LEARNING NAVIGATION

A Situated Map is developed in this research in order to store spatial knowledge and related learning objects in all learning spots in a mobile learning environment. There are three major elements in the situated map.

1. Area, a_i : indicates learning spots.
2. Path, $p_{u,v}$: presents the path and distance between two areas.
3. Learning object set, O_k : denote learning objects in learning area a_i.

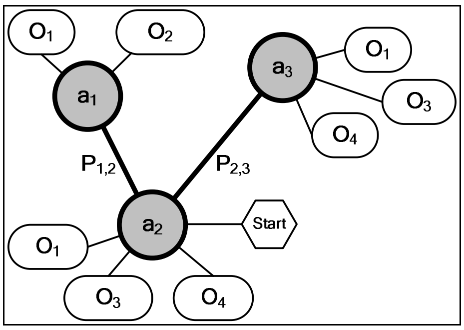

Figure 4. Situated Map Example

Figure 4 shows a situated map within there are three different learning spots. Assuming the start location for students is learning spot a_2. In spot a_2, students can find three learning objects, $O_2 = \{o_2, o_3, o_4\}$. Student could also go to spot a_1 through the path $p_{1,2}$ and observe learning objects in spot a_1. There is no path from spot a_1 to a_3. If students want to go to learning spot a_3 from spot a_1, they have to go to a_2 first then go to spot a_3.

When a student steps into the mobile learning environment, first learning object can be picked up by the system or assigned by teacher. After first learning object decided, the system can use situated map to point out which learning spot student should go. The system selects the learning spots contain the specific learning object and its distance between the learning spots and the student's current location. The learning spot with shortest distance from the student's current location is selected as the recommend learning spot.

After the student reaches the learning spot, the system gives the student several navigation questions to help the student observing the learning object. The questions are used to measure the student's learning effects, all concepts in questions have its corresponding information. The system selects the question with highest characteristic information to the student and selects another question to the student or leads the student to next learning spot consequently according to the answers.

In order to avoid observing same learning objects repeatedly, *Law of Diminishing Marginal Utility* is used. Law of diminishing marginal utility is a law of economics which measures the consumption degree of products..

According to the law of diminishing marginal utility, an effect parameter $\delta_{self} \in [0,1]$ is used to adjust the information of characteristics. Higher δ_{self} means the student will need to receive the information again and it also make student learn same object. The effect of law of diminishing marginal utility also affects the sibling characteristics through parameter $\delta_{silbing}$. Therefore, if student's answer is correct, δ_{self} and $\delta_{silbing}$ will set to lower values to avoid the student receiving same information again.

The formula of information adjustment for the concept c_c and its sibling concept c_s are:

$$I_{n+1}(c_c) = I_n(c_c) \times \delta_{self} \quad (3)$$

$$I_{n+1}(c_s) = I_n(c_s) \times \delta_{silbing} \quad (4)$$

The navigation process includes six steps:

1. choosing the first learning object according to the learning object information;
2. leading students to go to the nearest learning spot which has the specific learning object;
3. giving students navigation questions according to the learning object's characteristic types;
4. adjusting characteristic information and learning object information according to students' answers;
5. picking up the learning object with highest information within the learning spot and return to step3; if all learning objects in the learning spot have been learned then go to step 6;
6. choosing the next leaning object from other learning spots and return to step 2 until learning time is up.

Taking Figure 3 and Figure 4 as example, the first step is choosing learning object o_3 as the first learning object; the second step finds the learning spot a_2 is the closest learning spot and leads students to go to there; the third step selects two characteristic types, $c_2^{t_1}$ and $c_2^{t_2}$, as navigation question; according to student's answer, adjusts all information of characteristic c_2 and objects; since learning object o_3 still has highest information, the system chooses characteristic type $c_2^{t_1}$ as next navigation question; the system then keeps doing step 3 to step 5 until learning object $O_2 = \{o_1, o_3, o_4\}$ learned completely. After all learning objects in learning spot a_2 have been learned, the system chooses learning object o_2 as next learning object and leads students to go to the learning spot a_1.

DESIGN OF NAVIGATION SYSTEM

In this research, we designed a learning navigation system based on knowledge map and information theory. Figure 5 is the architecture of navigation system.

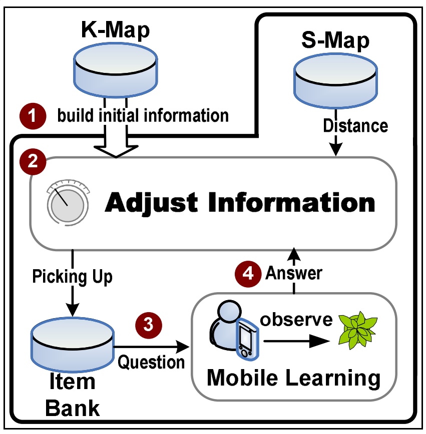

Figure 5. System architecture

The system extracts information for each learning objects in knowledge map at first (step 1 in Figure 5). Concepts in knowledge map are analyzed by experts and stored in database. Secondly, the concept with highest information is selected as learning objective (step 2 in Figure 5).

When the learning objective is selected, a navigation or learning question is picked up from item bank and sent via mobile devices. Students do mobile learning by observing learning objects according to the questions displayed on the mobile devices or following the navigation question to move to next learning spot (step 3 in Figure 5).

Finally, students select there answers as feedbacks based on their observations. The system selects the next learning objective or learning spot according to the answers provided by the students (step 4 in Figure 5). The step 2, 3, and 4, in Figure 5 form a learning loop and would be executed repeatedly if there is still learning objects needed for students to learn.

EXPRIEMENT DESIGN

This research uses navigation questions to give students guidance in the mobile learning environment. The experiment is expected to develop for 5^{th}-grade students, and the experiment unit, "Plant Observation", in the elementary level biology course in Cheng-Gong Elementary School, Tao-Yuan, Taiwan. All characteristics and plants that students need to know are stored in the knowledge map. The teacher will also need to build web pages to introduce the plants. This research uses wireless network and laptop as mobile device.

Students will be divided into several groups and assigned to different learning spots to start their learning activities. After they arrive the learning spots, students will use their laptops to notify the system where they are and the system will show the webpage to introduce the learning spots and give students navigation questions. Students then need to follow the navigation questions to obverse the plants and answer the questions. After students answer the navigation questions, the system will give students another navigation questions or lead students to other leaning spots according to students' feedbacks.

Figure 6 Screenshot of Experiment System

Figure 6 is the screenshot of navigation system. The upper-left panel shows teaching materials to introduce the learning spot and its learning objects. The upper-right panel shows the knowledge hierarchy of the learning unit. The bottom-left panel shows the situated map and the bottom-right panel shows the navigation question. Students can read teaching materials from their laptops; follow the navigation question to obverse the plants; and, answer the question.

During the experiment, there will be some problems needed to be solved: (1) Some learning spots might not be able to receive the wireless signal; (2) Students might not be able to find the plants immediately from pictures displayed on the mobile devices; (3) The guidance map might be too simple to use.

CONCLUSIONS

The research goal is building a navigation system to give students learning guidance according the information of learning objects abd its characteristics in the mobile learning environment. To reach the goal, this research uses the situated map to represent spatial knowledge; the knowledge map to store the learning objects and its characteristics in the mobile learning environment; and, the information theory and diminishing marginal utility to help the system choosing the learning object and characteristics and giving students learning guidance.

The system still has some works needed to do in the future: (1) establishing perfect wireless environment; (2) improving learning contents to fit different mobile devices; (3) providing simple and clear enough guidance include detailed map and clear guidance instructions.

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