Generating Location-awareness Items in Mobile Learning Environment

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ABSTRACT

Mobile learning allows students not only getting knowledge via electronic devices but also can see and touch the real objects physically in the learning process. Giving students instructions about which learning object in specific learning spot that students should observe first makes learning much efficient. For this purpose, this paper uses an item generating system to generate suitable navigation sentences to students. This research also takes information theory into consideration in order to decide which navigation sentence should deliver to the student first. At the end of this paper, an experiment system is implemented for the 5th-grade biology course, the Plant Observation.

1. INTRODUCTION

Mobile learning becomes an interesting issue in e-Learning field in recent years [4]. Mobile learning makes students not only getting knowledge via electronic devices but also can see and touch the real objects physically in the learning process. Students can access to any e-learning resources at anytime and anywhere via mobile devices, such as Personal Digital Assistant (PDA), mobile phone, tablet PC, and notebook [8].

Each learning spot in a mobile learning environment may have more than one learning object. Giving students instructions about which learning object they should observe first will make their learning more efficient. For this purpose, this paper constructs a navigating system to create human-readable instructions. The generated instruction is used to guide students to observe and learn the learning objects in sequence.

Section 2 introduces the research backgrounds, situated learning and knowledge map. The methods to navigate students learning in the mobile learning environment are described in Section 3. Section 4 designs a flow for location-awareness navigation system and implements an experiment system for plant-observation lesson. At the end, a brief conclusion is discussed in Section 5.

2. RESEARCH BACKGROUND

Lave proposed situated learning in the late 1980s and early 1990s and took learning as a situated activity [7]. Situated learning theory was based on Vygotsky's researches which proposed that human beings can only develop themselves by social interactions [10]. Situated learning theory described that human's everyday cognitions are related to their social situations and these cognitions construct their own knowledge representations in their minds. Furthermore, situated learning could make students construct more complete knowledge in their minds and allow them being able to apply what they have learned in solving real-life problems [1].

Applying situated learning into mobile learning environment could be an interesting issue, because the environment provides students a chance to 'touch' and 'observe' real learning objects. How to save the information of the real learning objects is an important problem and must be resolved. For this reason, knowledge base is an important component in designing navigation system in the mobile learning environment. This research uses Knowledge Map as the knowledge base. The architecture of the Knowledge Map involves two parts, Concept Hierarchy and Concept Schema, as Figure 1 shows [6].

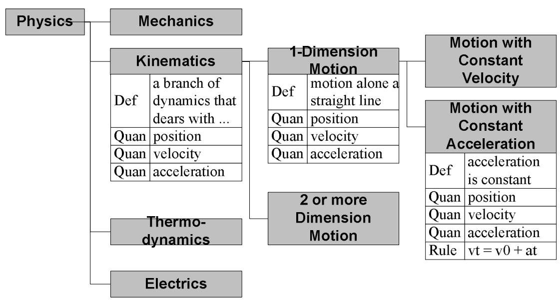

Figure 1. An example of knowledge map

1. Concept Hierarchy: concept hierarchy comes from the hierarchical network model [3]. Collins and Quillian have proved that human knowledge is stored in hierarchical architecture. Concept hierarchy presents the hierarchical relationships among concepts in the same domain.
2. Concept Schema: schema is the generic concept data structure in memory [9]. Concept schema

stores the concept attributes such like the definitions and examples.

This research uses knowledge map to organize the information that students must learn in mobile learning environment. Furthermore, arranging a suitable learning sequence and sending the navigating information to students.

3. NAVIGATION SENTENCES

In the mobile learning environment, each learning spot has various learning objects, which are defined as any entity can be used for education [5]. All of learning objects have different characteristics for students to learn. For example, students can learn the characteristics of a leaf when they are observing the tree. Figure 2 shows the leaf's characteristics of the camphor tree. Students can discover that the leaf shape is elliptic and the leaf margin is smooth and entire. There are three veins arising from the base of its leaf venation.

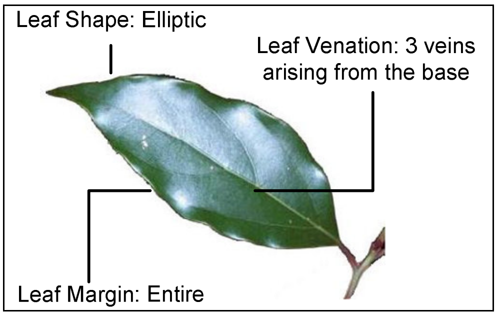

Figure 2. The example attributes of a leaf.

To guide students learning the features of the learning objects in an efficient way, this research focuses on finding a suitable learning sequence by arranging the learning objects and its features. The learning sequence makes students have a guidance to know which learning object they should learn first. There are three questions needed to be solved for this purpose. First of all is how to store the information of the learning objects and its related features; secondly, how to generate the navigation sentences to students via the electronic devices; thirdly, how to decide which learning object or related features that students should learn first.

(1) Knowledge Structure

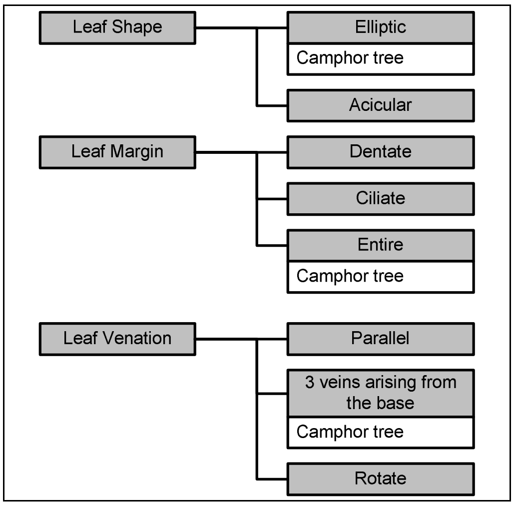

Figure 3. Example of Knowledge Map with leaf characteristics

The method to solve the first problem is using knowledge map which is mentioned in the previous section. The knowledge map organizes all the characteristics of learning objects in a structural way. Figure 3 shows an example of knowledge map with leaf characteristics. Three observable characteristics, leaf shape, leaf margin, and leaf venation, are listed in the root. The leaf shape of a plant could be either elliptic or acicular; the leaf margin could be dentate, ciliate, or entire; the leaf venation could be parallel, rotate, or 3 veins. These characteristic-types are the children of the root.

The concept schema in Figure 3 stores the plant name and related characteristic type. Taking Figure 2 as example, the camphor tree has elliptic leaf shape, entire leaf margin, and three veins arising from the base. Based on this information, the plant name, camphor tree, exists in three schemas with different nodes in Figure 3.

(2) Navigation Sentences

With the well-defined knowledge structure, the next step is to make a human readable sentence based on the knowledge map. Generative grammar is widely-used method for constructing/deconstructing sentences [2]. The purpose of navigation sentences is to ask students to observe the attributes of learning objects. For this reason, a navigation sentence should contain three elements, the learning object, the attributes, and the attribute types.

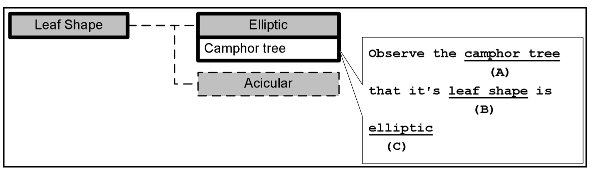

Figure 4. The relationship between constructing sentence and knowledge map

Figure 4 shows the connection between the knowledge map elements and the generated sentence. The left hand side of Figure 4 is a part of the knowledge map in Figure 3. If teacher wants students to observe the leaf shape of a camphor tree, an instruction just likes the right hand side of Figure 4. The sentence consists

(A) camphor tree, the learning object in the concept schema;
(B) leaf shape, the parent node in the concept hierarchy;
(C) and, elliptic, the child node in the concept hierarchy.

These three elements are inputs of the generative grammar for constructing navigation sentences. Figure 5 is an example of using generative grammar. The words in italic type are the terminal symbols; the words beginning with lower case character directly infer to the terminal symbols. Rule (2) shows that the "learningObject" will infer to a learning object from *Concept Schema*; furthermore, the "characteristicName" and "characteristicType" will refer to the concept hierarchy just like rule (3) and (6) demonstrated.

G = (D_N, D_T, S, R)
D_N = {learningObject, verb, beVerb, characteristicName, CharacteristicTypeSet, characteristicType, conj}
D_T = {*that*, *its*, *is*, *are*, *observe*, *take a look at*, *and*, *or*, …}
S = S
R:

(1) S → verb + learningObject + *that* + *its* + characteristicName + beVerb + CharacteristicTypeSet
(2) learningObject → a learning object in *Concept Schema*
(3) characteristicName → parent nodes in *Concept Hierarchy*
(4) CharacteristicTypeSet → characteristicType
(5) CharacteristicTypeSet → CharacteristicType + conj + CharacteristicTypeSet
(6) characteristicType → child nodes in *Concept Hierarchy*
(7) conj → *and*, *or*, …
(8) beVerb → *is*, *are*, …
(9) verb → *observe*, *take a look at*, …

Figure 5. Example of generating grammar

All of the generated sentences will be stored in the item bank and waited for giving to students as the navigation sentences.

(3) Information Calculation

When the navigation sentences are constructed, the next step is to decide which navigation sentence should give to students as the guidance. This research uses information theory to measure the information of each navigation sentence. A navigation sentence is asking students to observe a specific characteristic of the learning object. For this reason, the information calculation of navigation sentence is related to the information of the learning object's characteristic type. Because each characteristic type belongs to a characteristic name just like Figure 3 and Figure 4 show. The information values of learning objects' characteristics are only related to the probabilities of selecting the characteristic types.

For example, in Figure 3, the probability of selecting characteristic type, "elliptic", is (1/3)*(1/2) = (1/6). Therefore, the information of "elliptic" is

$$I(\text{"elliptic"}) = \log_2\left(\frac{1}{1/6}\right) = 2.585$$

After calculating all the information of characteristic types, the system lists the navigation sentences with descendent order.

4. SYSTEM DEMONSTRATION

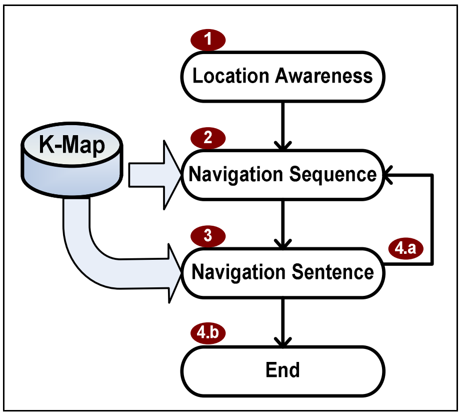

Figure 6. The flow chart of the location-awareness navigating system.

Based on the previous analysis, this research designs a location-awareness navigating system to construct guidance instructions. The system flow of location-awareness navigating system is shown in Figure 6. In the beginning, the system will wait for the student to notify his/her location. In step 2, the student sends his/her location in the mobile learning environment via the mobile device. When the system gets the location, it will generate the navigation sequence based on the information of learning objects stored in the knowledge map. In step 3, the system will retrieve the navigation sentence one by one from the knowledge map. In the last step, the student could choose to retrieve the next navigation sentence (step 4.a) or to end the navigation at this location.

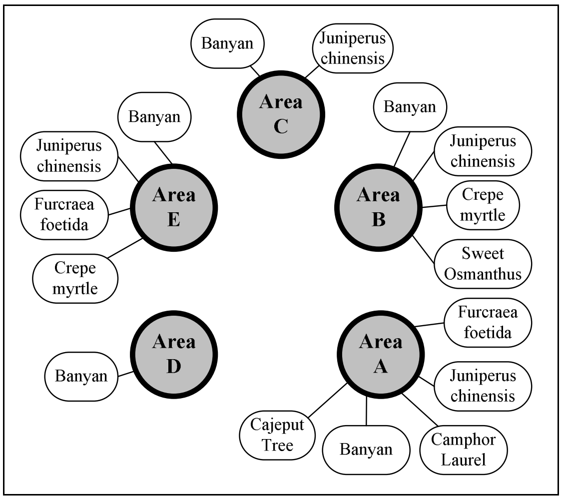

Figure 7. An example of a mobile learning environment for plant observation lesson.

A fifth-grade biology course, the plant observation, in Cherng-Gong Elementary School, Taoyuan, Taiwan, is used as the experiment course. The plant observation course asks students to observe the features of plants. The mobile learning environment is set in one of the school gardens. In the garden, there are five areas with various plants just like Figure 7 shows. The bold border circles represent the five areas, and the rounded rectangles indicate the plants growing in that area. Students use wireless-enabled laptops to connect to the course website and receive the navigation sentences.

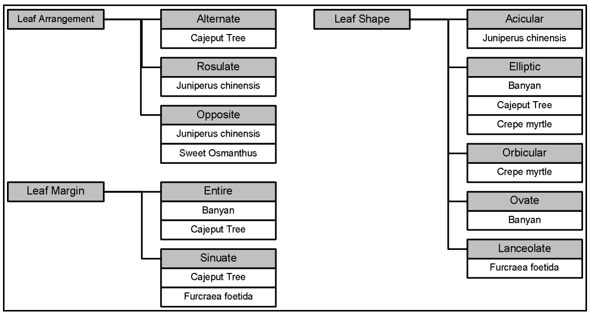

Figure 8. The knowledge map of the experiment.

All the characteristics that students needed to know are stored in the knowledge map. Figure 8 is the knowledge map used in this experiment. Three characteristics are asked students to learn, which are leaf arrangement, leaf margin, and leaf shape. The plants shown in Figure 7 are stored in the related concept schema of characteristic types. Using the knowledge map, the system will have the ability of the navigation sentences generation.

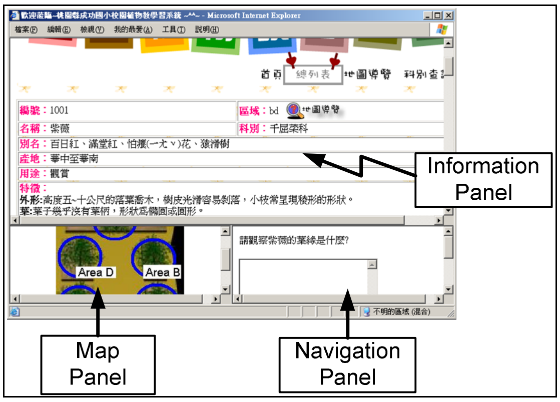

Figure 9. A snap-shot of the location-awareness navigating system

When a student starts learning in the mobile learning environment, he/she can click the button on the map panel in Figure 9 to make the navigating system knows which location he/she is at. After that, the system will send the navigation sentences of the navigating area one by one on the navigation panel in Figure 9. The students can also read the electronic teaching materials on the information panel.

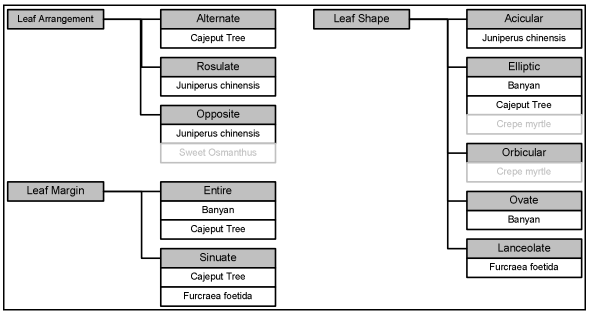

Figure 10. The eliminated knowledge map in the specific learning spot.

When a student chooses area A as his/her location, there are five plants exist in there. The system will identify the existing plants in the area and mark the learning objects in the knowledge map. Figure 10 shows that the schemas with black border and black text are the learning objects existing in the learning spot; the schemas with the gray border and gray text are not.

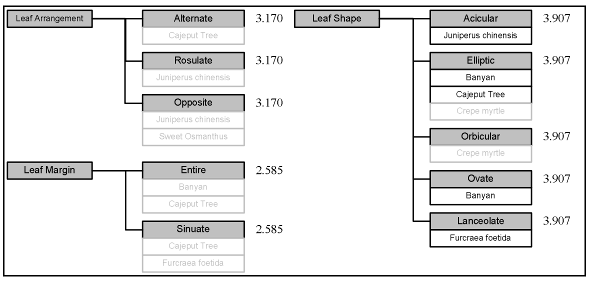

Figure 11. The knowledge map with the information of learning objects.

After knowing which learning objects exist in the learning spot, the system picks up the learning object' characteristic type with highest information. In Figure 11, the schemas with black border and black text are the selected learning objects. The system chooses one of the schemas with highest information and generates the navigation sentence based on the generative grammar to students. Using the generative grammar in Figure 5, the navigation sentence of the schema "Juniperus chinensis" in acicular leaf shape will be:

Take a look at Juniperus chinensis that its leaf shape is acicular.

5. CONCLUSION

This paper describes a method of navigation sentence generation and uses the sentences to guide students the learning sequence in mobile learning environment. Three major issues are solved in this research. First of all, learning objects in mobile learning environment can be stored in the knowledge map; secondly, the system can use the information of learning objects and characteristic types to decide the navigation sequence; and last, the generative grammar can reorganize the concepts in knowledge map in order to construct navigation sentences. .

There are still some issues could be discussed in order to improve the navigation strategy. First of all, how to arrange the learning sequence to make students have more learning efficient by saving the time from one learning spot to another. Furthermore, how the system navigates students to go to the next learning area with the direction instructions. Diminishing Marginal Utility could also be taken into consideration when the system receives the feedback from the student.

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