Implementing a Context-aware Learning Path Planner for Learning in Museum

ALEX CHANG
Department of Electronic Engineering
Chung-Yuan Christian University
No. 200, Chung-Pei Rd., Chung Li, 32023, Taiwan
TAIWAN

MAIGA CHANG
School of Computing & Information Systems
Athabasca University
1200, 10011-109 Avenue, Edmonton, Alberta, T5J-3S8, Canada
CANADA

JIA-SHENG HEH
Department of Information and Computer Engineering
Chung-Yuan Christian University
No. 200, Chung-Pei Rd., Chung Li, 32023, Taiwan
TAIWAN

Abstract: Learners in traditional or web-based learning environment might get little learning effect by just memorizing the lecture contents. Mobile learning can give learners a chance to remedy their weakness parts in the real world with touch, feel, and observation. This paper develops a learning path planner for learning in a museum according to learners' misconception. The planner gives learners a personalized learning path in a museum in order to make individual do an efficiently remedial study. This paper mainly describes the operational process of the learning path planner and uses a complete example as demonstration. The related detailed theories and calculation methodologies are not this paper's focus.

Key-Words: Mobile Learning, Learning Path, Knowledge Structure, Misconception, Situated Learning

1 Introduction

Even thought that teachers and students are separated in different place, the instruction still can be done via web-based teaching materials, e-mails, and video lectures [12]. However, some courses need students learning through observation are not very easy to create by either traditional classroom teaching or web-based learning environment, for examples, the butterfly-watching course and plant-learning in biology domain [4][5][8][15].

This paper develops a system to offer learners an opportunity to interact with learning objects in the mobile learning environment. The similarity of learning objects between the teacher's and the learner's concept maps will be considered for measuring the misconceptions. After the system finds out the learning objects which the learner needs to study again, the system constructs the best learning path to the learner according the whole learning gain which the learner might receive based on the misconception rate and travel distance in the real world. This paper mainly focuses on the system, the learning path planner, instead of describing the details of the theories and calculation methodologies.

Section 2 describes related researches include the knowledge structure measurement, situated learning, and mobile learning. The concept maps' similarity evaluation and the learning path's gain are explained in Section 3. Section 4 illustrates the operational flow of the learning path planner and an example of using the planner in the museum. Finally, Section 5 makes conclusions and discusses possible future works at the end of this paper.

2 Learning Strategies, Knowledge Structure & Diagnosis

The learners are not just passive receiving the learning materials from teachers as they doing learning. Students also could learn the concepts, knowledge, skill and ability via interacting with real learning environment [17]. Brown thinks that the concepts and knowledge are situation-based [3], and the learning will be influenced by teaching activity, situation and interactions which called situated learning.

Hence, mobile learning could make learners could get or apply what they learned in real environment [9]. Learners could both get the digital assistant and the real experience as they study in mobile learning environment. And that is why the mobile learning strategy is chosen in this research.

No mater what kind of learning strategy, what student think and learned is the most interesting issue to teachers and researchers [2]. Trying to find out what the lectures students memorized via testing or exam is very easy. However, the testing score could not provide enough information of learners' learning results. Even though the concepts and knowledge learners get from the same teaching material, what the relationship between concepts in learners' mind might not exactly the same [6][7].

Therefore, to know what the knowledge structure learners have is much more important than just check what the concepts learners have. The concept map was proposed by Novak and Gowin [13], concept map is a graphical tool for organizing and visualizing knowledge in human's mind. Learners could concrete the concepts and knowledge they learn on the course on paper via drawing concept map [14].

Learners could keep modifying their own concept map in learning, and the new concepts will be combined with the past concepts. As a result, teachers could check the learners' understanding about the lectures or teaching materials which they provide to learners [6][7][16]. Teachers can also adapt their instructions and lectures with concept map via discovering what students have learned and diagnose their misconceptions.

Since that what the knowledge structure is used in pedagogy has been found, there is another important issue, which is knowledge structure measurement. Novak propose Concept Mapping to evaluate the consistence between teacher's and learners' concept map [13]. There are four scoring standards, which are: (1) **Relationships**, which means the relation link between two concepts; (2) **Hierarchy**, the level which presented in concept map; (3) **Cross-links**, the linkage between some concepts which locate at different level; (4) **Examples**, learner could give an example about what he/she learned.

Another strategy about concept map measurement is Pathfinder, which is proposed by Goldsmith [1][10][11]. Pathfinder uses the Closeness Index to evaluate the similarity between teacher's and learners' concept map. Closeness is based on set theory, and the value of closeness is between 0 (totally different) to 1 (complete similar).

The closeness will be taken into consideration in measuring the similarity of concept map in this paper. The next Section will introduce the construction of teacher's and learners' concept map; analyze and design the measurement of concept map and find out the learning gain in mobile learning environment; and then feedback the learning sequence of concepts and context-aware learning path to individual learners.

3 Planning a Context-aware Learning Path

This research wants to feedback suitable teaching materials according to learners' learning effects and generates a context-aware learning path in mobile learning environment for students. Before providing the feedbacks to learners, there are some subjects need to be approached via three necessary phases as Figure 1 shows.

Phase I: digging out what the concepts learners have and making the unconcealed knowledge structure in their minds into concrete and visible concept map; **Phase II**: checking what the lacks of concepts students might need and measuring the similarity between teacher's and learners' concept maps; **Phase III**: evaluating the learning gain that students can get from each learning materials in real environment and generating the context-aware learning path according to their learning results.

There are two main knowledge structures in this research: (1) **concept map**, each teaching material such as vase in real environment are all have its own concept map for describing what the concepts in learning object; (2) **situated map**, in order to connect the learning objects in real world and related spatial information such as the position of learning objects and the distance between different learning objects. Figure 2 shows the relations among concept map and situated map for each learning object. Certainly, there are two same learning objects at different place.

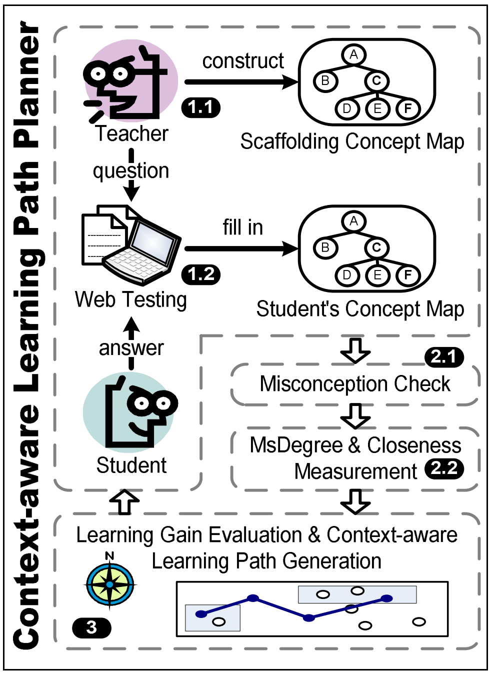


Fig 1. Flow of context-aware learning path planner

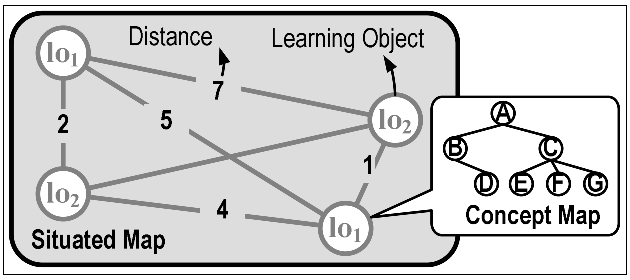


Fig 2. The relations among concept map and situated map

Before digging out what learners have been learned and think, teacher must construct his/her own concept map, which called scaffolding concept map, for each learning object and produce the related question (the step 1 shown in Figure 1). Figure 3 shows the single-choose question and options for the concept, *adomment*, in concept map. The question formulation requirement is that the concept in the question has to be observable.

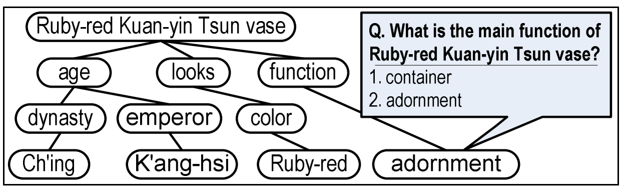


Fig 3. The question of concept in concept map

As step 1.2 shows, learner will construct his/her own concept map with answering the question provided from teacher. After learner returns the answer, the option which he/her chooses will be filled in his/her concept map. What the difference between teacher's and learner's concept map is easy to check with comparison and find out the misconception learner has in step 2.1.

Since what the misconception learner might need has been found, there still another two important issues which are what the feedback sequence of lacking concepts should provide to individual learners (step 2.2 in Figure 1); the second issue is how to generate the navigation path with consider both the result of concept map for each learning object and situated map in real learning environment (step 3 in Figure).

It is not good enough if the sequence of learning feedback generated is only based on the lack concepts or just consider the number of misconception without thinking about the concept relations. Therefore, the better strategy is taking each concept and its neighbor concepts into account for measuring the feedback sequence. In order to solve the first issue talked above, the similarity of concept map is used to measure the sequence of learning the misunderstanding concepts in the learning object.

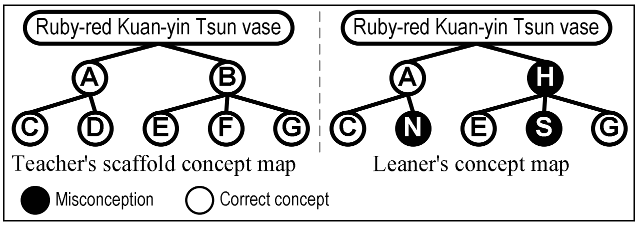


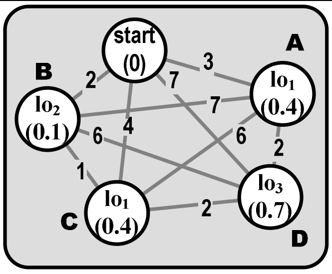
Fig 4. the comparison of teacher's and learner's concept map

Figure 4 shows the learner's learning result with concept map, the misconception is marked in black and the correct concept is marked with white concept node. As a result, what the *Accuracy* of each concept node could be measured easily by evaluating the neighbor nodes in both of the teacher's and the learner's concept maps.

Taking the concept *A* in Figure 4 for example, there are four neighbor concepts around the concept *A*, {*Ruby-red Kuan-yin Tsun vase*, *C*, *D*, *N*}. Furthermore, it is easy to measure the similarity, also called *Closeness*, between teacher's and learner's concept map by summarizing the accuracy for each concept node.

The system is then able to use the concept map characteristics to get the student's misconceptions, and uses the situated map to plan a context-aware learning path for the student (step 3 in Figure 1). The *Improvement*, has a negative relation with the closeness, is taken into consideration when the system does the learning path plan. Beside the improvement, the distance between two learning objects is also need to consider when planning the learning path. Longer distance will waste learner too much time in traveling from one learning spot to another.

Figure 5 has two parts. The left part shows the improvement value that each learning object may have if the learner goes to learn again and the distances between two learning objects. Values inside the nodes in situated map are the improvement of learning objects and values on the edges are the distances between two learning objects. The right part shows learning gains between two learning objects that the learner might receive based on the improvements and distances. For example, according to Figure 5, the learning gain form start to learning object *A* will be -2.6. Therefore, the most appropriate learning path will be Start → B → C → D, which has the maximum learning gain.



	Start	A	B	C	D
Start	0	-2.6	-1.9	-3.6	-6.3
A	-3	0	-6.9	-5.6	-1.3
B	-2	-6.6	0	-0,6	-5.3
C	-4	-5.4	-0.9	0	-1.3
D	-7	-1.6	-5.9	-1.6	0

Fig 5. The learning gian in mobile environment

4 Learning Path Planner in Museum

There are two main phases and five steps to learners as they learning with context-aware learning path planner as Figrue 6 shows. The two phases are the traditional learning & web-testing phase and the do remedy mobile learning phase. Within the two phases, at first, learners recieve the teaching materials (step 1); second, learners participate the web testing (step 2); third, the system checks the concept maps and generates the context-aware learning path with situated map (step 3); fourth, the system asks learner's position (step 4); and finally, the system gives the learner either a moving guidance suchlike "please go to the Area D in the room 203, and find out the artifact No. 23!" or a learning guidance suchlike "please observe what special mark the vase has."

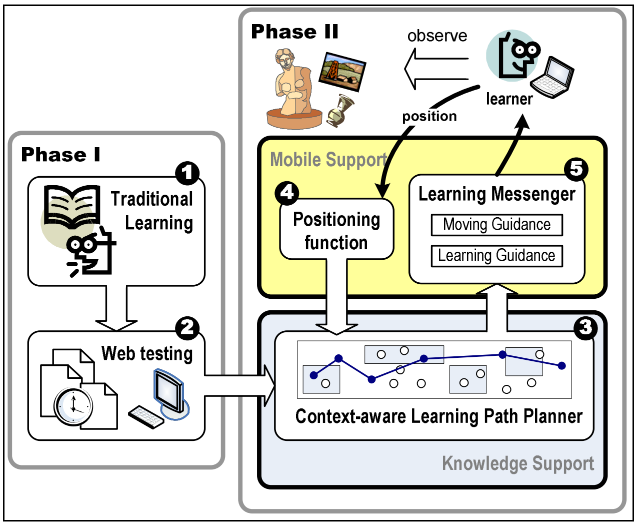


Fig 6. Two main phases of context-aware learning path planner

Figure 7 shows Alex's learninig path which is generated by the learning planner. The system asks Alex to walk to the artifact No. 10 at Area B by using the moving guidance first when Alex arrives room 203. Then the system ask him to observe the learning objects by using a learning guidance, "please take a look at the mark of the bowl." After finishing the remedial learning activity, the system uses another moving guidance to lead Alex go to area D and learn the vase, artifact No. 23, again.

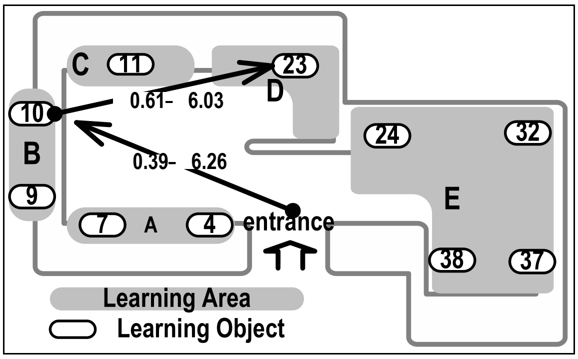


Fig 7. Artifacts at room 203 in the museum

5 Conclusions & Future Works

This paper focuses on developing a personalized context-aware learning path planner to support individual learner do self-learning in mobile learning environment according to his/her misconceptions and possible learning gains. There are still two possible future research issues. The first one is the cognitive level diagnosis issue: system could give suitable learning guidance based on different cognitive levels. The second is automatic moving guidance issue: system should be able to guide the learners from one learning spot to the next learning spot rather than ask teachers to input the moving guidance in advance.

References:

[1] Acton, W.H., Johnson, P.J. & Goldsmith, T.E., Structural Knowledge Assessment: Comparison of Referent Structures, *Journal of Educational Psychology*, Vol. 86, 1994, pp. 303-311.

[2] Bloom, C., Linton, F. & Bell, B., Using Evaluation in the Design of an Intelligent Tutoring System, *Journal of Interactive Learning Research*, Vol. 8, No. 2, 1997, pp. 235-276.

[3] Brown, J. S., Colins, A. & DuGuid, P., Situated Cognition and the Culture of Learning, *Educational Research*, Vol. 18, No. 1, 1989, pp.32-42.

[4] Chang, A. & Chang, M., A Treasure Hunting Learning Model for Students Studying History and Culture in the Field with Cellphone, In *the Proceedings of the 6th IEEE International Conference on Advanced Learning Technologies*, (*ICALT 2006*), Kerkrade, The Netherlands, July 5-7, 2006, pp.106-108.

[5] Chang, A. & Chang, M., Adaptive Mobile Navigation Paths for Elementary School Students' Remedial Studying, *IEEE International Conference on Interactive Computer Aided Learning*, (*ICL 2006*), Villach, Austria, Sept. 27-29, 2006.

[6] Chang, A., Cheng, K.-F., Chang, M. & Heh, J.-S., Designing a Feedback System for Teachers to Diagnose Students' Concept Map in the Web-based PBL Learning Environment, In *the Proceedings of 17th AACE World Conference on Educational Multimedia, Hypermedia & Telecommunications*, (*ED-Media 2005*), Montreal, Canada, June 27-July 2, 2005, pp. 3043-3049.

[7] Chang, A., Cheng, K.-F., Chang, M. & Heh, J.-S., Measuring the Consistency of Concept Abstraction and Similarity of Concept Map from Discussion Database in the PBL Learning Environment, In *the Proceedings of 9th Global Chinese Conference on Computers in Education*, (*GCCCE 2005*), Hawaii, USA, June 6-9, 2005, pp. 677-685.

[8] Chen, Y.-S., Kao, T.-C., Yu, G.-J. & Sheu, J.-P., A Mobile Butterfly-Watching Learning System for Supporting Independent Learning, In *the Proceedings of 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*, (*WMTE 2003*), Jhongli, Taiwan, March 23-25, 2004, pp. 11-18.

[9] Darmarin, S. K., School and Situated Knowledge: Travel or Tourism?, *Educational Technology*, Vol. 33, No. 3, 1993, pp27-32.

[10] Goldsmith, T. E., Johnson, P.J. & Acton, W.H., Assessing Structural Knowledge, *Journal of Education Psychology*, Vol. 83, No. 1, 1991, pp. 88-96.

[11] Johnson, P. J., Goldsmith, T.E. & Teagur, K.W., Locus of the Predicitive Advantage in Pathfinder-based Representations of Classroom Knowledge, *Journal of Educational Psychology*, Vol. 86, No. 4, 1994, pp. 617-626.

[12] Martin, B.L., Using distance education to teach instructional design to preservice teachers, *Educational Technology*, Vol 34, No. 3, 14, pp.49-55.

[13] Novak, J.D. & Gowin D. B., *Learning how to learn*, New York and Cambridge, UK: Cambridge University Press, 1984.

[14] Novak, J.D., Applying learning psychology and philosophy of science to biology teaching, *American Biology Teacher*, Vol. 43, No. 1, 1981, pp. 12-20.

[15] Thornton, P. & Houser, C., Using Mobile Phones in Education, In *the Proceedings of 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education*, (*WMTE 2003*), Jhongli, Taiwan, March 23-25, 2004, pp. 3-10.

[16] Turns, J., Atman, C.J. & Adams, E., Concept Maps for Engineering Education: A Cognitively Motivated Tool Supporting Varied Assessment Functions, *IEEE Transactions on Education*, Vol. 43, No. 2, 2000, pp. 164-173.

[17] Vygotsky, L.S., *Mind and society: The development of higher mental processes. Cambridge*, MA: Harvard University Press, 1978.