行政院國家科學委員會專題研究計畫　成果報告

以 SCORM 標準為基礎之課程規劃評估系統

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一、中文摘要

關鍵詞： 近幾年來，遠距教學廣泛的運用，有些遠距教學標準與平台。例如 ADL SCORM, AICC CMI, IMS QTI, IEEE LOM, IEEE LTSA. 這些組織提供國際上有名的遠距教學規格. 有了這些遠距教學規格可以讓教材達到共享、重複使用、便利性。透過這些遠距教學標準的支援, 我們希望建置一個結合去年計畫的課程設計成果。希望將系統加上 SCORM。在本文中，我們提出一個課程架構的轉換方式，並且依據這樣的轉換，成為符合規格的結構。

Abstract

In recent years, distance learning on the web is widely available. Some e-learning standard and platform are proposed, such as ADL SCORM, AICC CMI, IMS QTI, IEEE LOM, IEEE LTSA. There are also some organizations devoted to e-learning standard, such as IEEE LTSC , ADL, AICC, ARIADNE, IMS, and ULF. Among current e-learning technology software application, there is little courseware design with strategic assessment. It is worthy to develop a courseware diagramming system object oriented system for instructors to develop their course. In this paper we develop a system for construction courseware structure based on influence diagram. We also try to transform the result to SCORM standard format. The mechanism is implemented as a decision support system.

Keywords: e-Learning, SCORM, Courseware Diagram System, Concept Map

1. Introduction

Nowadays, E-learning has become a popular and modern learning activity. Students are educated in school. People who graduate from school will attend many kinds of education or training. Instructors spent hundred hours preparing for lectures. They have to design lecture and make several teaching materials. America Department of Defense (DoD) established the Advanced Distributed Learning (ADL) Initiative to develop a DoD-wide strategy for using learning and information technologies to modernize education and training.

However, instructors are not all computer expert, they can't follow SCORM with their own. To realize SCORM and use it is very hard to normal people. Generally speaking, people are used to use authoring application software to authoring and editing learning content, such as MS Word, Ms FrontPage, and Macromedia Flash. Therefore, a windows user interface authoring system for authoring learning content is indispensable to e-learning. In this paper, we propose an e-learning content authoring system. We divide several sections to introduce this system.

2. Related Work

Some researchers [2,3,4,5,6,8,9] concentrate on developing communication tools and group cooperation while others concentrate on analyzing and evaluating student's learning performance. Our study falls into the last field - measurement of student's learning performance. In our study, we refer to two tools and a theory for the work of assessment, decision-making and goal setting. They are concept mapping, influence diagram and the theory of learning cycle. We combine the advantages provided in each tool and included in our courseware diagram.

Concept mapping [1] is a two dimensional graphic which constructs the records of information in hierarchical format starting with the most general concepts and proceeding downward in increasingly greater detail. One advantage provided by concept map is that response from students is obtainable. The instructor can receive responses from students and take them into consideration in order to adjust teaching material or style in order to maximize student learning performance.

The Influence Diagram [7] was developed for representing decision problems. It grows linearly (as opposed to growing exponentially of decision trees) so that larger decision problem can be represented. It is a singly connected DAG (Directed Acyclic Graph) without loop. Two types of nodes and links are utilized in the influence diagram – decision nodes, chance nodes, informational links, and conditioning links. A decision node is depicted by a rectangle or a square that represents a variable under the decision maker's control. An oval or

a circle that denotes a probabilistic variable represents a chance node. A conditioning link always points toward a chance node and represents a probabilistic dependence. On the other hand, an informational link always points toward a decision node and denotes available information. In addition, the sequence of decision nodes must be fully ordered. This is known as the no-forgetting condition. A decision is made with all outcomes of its direct predecessors. Thus, informational links imply a chronological order but conditioning links don't. Another importance issue is the direction of conditioning links. In general, representation of a decision problem is not unique.

3. Using Course Diagram to Represent Course Design Problem

Influence diagram is very useful for designing distance-learning courses. Due to the nature of designing courses, few adjustments should be made in order to meet the final goal – a maximized student learning result. Transformation from influence diagram to courseware diagram [10,11] is described in this section.

Nodes used in our courseware diagram are evaluation nodes and course nodes that are very similar to decision nodes and chance nodes used in influence diagram. Decision nodes can represent evaluation nodes. And chance nodes can represent course nodes. The value node can represent the final value of student's learning performance.

There are six possible connections among three types of nodes. However, not all of them are all allowed in our courseware diagram for the sake of the violation of normal practice. Two types of links are prohibited. First, links from course unit to final value unit are prohibited because knowledge value can only be measured by taking exam. Second, links from evaluation node to evaluation node are constrained. Links from course unit to both course unit and evaluation unit and links from evaluation unit to final unit are defined as ***informational link*** represented as a solid line with arrowhead. Regarding links from evaluation unit to course unit, it is defined as ***conditioning link*** represented as a dash line with arrowhead.

4. An Example of Constructing Courseware Diagram for Algorithms Course

As an example to show the usage of courseware diagram, we illustrate an example in this section. Figure 1 is a courseware diagram for algorithm class. This class starts with the course of mathematical foundations and ends with the last evaluation unit. On every course unit, there is a Course Knowledge Weight (CKW) attached to it and the total value of all course units is one. Due to the topology of parallel learning, unrelated courses can be embedded in a parallel structure. AD is calculated by adding up previous CKW on the path. So, at sorting course unit AD is [0.35,0.35] and at data structure course unit, AD is [0.25, 0.25]. Before evaluation 1, AD should be 0.45 because there are totally three courses taken by students. These courses are weighted 0.15 for mathematical foundations course, 0.2 for sorting course, and 0.1 for data structure course respectively. The result of evaluation 1 is that 25 percent of best-performed students who receive an average score of 90, 50 percent of average performed students who receive an average score of 70, and 25 percent of worst performed students who receive an average score of 50. Therefore, the discount rate is 0.5, 0.7 and 0.9. AD for these three types of students is deduced to 0.45*50% for worst performed students, 0.45*70% for average performed students, and 0.45*90% for best-performed students. Before move on to the next course, the maximum AD is 0.405 (0.45*90%) and the minimum is 0.225 (0.45*50%). Then, all students have to further their study to advance data structure course (CKW=0.15), graph algorithm course (CKW=0.1), number-theoretic algorithm (CKW=0.1), computing theory (CKW=0.1), and clustering (CKW=0.1). However, graph algorithm and both courses, number-theoretic algorithm and computing theory, can be learned simultaneously. These three courses are designed in a parallel learning structure. Advance data structure (CKW=0.15), graph algorithm courses (CKW=0.1) and number-theoretic algorithm (CKW=0.1) that have an accumulated CKW 0.35 are included in evaluation 2 and should be deduced by discount rate (0.5,0.7,0.9). Before taking computing theory course, the maximum AD is 0.72 (0.35*90%+0.405) and the minimum is 0.4 (0.35*50%+0.225). Then, move on to computing theory course. In evaluation 3, computing theory course (CKW=0.1) and clustering course (CKW=0.1) are included and should be deduced by discount rate (0.5,0.7,0.9). Before reaching the final value unit, the maximum AD is 0.9 (0.2*90%+0.72) and the minimum is 0.5 (0.2*50%+0.4). Since there are no more courses existing after evaluation 3, AD at the final value node is [0.5, 0.9]. In conclusion, the expected students' learning performance is ranged between 0.5 and 0.9.

5. SCORM Transform Algorithm

Courseware diagram system can build course chart systematically, improve students learning performance by taking different level of remedial courses based on student performance and analyze student's learning performance to adjust course content to maximize students' learning result. However, it is just a tool for specific platform. When the course content exports to other learning management systems, it can not work successfully. To solve the problem, we follow SCORM standard to achieve accessibility, interoperability, durability, reusability and

cost effectiveness. Before transform the course content, there is a graphic problem. Courseware diagram graph is directed tree but the SCORM format is rooted tree structure. Directed tree differs from rooted tree in structure and arrow edge.

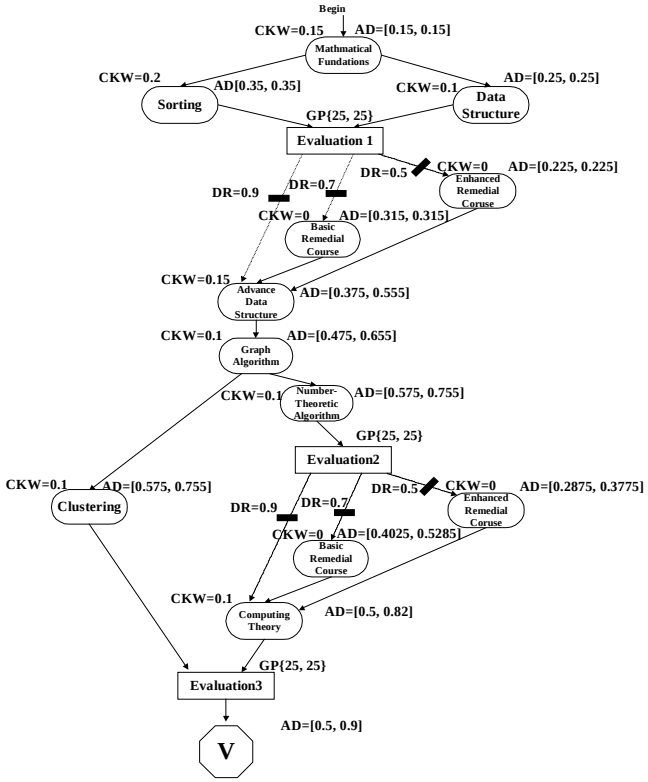

Figure 1: Courseware Diagram for Algorithms Class

6. Implementation

SCORM Base Courseware Editor Version 2.0 is implemented by Java which provides teachers to draw the courseware graph. In Figure 2, the upper dotted line area is the function table. The button ( ) is used to move the node position. The button ( ) is the course node. Course node has two types. One is general course, the other is remedial course. The button ( ) is the evaluation node. Teacher can choose the exam content to this evaluation node. The button ( ) is the final node. It counts the final value of the evaluation progress. The button ( ) is the arrow from node to node. The button ( ) provides package function which will transform the courseware diagram into SCORM compatible package. The button ( ) provides clear screen function. In Figure 3, it shows the individual course node attribute table which provided setting learning resource and the course knowledge weight value. We may set the attribute at general and remedial course. In Figure 4, it shows the evaluation course node attribute table.

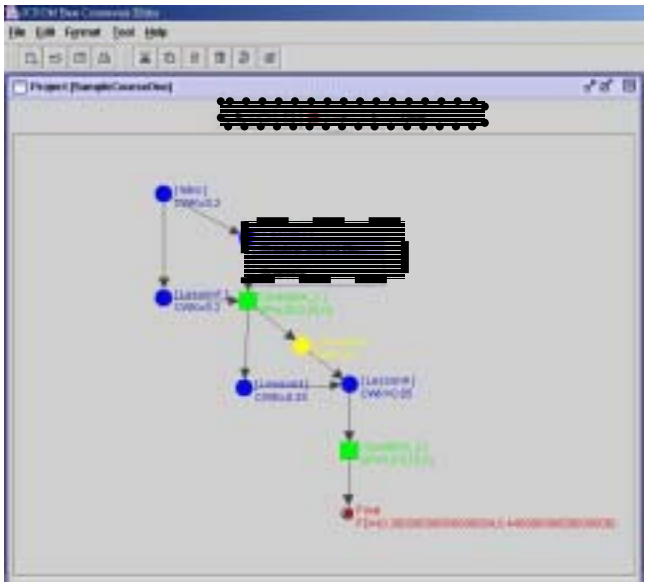
Figure 2: The dotted line of the upper area is the drawing tool buttons. The dotted line of the lower area is the individual course node property. It also provided preview content function.

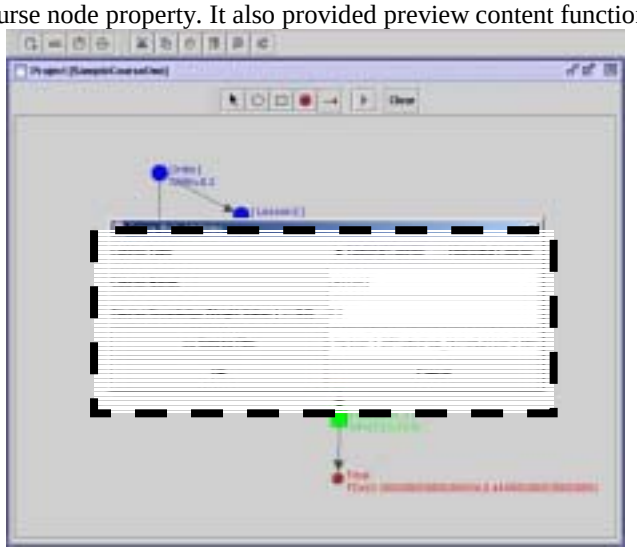
Figure 3: The dotted line area is the individual course node attribute table. There are general and remedial course.

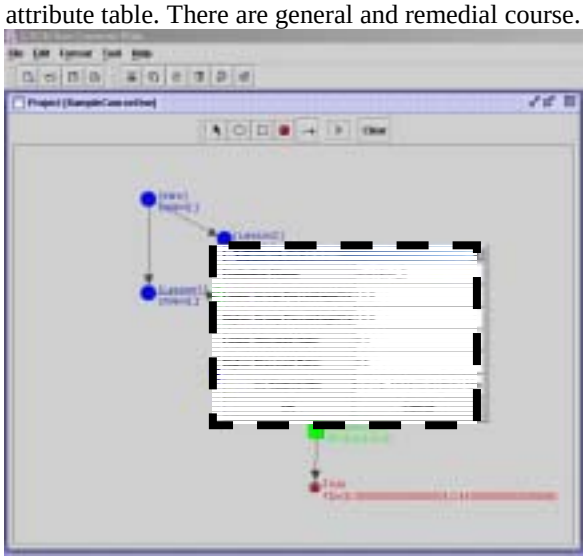
Figure 4: The dotted line area is the individual evaluation node attributes table.

The Advanced Distributed Learning (ADL) provided SCORM Version 1.3 Sample Run-time Environment (RTE) Version 1.3 Beta-3. This version of the Sample RTE was implemented as a Web-based client/server application using HTML, JavaScript, Java Server Pages (JSP), Java Applets and Java Servlets. In order to prove our packaged file is compatible with SCORM, we put the generated package file in the test environment. Figure 5 showed the successful result. Our packaged course is compatible to SCORM version 1.3 and successfully running on the run-time environment.

Figure 5. Our Courseware Diagram course is successfully running in SCORM Environment

7. Conclusion

This paper proposed a theory of concept and influence diagram combined together as a new courseware diagram. This mechanism can be easily used by instructor and student because of its user-friendly interface. Also it allows the instructor to receive prompt feedback from students. In the courseware diagram, it provides three aspects. First, a course diagram flow chart can be built systematically. Then students learning performance can be improved by taking different level of remedial courses based on student performance. Second, course content can be adjusted to maximize students' learning result with analyzing student's learning performance. Thirdly, the courseware diagram can be generated with the international distance learning standard Sharable Content Object Reference Model (SCORM). With the SCORM compatibility, all course content achieve accessibility, interoperability, durability, reusability and cost effectiveness. This approach makes SCORM more educational and the courseware diagram theory more international.

8. Reference

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