智慧型網路教學系統之研究
Designing an Intelligent Web-based learning System

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摘要

目前大多數網路教學系統的教材與題庫之製作，除了增加多媒體的效果外，大都只將其內容改為網頁而已，其效果不見得比直接閱讀還佳。本研究擬利用以知識為基礎的方法，來建構課程體，以提供一個彈性、有效的學習環境，讓學習者可更深一層地探討其所欲瞭解的內容，亦即將以往消極地瀏覽網頁的情形，改變為可積極探索其所欲瞭解的相關知識的學習模式，以增加學習的深度及廣度。本研究亦將提出智慧型自動造題機制，其可源源不斷地自動產生試題，而大幅提升建立題庫的效率。最後本研究亦提出可以監督學習者學習的機制，監督學習者是否上網認真學習，以確保學習效果。

關鍵字：網路教學系統、虛擬教師、課程體、題庫

Abstract

At present, the contents and item banks in most Web-based learning systems are just added the presentations of multimedia or converted the contents of textbook into homepages. To read the contents of homepages is not better than to read directly the textbooks. This study tries to build an intelligent Web-based learning system that uses a knowledge-based approach to build courseware for providing a flexible and effective learning environment. This approach changes passive browsing homepage situation into active searching for selecting adequate contents, understanding related knowledge learning model, and increasing the depth and breadth of learning. In addition to offering a flexible and effective learning environment, this study also deploys the following mechanisms: two intelligent automatic question-making mechanisms and a learner's learning monitoring mechanism. The intelligent automatic question-making mechanisms can make test questions automatically and continuously for the teaching units. The learner's learning monitoring mechanism is used to monitor the learner's learning on the web to assure the learning effectiveness.

Keywords：Web-based learning system, Courseware, Item bank

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1. Introduction

Following the popularity of Internet, the education researchers start to think how to transfer the traditional teaching activities into the newest popular teaching system --- the Web-based learning system. In the beginning, through the one by one key-in tasks, the contents of textbook can be converted into homepages. Then using the browser and hypertext in the Internet, the learners may be able to find the learning targets. Owing to the contents of textbooks that are plain media and one way transmission, the above one by one key-in courseware cannot provide plentiful

multimedia information. The newer Web-based learning system integrate various teaching multimedia including texts, graphics, voices, animations, video, and so on to develop a better learning environment (Cloete, 2001). On the other hand, through the function of interaction, the learners not only passively receive information, but also actively conduct the whole learning activities for achieving better learning climate.

Are Web-based learning systems only with the function of multimedia? The answer is negative. By using various information technologies, Web-based learning systems may dramatically decrease the load of the teachers and the learners. For the teachers, the tasks of preparing and presenting the multimedia teaching contents are usually overload. For the learners, they may get lost in the limitless Internet labyrinth if there is no a complete learning navigation path. This study tries to build an intelligent Web-based learning system that uses a knowledge-based approach to build courseware for providing a flexible and effective learning environment. The intelligent Web-based learning system will be able to effectively organize the teacher's professional knowledge and transform it into Web-based teaching content. The teaching content will be present in a proper and user friendly way for the learners. The intelligent Web-based learning system changes the passive browsing homepage situation into the active searching for adequate contents, understanding related knowledge learning model, and increasing the depth and width of learning. In addition to offering a flexible and effective learning environment, the intelligent Web-based learning system is also with the following mechanisms: two intelligent automatic question-making mechanisms and a monitoring learner's learning mechanism. The intelligent automatic question-making mechanism can make test questions automatically and continuously for the teaching units to improve the efficiency of the traditional item bank style. The monitoring learner's learning mechanism is used to monitor the learner's learning on the web to assure the learning effectiveness

2. Courseware and Item Bank

Owing to the rapid development of Internet, the presentations of the Internet courseware are various and include more multimedia features, such as hyper-links, a large number of video clips, on-line exercises, and so on (Lupo and Erlich, 2001). The main motivation of developing Web-based learning systems is for the learners to learn knowledge. Exceeding the limitations of time and space, the presentations of teaching contents in the Web-based learning systems help the learners actively learn and acquire knowledge. The link relationship between the courses is the critical factor to build complete knowledge architecture.

Today, most Web-based learning platforms (such as WebCT. Learning Space, ALICE) use the editing approach of "textbooks on the Web" to present the contents of courses. The learners are just from the past reading the plain contents of textbook to the browsing the contents of homepages. To read the contents of homepages is not better than to read directly the textbooks. On the other hand, building complete contents of courses in the Web-based learning systems needs a lot of time and intensive manpower involved. The editing approach of "textbooks on the Web" is usually with the problem of redundancy. It wastes time and manpower. Therefore, to design a better and easy courseware building approach is imperative.

The learners are very easy to get lost in the Web-based learning environment. Just browsing the homepages is not a good way to learn the knowledge of contents. Thus, to design an effective learning navigation path in the Web-based learning environment for achieving the objective of adaptive learning is explicitly important.

Learning evaluation acts as a critical role in teaching activities. The objectives of learning evaluation are in testing the student's learning result and ascertaining courses and teaching methods reaching the teachers and the learners expectations (Tyle, 1950). Following the information technology progressing, testing evaluation starts to consolidate with information technology. Recently, applying computers and Internet technology in testing evaluation includes two major functions: (1) building test and (2) implementing test. Building test means to build item bank. Implementing test is to use computers and networks as test media (Alessi & Trollip, 1991). Item bank is the heart of test evaluation. The broad definition of item bank is a set of easy use questions (Millman & Arter, 1984)；The narrow definition of item bank is to arrange and classify the test questions by contents (such as units or subjects) or statistic features (such as the degree of difficulty), to store the questions by digitalization, and to manage and operate the test question combinations by computers (Hsu & Sadock，1995). In implementing test, the computerized test is more important because the result of the computerized technology development. Computerized adaptive test (CAT) is an important implementing test in recent computerized test development. With the item response theory, The CAT is a personalized test through the computerized test (Hsu & Sadock，1995). In the CAT, the process of learning evaluation is according to the degree of student's to respond the student's learning result. No matter how test is implementing, the most important task is building the item bank. In order to build abundant, various, and sharing item banks, it is necessary to consolidate the expertise of the teachers and the test specialists. To build an item bank with abundant and complete contents for correctly measuring the degree of the student learning needs a lot of time and manpower. An automatic question-making mechanism may be able to solve above problem. At present, only a few works relative to the automatic question-making subject could be found.

3. An Intelligent Web-Based Learning System

The intelligent Web-based learning system that suggested by this study includes three major functions: building courseware, learning evaluation, and learner's learning monitoring.

3.1 Building courseware

The main objective of building courseware is to improve the concept of "virtual classroom" in common distance learning system: all students with identical learning contents. The function of building courseware in the intelligent Web-based learning system offers various editions of learning contents for the learner's selection. The learner can select appropriate contents by her/his ability and interest for achieving the goal of adaptive learning. Three key designs in the function of building courseware are: (1) using the semantic net as the basis of building courseware, (2) using the logic children to build the relationships between courses, and (3) designing the

courseware schema.

3.1.1 Using the semantic net as the basis of building courseware

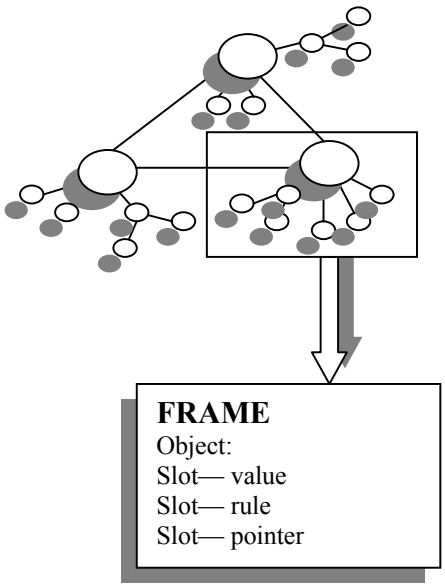

Fig. 1：The semantic net presenting the relationships of the course units (Harman & King, 1985)

This study adopts the semantic net of knowledge representation in Artificial Intelligence to present the relationships between the units of each course. Marked circles and lines present objects and relations respectively in the semantic net. The circles are called nodes. The lines are called links. The nodes in the Fig. 1 represent the units of courses in the intelligent web-based learning system. Under the same domain, there are some relations within various courses. These relations become the link relationships within the course units. Please see following section for the details of link relationships.

3.1.2 Using the logic children to build the relationships between courses

Fig. 2 shows two trees: Tree A and Tree E. Each Tree includes a Node B, respectively. That means there are two different courses, Course A and Course E, including a same unit, Unit B, In order to avoid repeating the data entry of Unit B in different courses. This study uses a pointer in the tree E to represent the content of Unit B. The pointer present the data section address of Unit B in the Tree A. Therefore, the Unit B in the Tree A is a logic child of the Tree E because Tree A and Tree E are independent. The pointer is called the logic child pointer. We only need to build one content of Unit B for two Unit Bs in two Trees. This approach may avoid the redundancy and repeating data.

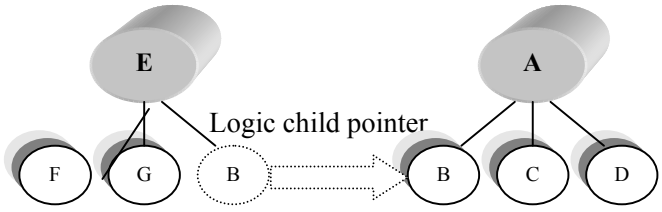

Fig. 2：A Logic child relationship diagram

This study cites the concepts of logic children in building the courseware of the intelligent Web-based learning system. Fig. 3 shows an example. In Fig. 3, the Logistics is a unit of E-commerce course, but in the same Web-base learning system the Logistics is one of the courses. In order to avoid wasting time and manpower on repeating building the content of Logistics and increase the efficiency of building the contents of courses, this study uses a logic child pointer to substitute the Logistics unit in the E-commerce course. Anytime when the learning activity triggers the Logistics unit in the E-commerce course, the system links the pointer to the Logistics course with the contents acquired from the expertise of Logistics professors. This approach increases the expertise of contents and decreases time and manpower needed in building the courseware. On the another hand, the learner may actively retrieve the desired knowledge to achieving the goal of active learning.

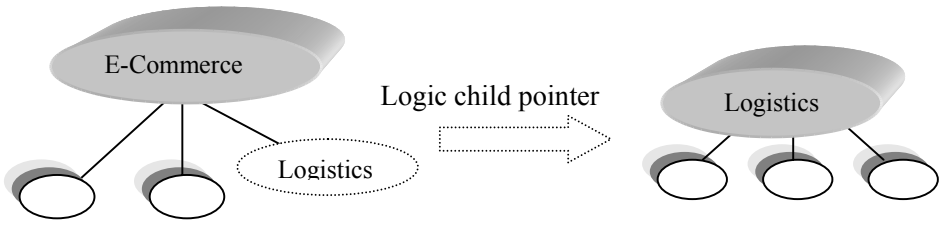

Fig. 3： A logic child relationship diagram --- Using the relationships of E-commerce and Logistics as example

3.1.3. Designing the courseware schema

The courseware schema in the intelligent Web-based learning system is designed as:

a. Course = [Course ID]+[Course Description]+ …

b. Topic = [Belong to Course]+[Topic ID]+[Topic Goal]+ ……

c. Lesson = [Belong to Topic]+[Lesson ID]+[Lesson Goal]+ ……

d. Unit = [Belong to Lesson]+[Unit ID]+[Unit Goal]+ ……

e. Edition = [Belong to Unit]+[Edition ID]+[Difficulty]+[Content]+[Bonus]+ ……

Basing on above courseware schema, every unit may have various editions. There are three functions in the courseware schema:

1. Virtual teacher: The learner can select appropriate contents according to her/his ability and interest like many teachers offered by the intelligent Web-based learning system to improve the concept of "virtual classroom": all students with identical learning contents.

2. Adaptive learning: The same unit in different courses may include different contents with different degrees of difficulty. Thus, the teachers in the professional fields need to make different editions of contents in the same unit for the learners with different degrees (see Fig. 4).

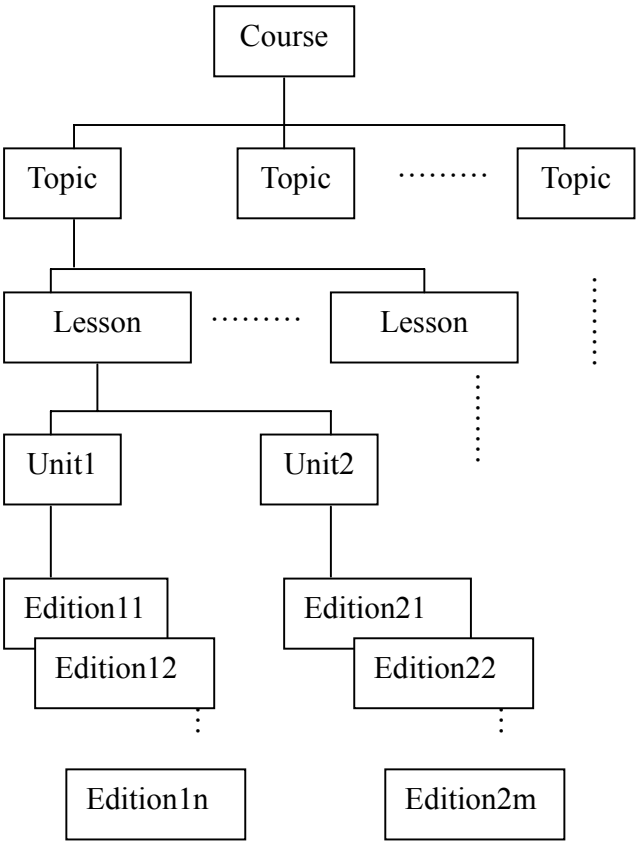

Fig. 4：The courseware schema architecture

3. The intelligent Web-based learning system employs the techniques and methodologies of data mining to process and analyze the learner's background and learning records to attain the adaptive learning. The learner can learn by her/his ability and interest.

4. Avoiding building the repeating course contents: This study cites the concept of logic children in building the courseware of to avoid wasting time and manpower on repeating building the content of courses.

3.2 Intelligent automatic question-making mechanisms

Without lots of manpower and time involved, the traditional one by one key-in item bank style cannot reach the objective of building high quality item banks, but manpower and time are always limited. On the other hand, the test questions with better evaluating effectiveness in the item bank are easy to be overused and to be the guessed targets. Using the test questions being easily guessed to test the learner will lose the meaning of learning evaluation. In order to enrich the contents of item bank and achieve the objective of automatically and quickly generating test questions, this study suggests two kinds of question-making mechanisms: intelligent question-making mechanism I and intelligent question-making mechanism II. The intelligent

question-making mechanism I is good for the courses relative to Mathematics or Physics fields. The intelligent question-making mechanism II is good for the other courses. The details are described in the following:

● Intelligent question-making mechanism I

Basing on the style of test questions, the teachers offer the algorithms. Then the mechanism generates the stems, the correct answers, and the relative distracters randomly by using the algorithms. Infinite permutations and/or combinations of various test questions may be generated after the mechanism processed (see the Fig. 5). The problems of being overused and being the guessed targets could be solved because the infinite permutations and/or combinations of various test questions generated. For an example of primary school arithmetic, the mechanism generates an operator and two operating values as the stem of test questions basing on the style of test questions. The contents of operators include addition (+), subtraction (-), multiplication (*), division (/), and so on. The contents of operating values include two groups: group 1 (addend, subtrahend, multiplier, and divisor) and group 2 (summand, minuend, multiplicand, and dividend). The contents of operating values generate the values in the ones place, in the tens place, or hundreds place according to the degree of difficulty defined. Then the mechanism automatically computes the correct answers and the distracters that are similar to the correct answers. Finally, the mechanism permutes and/or combines the stem of test questions, correct answers, and relative distracters to generate a great quantity of various test questions. This study has successfully built the question-making mechanisms on the primary arithmetic course and the accounting course with the ability to generate a great quantity of various test questions randomly and automatically.

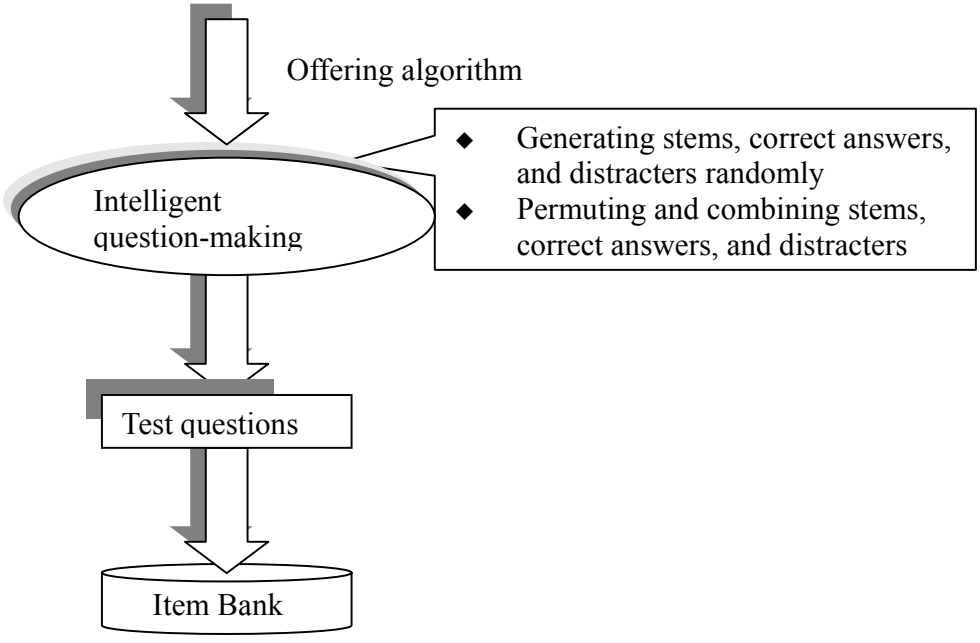

Fig.5：The intelligent question-making mechanism I

● **Intelligent question-making mechanism II**

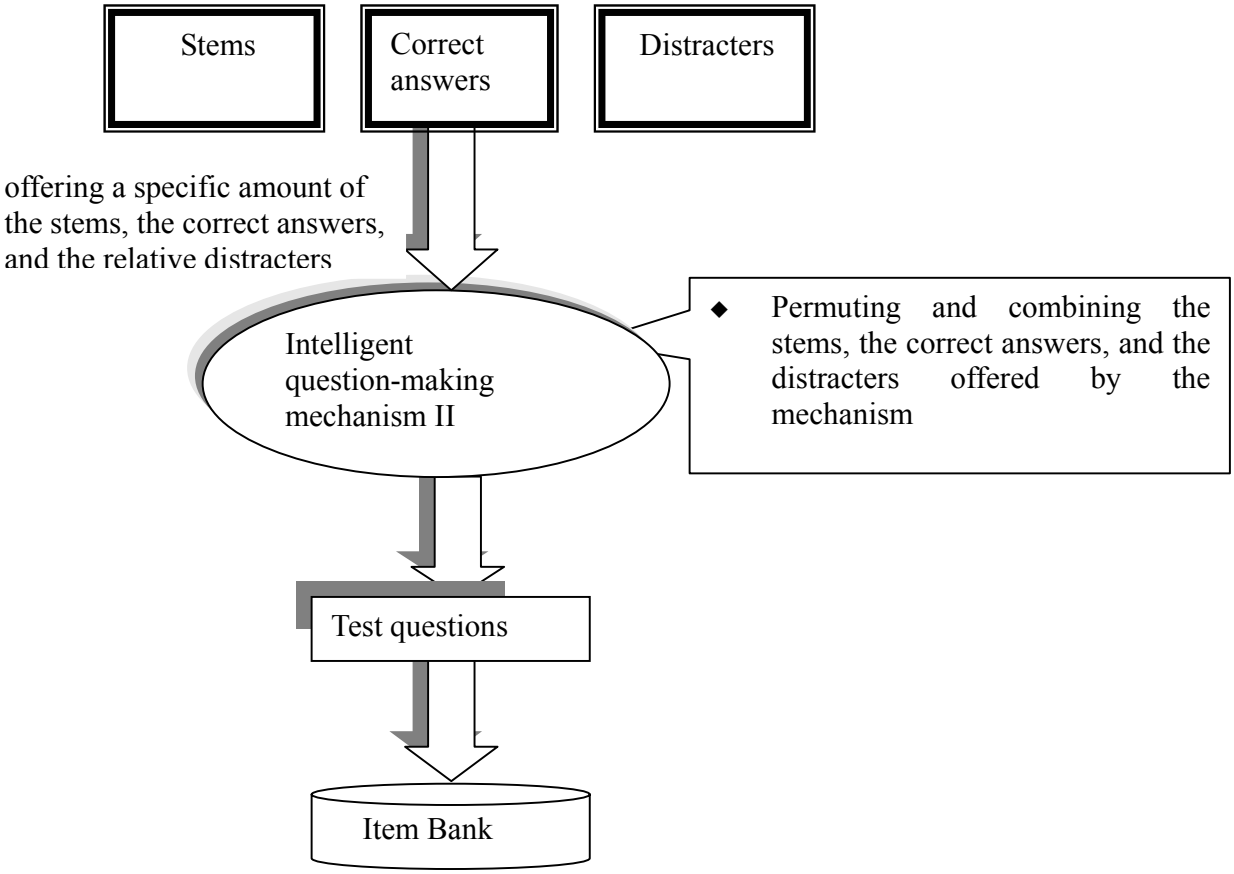

Fig. 6： The intelligent question-making mechanism

According to each style of test questions, the mechanism offers a specific amount of the stems, the correct answers, and the relative distracters. Then the mechanism permutes and combines the stems, the correct answers, and the relative distracters (see the Fig. 6). Therefore, the mechanism may automatically generate different styles of test questions to solve the problem of repeating test questions in item banks. For an example, in the course of basic computer concepts, the mechanism offers the following stems:

1. ◇ What is a device of the
   ◇ What is belong to the

2. ◇ Input unit
   ◇ Output unit
   ◇ Memory unit

3. ◇ Scanner
   ◇ Mouse
   ◇ Keyboard

4. ◇ Screen
   ◇ Printer

5. ◇ Hard disk
   ◇ Floppy
   ◇ Compact Disk

According to the algorithm, the mechanism permutes and combines the stem of test questions, the correct answers, and the relative distracters to automatically generate different styles of test questions, for an example:

What is a device of the input unit?

1. Printer
2. Hard disk
3. Mouse
4. Screen

The more quantity of the stems, the correct answers, and the distracters are offered, the more abundant test questions are generated. This study has succeeded in developing the intelligent question-making mechanism II for the course of basic computer concepts. It is able to make over one thousand test questions according to ten stems.

3.3 The learner's learning monitoring mechanism

In order to monitor the learner's learning effectiveness in the Web-based learning systems, this study suggests a learner's learning monitoring mechanism. It integrates the teaching contents and the test questions into a teaching unit. It evaluates the learner's learning results after her or his finishing each teaching unit. It can also monitor the learner's learning attitude.

For the purposes of monitoring the learner's learning effectiveness and achieving the objective

of Web-based active learning, the learner has to pass the test before starting to learn the next unit. The mechanism may automatically suggest a specific unit for the learners to learn. The learner can also select wider or deeper contents to learn. If the learner does not pass the test, she or he has to read the present unit again till passing the test (see Fig. 7).

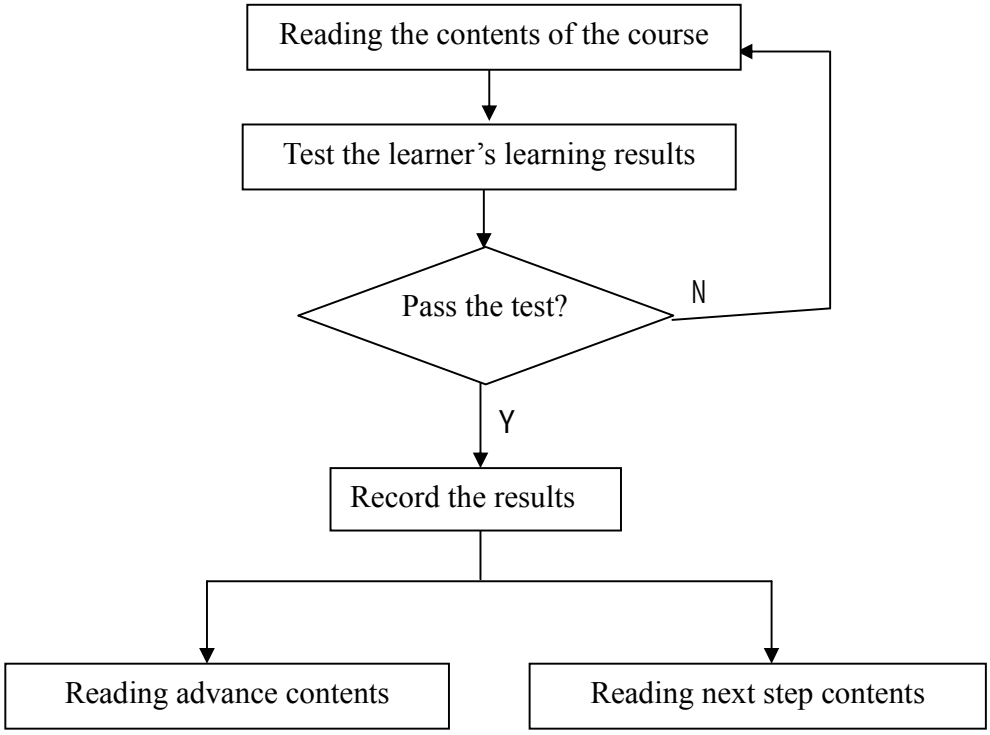

Fig. 7：The flow chart of learner's learning monitoring mechanism

The learning way under the monitoring of the learner's learning monitoring mechanism can assure the quality and effectiveness of the Web-based learning and may avoid the learner's idle learning on the web-based learning systems.

4. The advantages of intelligent Web-based learning systems

The major advantages in the intelligent web-based learning system are characterized as:

1. It offers a flexible and efficient learning environment and changes the learner's passive browsing learning into an active learning

2. It helps the learner to active seek the desired related knowledge for achieving the effectiveness of wide, deep, and active learning.

3. Professional teachers edit the courseware to reach the effectiveness of labor division.

4. It can avoid the repeating contents.

5. It issues the concept of "virtual teacher" to let the learner select adaptive contents

according to her or his degree and interest.

6. It is able to automatically generate a great quantity of various and effective test questions for achieving the function of automatic question making. This function may decrease the load of teachers and shorten the time of making item bank.

7. It integrates the teaching contents and the test questions into a teaching unit. In addition to evaluating the learner's learning results, it can also monitor the learner's learning attitude...

8. It adopts the learner's learning monitoring mechanism and provides a systematic learning navigation path to urge the learner's learning progress.

The intelligent Web-based learning system suggested by this study is appropriate for many kinds of subjects, such as the subjects of electronic commerce fields, basic computer concepts, and

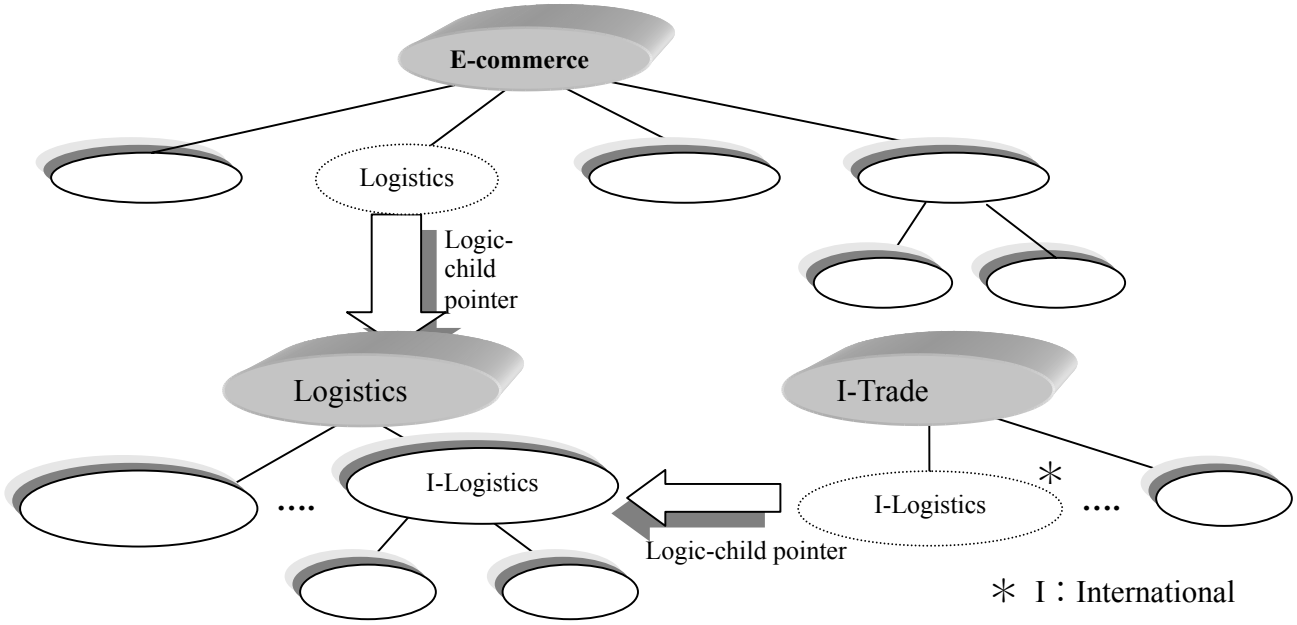

Fig. 8 The relationship of Logistics related courses

business related fields. Fig. 8 shows the relationships of Logistics related courses. The Logistics is one of the major units in the E-commerce course. The Logistics is also an independent course, so it is a logic child of the E-commerce course. The International Logistics is one of the major units in the Logistics course. The International Logistics is also one of the major unit in the International Trade course, so the International Logistics unit in the Logistics course is a logic child of the International Trade course.

5. Conclusion

The teaching method in the traditional We-based learning systems adopts the concept of "virtual classroom". That means every learner has to accept an identical teaching content and has no opportunity to choose different teaching contents. In order to improve this problem, this study issues the concept of "virtual teacher". That means the same teaching unit is composed of

different editions of teaching contents for the learner to select. It provides a flexible and effective learning environment. In order to improve the passive learning problem, this study suggests an intelligent Web-based learning environment for achieving the effectiveness of wide, deep, and active learning. Improving the problems of a traditional item bank is also an important issue of this study. Developing the intelligent question making mechanisms is for the purpose of achieving the objectives of quick making abundant and effective item banks and then it can solve the problem of overusing test questions. Furthermore, in order to assure the Web-based learning effectiveness, this study also suggests a learner's learning monitoring mechanism to effectively monitor and manage the learner's learning conditions.

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