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## Teaching System Based on Intelligent Computer Assisted Instruction

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### Abstract

ICAI (Intelligent Computer Assisted Instruction, hereinafter referred as ICAI), is a teaching mode on the theoretical foundation of the cognitive science and thinking science, through the study of the characteristics and process of the thinking of human in learning, with the application of the

artificial intelligence technology to the computer assisted instruction. The domain knowledge as the "memory" of the intelligent computer assisted instruction system for the storage of knowledge is an important part of the Intelligent Computer Assisted Instruction System. In this paper, according to the characteristics of the current single and linear organizational relationship that exists in the current ICAI system, it describes the basic theory and the development principles of the ICAI system, for the Authorware software platform, it adopts the Prolog language and the SCORM standards as well as other related technologies as the development tools, to have an in-depth discussion on some of the important models in the process of system design and the key technologies which are applied in the system; the basic model and structure of WBIETS system is designed, and an overall framework and application module is developed to support four kinds of users including students, teachers, educators and administrators to complete a variety of English teaching, evaluation and management activities in Web.

**Key words:** INTELLIGENT COMPUTER ASSISTED INSTRUCTION, ARTIFICIAL INTELLIGENCE, LINEARIZATION OF RELATIONS, ENGLISH TEACHING.

### 1. Introduction

With the development and maturing of the computer network technology, artificial intelligence has achieved success in the field of expert system, providing a new space for the development of CAI [1]. ICAI is developed on the basis of CAI by the introduction of artificial intelligence (AI), which has overcome many of the weaknesses in the traditional CAI, and provided the students with a new kind of learning environment. In the different period of development of ICAI, the focus of the study is not the same either [2]: the early ICAI was mainly focused on the representation of professional knowledge. In the late 1970s, AI techniques were adopted to construct the student model that represented the student status and the teacher model that reflected the teaching methods and styles of the teacher. After it went into the 1980s, the research of ICAI system was focused on the application of AI technology to represent the exact model of the students and teachers, so as to allow the teaching system to have a higher level of response sensitivity and overall concept. In the 1990s, attributing to the further development of the computer technology and artificial intelligence theories and methods, as well as the construction of the attention theory and so on, the research of ICAI system was focused on collaborative teaching model, and the construction of the students model and the research of the intelligent hypermedia CAI System and other aspects [3].

The artificial intelligence (AI) technology which is based on knowledge engineering has the capacity to solve the defects of the traditional CAI, therefore all the fields of higher education technology have the tendency to introduce AI technology at present. And the AI involved in the current educational technology is mainly in the following fields [4]:

1). The Representation and Access of Knowledge: Knowledge is the foundation to achieve knowledge-based reasoning and expert system, and the

premise to build the knowledge base is to solve the issue of formal representation of knowledge and the access and call of the knowledge, therefore, the representation of and access to knowledge is one of the core technologies in artificial intelligence, and also one of the tough problems that need to be addressed in order to introduce the AI into the field of education.

2). Automatic Diagnosis of the Errors Made by Students: Not only to be able to discover the errors made by students, but also to be able to point out the source of errors of the students, so as to make targeted tutoring or provide learning recommendations. In order to be able to make correct diagnosis, usually the thinking process of students needs to be tracked. Therefore, the issue of automatic diagnosis of errors is both related to the AI technology but also related to the students' cognitive law and cognitive characteristics namely the construction of the student model.

3). The Realization of the Intelligent Hypermedia Teaching System: As described above, the hypermedia system has the ideal teaching environment, which is easy to stimulate students' interest and motivation to learn, however, it cannot guarantee the achievement of the expected learning goals, in addition, as it does not know the objects to be taught, it cannot give targeted guidance, and thus cannot provide customized instruction. However, the Intelligent Computer Assisted Instruction System is just the opposite. The combination of the two can achieve the complementarity in performance, thus to develop a new generation of high performance intelligent hypermedia teaching system.

The purpose of this research is to develop an IC-AI-based intelligent English teaching system WBIETS, with the efforts to make innovation and trials in this regard.

### 2. Knowledge space theory

The knowledge space theory [7-8] that Doignon and Falmagne et al proposed provided a method to

represent the knowledge structure, as a psychological theory that measures the students' knowledge level, and knowledge structures. In this theory, the state of knowledge regarding a domain (a limited set of subjects) is represented by the subset of the subjects which can be answered by the person being evaluated, and the state of knowledge is under strict constraints of the premise relationship between the subjects, due to the existence of the premise relationship between the subjects, not all the subsets of the subjects are the state of knowledge. The knowledge space is a set of all possible states of knowledge which constitute a particular field of knowledge, which is closed for the union of the states of knowledge, i.e., the union of two states of knowledge is also the element of knowledge space. The following are some of the basic definitions in the knowledge space theory.

**Definition 1.** Let knowledge domain  $Q$  be a finite set of subjects, we refer to the set of subjects that the students are able to answer the state of knowledge  $k$ , that is,  $k \subseteq Q$  is called the state of knowledge, if and only if  $\forall_{q_1, q_2 \in Q}, q_1 \leq q_2$  and  $q_2 \in k \Rightarrow q_1 \in k$ . Where " $\leq$ " relationship is the precondition relationship, that is, if the subject  $q_2$  can be solved correctly, the correct solution to subject  $q_1$  can be deduced as well. This definition suggests that if subject  $q_2$  is in the state of knowledge  $k$ , then all premises  $q_1$  of  $q_2$  are also in the state of knowledge  $k$ .

**Definition 2.** Let the knowledge domain  $Q$  be a finite set of the subjects, and the set of  $Q$ 's subset  $K$  is called the knowledge space. If and only if (i)  $K$  contains the null set  $\emptyset$  and the set of subjects  $Q$ , (ii) for any states of knowledge  $k_1, k_2 \in K$ , and their union  $k_1 \cup k_2$  also belongs to  $K$ . This definition indicates that the knowledge space is the set of all possible states of knowledge, and its union between the states of knowledge is closed.

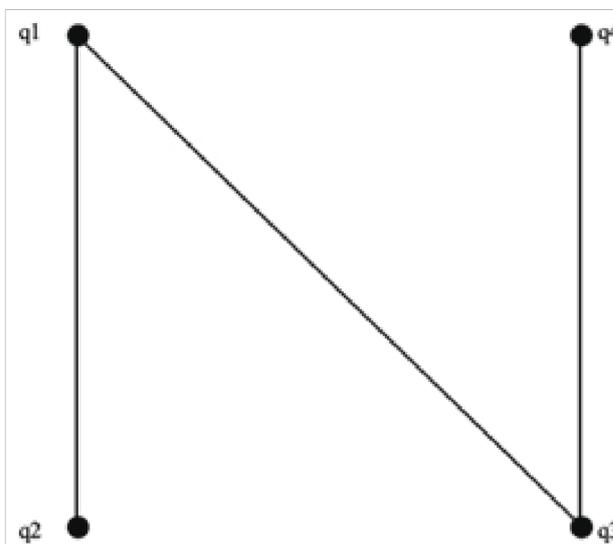
**Example 3.1** Let the knowledge domain  $Q = \{q_1, q_2, q_3, q_4\}$  contain four subjects, among these subjects the premise relationship is as follows:

(1) If a student can solve the subject  $q_1$ , then he / she can solve the subject  $q_1$ 's premise subject  $q_2$  and subject  $q_3$ .

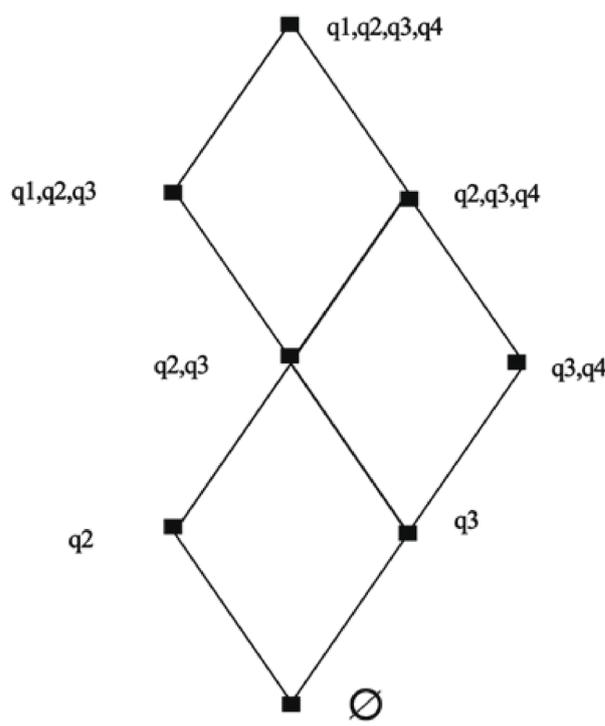
(2) If a student can solve the subject  $q_4$ , then he / she can solve the subject  $q_4$ 's premise subject  $q_3$ .

The above relationship can use ANDOR graph to represent (see Figure 1), from this figure each state of knowledge can be determined. For example,  $\{q_1, q_2, q_3, q_4\}$  is a state of knowledge, as it does not conflict with the aforementioned three conditions, while  $\{q_1, q_2\}$  is not a state of knowledge, as it contains the subject  $q_1$ , but does not include the premise subject  $q_3$  of subject  $q_1$ , which has conflict with the first premise relation. All the states of knowledge, namely those sets not in conflict with the premise relationship,

together with the null set  $\emptyset$ , and complete set  $Q$  to make up the knowledge domain  $Q$ 's knowledge space  $K = \{\emptyset, \{q_2\}, \{q_3\}, \{q_2, q_3\}, \{q_3, q_4\}, \{q_1, q_2, q_3\}, \{q_2, q_3, q_4\}, Q\}$  figure 2 is the Hasse figure of the knowledge space  $K$ .



**Figure 1.** ANDOR Graph of Premise Relationship



**Figure 2.** Hasse Diagram of Knowledge Space  $K$

In certain particular field of knowledge domain, the premise relationship between the subjects shall be determined by the experts in the field. And generally Dowling and Carus Char method can be adopted, to put forward a series of standard form of judge sentences to the experts: "Suppose a student did not answer the subject  $p_1, p_2, \dots, p_k$  correctly, then whether or not it would impossible for the student to answer the subject  $q$  correctly?" Herein  $p_1, p_2, \dots, p_k$  consti-

tute the premise, and the subject  $q$  is the conclusion, the reaction of the experts to these judge sentences is either acceptance or rejection. Thus the premise relationship between the various subjects can be determined according to the reactions of the experts.

Definition 3. Let the knowledge domain  $Q$  be a finite set of subjects, and  $K$  is the knowledge space on knowledge domain  $Q$ . And the distance between the states of knowledge  $k, k'$   $d(k, k')$  is equal to the size of the symmetric difference of their sets,  $d\{k, k'\} = |k \Delta k'| = |(k - k') \cup (k' - k)|$ . The set of the state of knowledge  $F(k) = [\cup N(k) - \cap N(k)]$  is known as the boundary of the state of knowledge  $k$ , namely the set of different subjects in the neighbors of the state of knowledge  $k$  from the state of knowledge  $k$ .

As known from the definition of  $F(k)$ , for any subject  $q \in k$  and  $q \in F(k)$ , the set  $k - \{q\}$  is the state of knowledge; for any subject  $q \notin k$  and  $q \in F(k)$ , the set  $k \cup \{q\}$  is also the state of knowledge. The neighbor of certain state of knowledge  $k$   $N(k)$  is on the Hasse diagram of the knowledge space, from the state of knowledge  $k$ , through zero stop or one step to reach the set of the state of knowledge, including the state of knowledge  $k$  itself and the direct neighbor of the state of knowledge  $k$ , while the subjects with the elements that the boundary  $F(k)$  of the state of

knowledge  $k$  contains as the premise subjects are all included in the subjects of the state of knowledge  $k$ .

Example 2 The neighbor of the state of knowledge  $\{q3\}$  in Example 1 is the set

$N(\{q3\}) = \{\emptyset, \{q3\}, \{q2, q3\}, \{q3, q4\}\}$ , the boundary of the state of knowledge  $\{q3\}$  is the set

$$F(k) = \{q2, q3, q4\}.$$

### 3. The realization of wbiets system

As WBIETS system engineering is relatively huge and complicated, the application of Authorware software adopts the modular method in design. The idea to adopt the module is to save the segment of program composed by a number of design icons on the program flow-line in the Authorware system, so that in the future edition of Authorware program, the saved segment of program can be introduced into the program, with the characteristics of repeated use and free modification, so as to improve the work efficiency. After this education system is divided by different users into the corresponding student, teacher, educators and administrator subsystem, the appropriate subroutine design module can be performed on the basis of various subsystems, and finally the modular processing can implemented on these subroutines, then the development work of the entire education system will be completed.

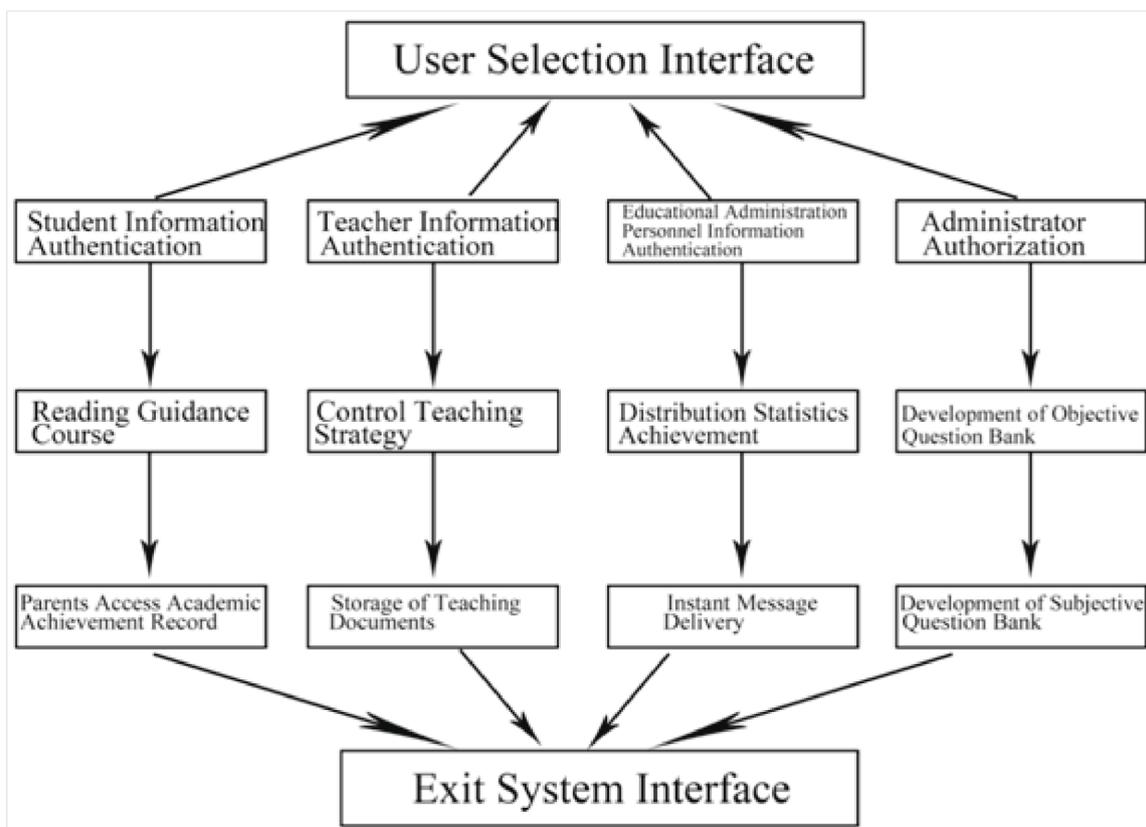


Figure 3. System Subroutine Flow Chart

## 3.1 Realization of the Student Subsystem

In Authorware, in fact, the object of knowledge is in fact the expansion of the module, which is the module with the visualized configuration wizard. By the application property configuration wizard similar to what you see is what you get (WYSIWYG), designers can easily and quickly make use of the existing knowledge objects without having to go through the repetitive process of design work.

1). Thought the adoption of the login knowledge objects the back-end database can be realized, but to modify some of the interface and technical parameters, the knowledge objects are locked module, which cannot be extended or modified. Delete all the unnecessary icons in the frame portion, modify the parameters associated with the login database, adjust the corresponding interface to import the list of all students in the Student\_data table, and the default password is the student number. The system only allows the students to log in, and new users cannot be added in the interface casually, but the user password can be modified by the user after logging in the system.

2). Make use of the two components of the knowledge object of the learning management system LMS (initialization) and LMS (data transmission) to generate the contents in line with SCORM LMS.

LMS (initialization) KO is used to initialize the communication and exchange of information with the

learning management system (LMS). It contains the necessary functions with any learning management system which is compliant with the SCORM standard, and users only need to fill in the content of LMS (initialization) as required.

LMS (data transmission) KO has two functions, which are typically used to send standard tracking data to LMS, or send commands to the LMS to end the tracking information. When used to interrupt or end the tracking, it is usually when the user presses the end or exit.

Student cognitive module is composed by a comprehensive "Student Record" and the knowledge level determination module, learning tracking module and learning status module to confirm the contents of each data item in the "Student Record", whose abstract structure is shown as the figure below. The evidence to infer the level of knowledge of students is collected through the following three channels: Firstly, implicit information, which is obtained from the student's answering behavior, and interactive problem-solving actions; secondly, the explicit information, which is acquired from the system direct interaction with the students in the conversation; and thirdly, the background information, which is acquired from the estimation based on the average level of the students. The student structure is shown in Figure 4.

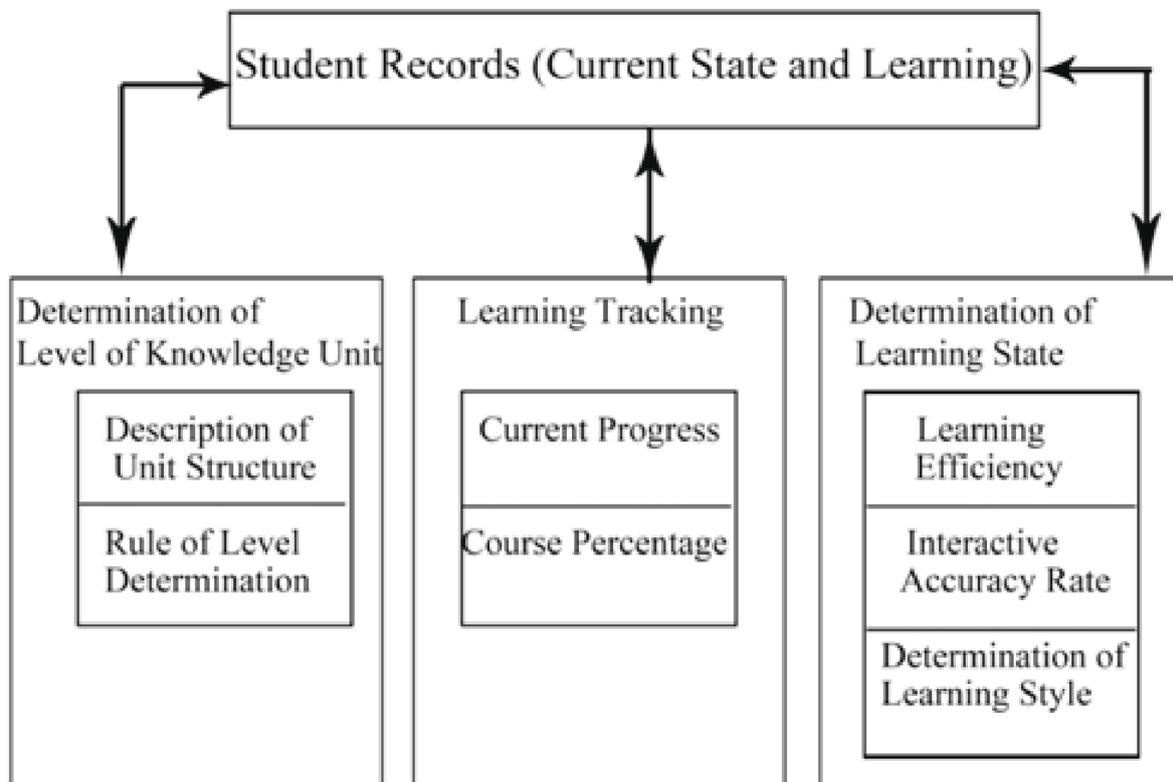


Figure 4. Structure of the Student Model

### 3.2 Realization of the Teacher Subsystem

The task of teaching strategies reasoning machine is to take the status feature of the students as the parameter, and select the required teaching strategy rules, to generate the corresponding teaching activity sequence, so as to achieve the appropriate teaching process. The realization of the reasoning process is mainly the application of searching method to search the teaching strategy that matches the student status parameter in the teaching strategies rules base. The approach of the knowledge search for the research on the reasoning machine and the strategy selection is called reasoning control strategy, which is the most critical issue in the teaching strategy reasoning machine, and is related to the effectiveness and efficiency of reasoning. Generally there are 3 kinds of reasoning control strategies, which are forward reasoning, backward reasoning and mixed reasoning. In this education system, the forward reasoning control strategy is selected.

In teaching, the focus and difficulty of different points of knowledge is different, and the teaching methods and schedule shall also vary from person to person, when to select the key point review, when to accelerate the progress with the required experience, therefore, different teaching strategies are utilized to guide the teaching for students at different levels. The teaching strategies are represented with the production rule of the artificial intelligence techniques, and the general form is:

Rule name: If <condition> then <action> the main feature of the production rule based teaching strategy representation method is that it can simulate the human cognitive process, and get close to the way of thinking of human being, making it easy to understand, with clear control strategy.

The Intelligent Teaching System rule database has the following rules:

R001: IF (good grade) AND (high cognitive ability)

THEN (continue to learn the next knowledge point) R002: IF (good grade) AND (general cognitive ability)

THEN (improve the cognitive ability on the current knowledge point)

R003: IF (general grade) AND (general cognitive ability)

THEN (repeat the leaning of the current knowledge point)

R004: IF (general grade) AND (low cognitive ability)

THEN (repeat the leaning of the current knowledge point)

R005: IF (poor grade) AND (low cognitive ability)

THEN (return to the learning of the last knowledge point)

As can be seen from the above, the rules in the rule database are for a specific field, but not for a particular task environment. The rule database does not contain the information of a student's specific learning status, as well as the knowledge of how to use these rules for reasoning.

From the specific implementation point of view, to determine the difference between a good academic performance and a poor one can be evaluated by analyzing the scores that a student get after taking the test with the subjects of some part of the knowledge points; the determination of the level of cognitive ability can be obtained by analyzing the value of the cognitive ability after the student takes the test on some part of the knowledge points.

The application of prolog to express rule is:

R001: Knowledge (continue\_study):-score(-good),ability(higher).

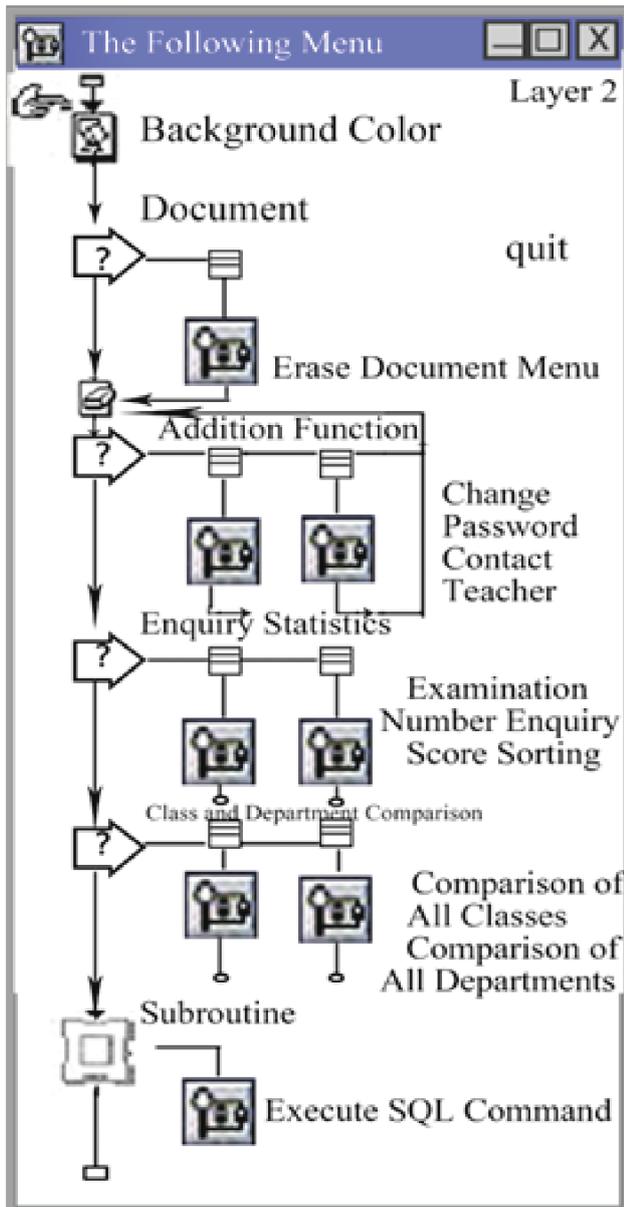
When students complete the leaning on the content of a section, and answer the subjects the system asks with the result score less than the threshold of this section, the system will not mark the section as having been learned. So next time when the student logs in, the system will make the student to learn the contents of the section again. Usually the section with the special important role in the discipline has a relatively high threshold. The method given below is to evaluate the importance of a section in the course:

Important (N) = IN (N) + OUT (N)

Important (N) – The position of the knowledge in Section N (arrange the sections of the book in the form of serial number) in this course; IN (N) – in this course, the sum of numbers of knowledge points in the remaining sections that have influence on the knowledge in section N; OUT (N) – in this course, the sum of numbers of knowledge points in section N that have influence on the knowledge in the remaining sections. After the calculation of all Important (N) in this course is completed, the threshold of certain section can be given pursuant to the calculation result. Threshold Valve (N) is expressed in the form of percentage, which is less than 1 and proportional to the Important (N).

Let Right (N) indicate the accuracy rate of a student in the answer to the subjects proposed by the system after the completion of the leaning of the knowledge in section N. The variable Ruler = 1-Valve (N). The modification rule of the given cognitive model is as follows:

If  $Right(N)$  If  $Valve(N) \leq Right(N)$  If  $Valve(N) + Ruler * (1/3) \leq Right(N)$  If  $Valve(N) + Ruler * (2/3) \leq Right(N)$  Then the cognitive ability is determined to be "high"



**Figure 5.** Educators Subsystem Module Flow Chart

The specific process applying forward reasoning in the teaching strategy reasoning in this teaching system is as follows: Firstly, the reasoning machine obtains the student learning characteristic parameter DB1 and the knowledge characteristic parameter DB2 respectively from the student model and the discipline knowledge database, and then extract the teaching rules that meet the conditions of the aforementioned two parameters from the teaching strategy rule database KB1, and select and execute the teaching action of one of them, so as to form the new facts, and add these facts to the new fact library, and the control module is actually a recursive process, re-

peating the process until the teaching objectives are reached.

1). Develop table in the jxgl.mdb database: Educator table Educator\_data: Three fields including LoginID (accession number), Name (full name), and password (password); open the table and enter the specified educator's name and password.

2). Make the educator password program, a method similar to making the student login password program.

3). Make the distribution statistical program, use Authorware graphics function to have the statistics on the achievement scores of students in the form of bar graph, using the random color to draw the bar graph, showing the number of students in various segments of scores, the statistics of the overall situation of each class and department, as well as the comparison of classes supervised by the teacher of the class.

4). Make email delivery, the educators can send the statistic teaching information via e-mail to all the teachers of the classes.

The educator structure is shown in Figure 5.

#### 4. Wbiets system test

Test the overall functionality of the WBIETS system to see if it meets the design requirements, and whether each module is operating normally. The specific test objectives are as follows:

(1). Platform launching: Configure the web publishing environment of the Authorware platform.

(2). System interface startup: Display a welcome message and user selection interface.

(3). Student system login: The authentication of the user name and student number is required

(4). Read the tutorials: Students can read the knowledge points of each chapter and unit based on their own learning progress.

(5). Unit test training: Students can take the test training on the six sets of practice tests according to their own learning situation, and each test includes five examination points: listening comprehension, reading comprehension, vocabulary and structure, cloze test and writing.

(6). Teacher system login: The authentication of the user name and student number is required.

(7). Teaching document saving: Storage of teacher dissertation collection, archival bags, grade books, paper clips, and notes.

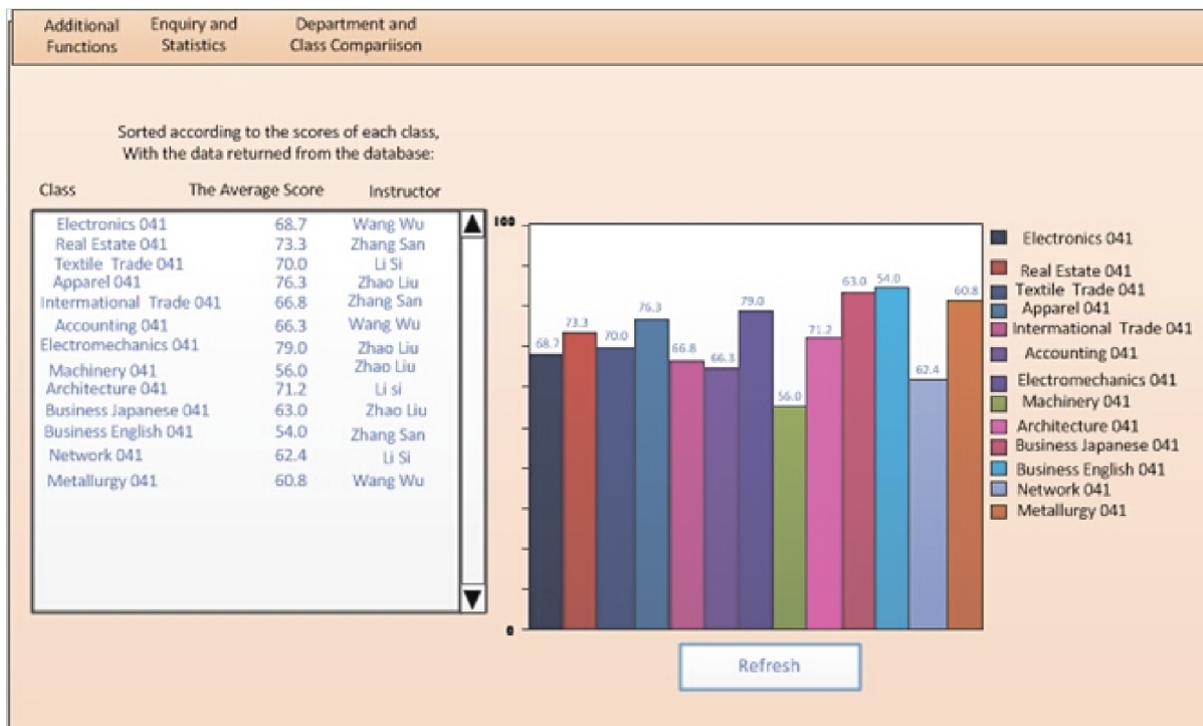
(8). Supervisor system login: The authentication of user name and student number is required.

(9). Distribution statistics of the teaching outcomes: Sorting the student scores, the overall statistics of each class and department, as well as the comparison of classes supervised by the teacher of

the class.

(10). Real-time transmission of information: The educator can send the statistic teaching information via e-mail to all the teachers of the classes.

(11). Enquiry by parents: Enter the student's school number or name to access the student's learning status and achievement in school, as well as the ranking in the class.



**Figure 6.** Graphics Interface of the Statistics of the Scores of Each Class

Objective test, six sets of unit test subjects are stored in the subject database, including listening subject, vocabulary subject, reading comprehension and cloze test.

The statistical distribution of achievements shows that the number of students in various score sections, the statistics of the overall situation in each class and departments, as well as the comparison of classes supervised by each teacher of the class, and here is a graphical interface with the statistics of the scores of each class, as shown in Figure 6.

### 5. Conclusion

This paper made an overall architecture design of the system and analysis of functional modules on the foundation of the basic model and structure program of the Web-based intelligent teaching system WBIETS, including the system components, system block diagram and system functions, and had a thorough discussion on the key technologies applied in the intelligent teaching system; elaborated in details the realization process of the Web-based intelligent teaching system WBIETS, including the implementation of four major user program modules such as the main system interface design, student subsystem, teacher subsystem, educator and administrator subsystem, developed the overall framework and application module that can support five major users including

students, teachers, parents, educators and administrators to complete a variety of teaching, evaluation and management activities in Web; and performed functional test for the designed WBIETS system.

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# Structural-functional analysis of future mining engineers readiness for professional activity

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### Abstract

In the article, components of readiness of future mining engineers for professional activity are characterized; their contents and functions are investigated on the basis of theoretical generalization of scientific literature.

Key words: MINING ENGINEER, READINESS, READINESS OF FUTURE MINING ENGINEERS FOR PROFESSIONAL ACTIVITY, READINESS STRUCTURE

Relevance of research is defined by a wide problem field, which can be presented in the form of contradictions between public requirements to training quality of mining engineers and the actual level of technical HEI graduates readiness for performance of socially induced professional functions.

The certain aspects of the investigated problem were covered in scientific works with technical training of mining engineers. For example, the role of natural sciences in technical training of future miners is covered by N. Komarova, formation of communicative competence is investigated by Z. Bakum,