World Academy of Science, Engineering and Technology
International Journal of Computer and Information Engineering
Vol:4, No:5, 2010

A Study and Implementation of On-line Learning Diagnosis and Inquiry System

YuLung Wu

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

***Abstract*—**In Knowledge Structure Graph, each course unit represents a phase of learning activities. Both learning portfolios and Knowledge Structure Graphs contain learning information of students and let teachers know which content are difficulties and fails. The study purposes "Dual Mode On-line Learning Diagnosis System" that integrates two search methods: learning portfolio and knowledge structure. Teachers can operate the proposed system and obtain the information of specific students without any computer science background. The teachers can find out failed students in advance and provide remedial learning resources.

***Keywords*—**Knowledge Structure Graph, On-line Learning Diagnosis

I. Introduction

IN on-line distance learning environments, Internet is the major media for communication between teachers and students. The methods most frequently used by teachers to understand the situation of students are setting homework or examinations. However, these methods do not provide teachers with immediate feedback, and the feedback obtained inevitably lags behind teaching progress. The lack of face-to-face interaction between teachers and students in on-line distance learning makes it difficult for teachers to know the situation of students, and this weakness must be improved. By recording and analyzing student behavior, details of individual learning situation can be obtained, including progress, strengths and weaknesses.

The purpose of educational tests is to improve the instruction, ensure the accomplishment of instructional goals, evaluate learning results of students and assess learning of students as the criterion of remedial instructions [10]. The learning result of students tends to depend on their grades. However, the purposes of educational tests are usually neglected. In online learning environment, due to the lack of face-to-face interaction between teachers and students, it is important to probe into difficulties of students in their learning activities. Based on learning portfolio and knowledge structure of students retained in online learning, this study aimed to recognize learning situation of students more thoroughly and assess their learning as the criterion for the remedial instruction of teachers.

YuLungWu is with the Department of Information and Communication, KunShan University, Taiwan (corresponding author to provide phone: +886-6-2727175 ext 356; fax: +886-6-2050014; e-mail: ylw@ mail.ylw.idv.tw).

For helping teacher to know learning situation of students, this study proposes a new diagnosis strategy for on-line learning. The diagnosis strategy is based on Knowledge Structure Diagram (called KSD), and cooperates with the proposed system, Dual Mode On-line Learning Diagnosis System. User can find out different characteristic students from e-learning system easily, without need of understanding the technology of database or IT. With the assistance of the proposed system, teachers can prepare remedial learning strategies for different students.

II. Related Works

The "Conceptual graph"[7]-[9] is a traditional assisted teaching method. A conceptual graph is composed of propositions defined by two concept nodes and one connecting relation link. The concept nodes are arranged in a hierarchical structure. The conceptual graph can effectively represent knowledge structures of students.

Chang[3] proposed a similar approach for diagnosing student performance via a courseware diagram. The courseware diagram is a conceptual graph that contains course units and evaluation units. A course unit represents a teaching process and an evaluation unit represents an evaluation process for a learning activity. This study designed different levels of difficulty for course units for a topic, including normal course, basic remedial course and enhanced remedial course. According to evaluation results, the evaluation unit chooses the suitable course unit as the next course unit to continue the learning activities.

Hwang[5],[6] designed a computer-assisted diagnostic system that includes concept-effect relationships. The concept-effect relationship is a set of association levels (Test Item relationship table, TIRT) that represents the relationship between each concept node and each test item. In Hwang's study, the teacher must set an association level for each relationship before the course begins. According to the answers of students, the algorithm could obtain student learning information with each concept node.

The KSD shows the sequence of learning mainly in our study. Each node is a course unit that contains learning and testing activities, and connection of two nodes represents learning sequence. From Fig. 1, a link exists between course units A and D, and the direction of the arrow represents the learning sequence. Course unit A is a prior-knowledge of course unit D. Similarly, students should learn course unit A before course unit D in the learning activities. According to the different

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

learning situation of each course unit, students have individual learning outcomes from their KSD.

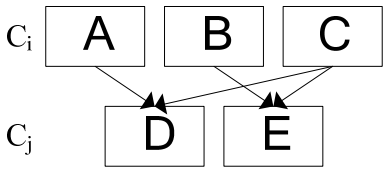


Fig.1 An Example of KSD

For reconstructing the relationship between teaching and testing, it is required to realize how to build knowledge structure and what is characteristic of knowledge structure [10],[11]. Schvaneveldt[12] proposed "pathfinder scaling algorithm" and developed "Knowledge Network Organizing Tool", called KNOT. The method of pathfinder scaling algorithm is letting students give scores to pairs of concept, higher score represent more similar. After deleting lower scores, the reminders represent there are relationships between two concepts. With drawing concepts and links, the graphs represent knowledge structure of students, which are named pathfinder net (called PFNET). By applying Pathfinder software, Goldsmith [13] converted the approximate concept matrix of users into a network structure, and calculated the similarity between two network structures of users based on set theory, the result of which was a close value C between 0 to 1. A high value denotes a close relationship between the graphs of student maps to that of an expert and, furthermore, the student has learned a significant amount of the knowledge theme [2].

Notwithstanding that the learning status and problems could be obtained from the KSD, it is a time-consuming job for the teachers to survey the KSD of every student. Moreover, the original records of on-line learning must be reviewed to obtain actual information. It is an important subject for the common people without any information technology background to learn how to operate database with SQL. SQL, which was initiated by IBM and turned into an international standard in 1987, now serves as a universal access method supported by all database systems. It is the main objective of this study to help teacher managing the learning situations of all students in classroom easily. Chen [4] proposed a "Feature Space Concept" theory, which, based on preset conversion rules, such as: account number, number of feedback, number of reading and field of database, allows you to convert the intended query conditions into SQL language, without need of learning the complex operations of database.

Chan [14] initiated a structure of learning features, and then combined with data mining algorithm, thus enabling the teachers to learn the abnormal situations of students from their learning portfolio, and then take remedy teaching or tutorship. After analyzing the learning behavior of students through numerous on-line learning portfolios, Jong[1] established a learning behavior model and a prior notification mechanism for abnormal learning behavior, thereby providing timely tutorship to improve the learning efficiency.

The study of Chan[14] and Jong[1] only analyze learning behaviors with learning portfolios of students. With Lacking of knowledge structure means lacking of a part of students learning information. In this study, providing learning information includes either learning portfolios or knowledge structure. And this study proposes a Dual Mode On-line Learning Diagnosis System that supports two types of diagnosis information, one is "Learning Portfolio Query" which provides learning portfolio of students, and the other is "Knowledge Structure Query" which provides user to find out students with specific knowledge structure. Finally, two methods can be combined and provide more learning information of students.

III. On-line Learning Diagnosis and Inquiry

A. Learning Portfolio Query

Although KSD reveals learning of students and allows teachers to recognize learning difficulties, it is still time consuming for teachers to check KSD of students. Moreover, some abnormal learning cannot be shown in KSD, so that teachers must check the original records of students through online learning. Thus, it is necessary to provide a system for teachers to obtain learning portfolios and knowledge structures of students.

The framework of learning portfolio query system is shown in figure 2, wherein the system is composed of physical description layer, parameter definition layer, feature definition layer and abstract query layer from bottom to top.

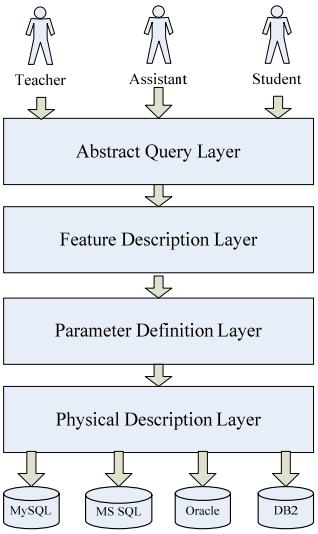


Fig.2 The framework of Learning Portfolio Query System

To eliminate the need of parameter or authority settings and reduce the operational complexity in the physical description layer, the users are not required for interaction with database system. And, the specifications of database, access method and authority settings, etc, are already described in the physical description layer. With the help of physical description layer, database system could even be replaced by just modifying the specifications in the physical description layer.

All learning records in database are stored in the tables and separated by the fields, but these technical descriptions make it difficult for the users to understand which are referred to data types, field names, primary key and foreign key. So, the

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

purpose of parameter definition layer is to convert the symbols in database into intuitional expression modes, e.g. the scores of students are stored into the field "Score" in the table "Students", meaning that the "scores of students" could represent Student.Score.

Data query in database must be restricted to some conditions, and then database will filter out the data with these conditions, that's to say, it is required to execute query by designating some conditions of students. For instance, if Student.Score < 60 is provided to find out the students with score<60, these students will be listed in database. In the feature definition layer, the users could replace the query instruction of database with description of learning features. For instance, the learning features of score<60 means "fail", so the users could represent Student.Score < 60 by "fail". To improve the flexibility and convenience of feature description, the predefined learning features could be combined to generate new feature descriptions, e.g. "fail" and "little attendance" are combined into a new feature-"passive learning", so feature descriptions are changeable to describe the learning status of students.

In the abstract query layer, the users are only required to select the well-defined learning features for query of database, without need of understanding the query instructions. Thus, when "fail" is defined in the feature definition layer, the users could find out these students by "listing the students who fail in the examination".

Based on this system proposed herein, teachers could obtain necessary support during the teaching process, without the need of database management and operation. For example, teachers could learn the learning status and extent of absorption through learning portfolio query; the assistants could also find out which students are poorly performed, and the students could realize their problems to provide a reference for self-improvement.

B. Knowledge Structure Query

To incorporate KSD into the system during data analysis of learning portfolio, a knowledge structure query method is proposed, allowing the users to inquire about the necessary data without understanding the storage method of the knowledge structure. As the structure and linkage relationship of KSD cannot be stored directly into database, the linkage relationship of individual course units in the KSD is divided into single segment and stored into database. When learning portfolio query is used, only the contents of a single course unit in the entire KSD could be obtained, leading to the loss of overall information contained in KSD.

To obtain and analyze completely the learning information contained in the KSD, a structure conversion layer is added between the parameter definition layer and feature definition layer, so the structure of the KSD is converted into database storage format, with the system framework shown in figure 3. Next, the users could select the learning feature-"listing the students with scattered knowledge structure" from the abstract query layer, then the "scattered knowledge structure" will be converted into database query syntax, whereby compatible data could be screened out from database.

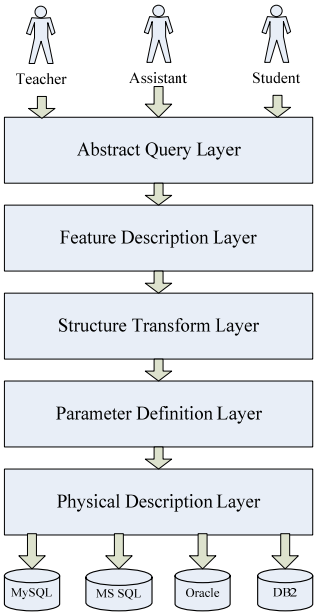


Fig. 3 The framework of Knowledge Structure Query System

The KSD shall be rearranged and re-classified to select the knowledge structure of interest, helping the users to select easily the students of special knowledge structure, without need of understanding the storage and query methods of knowledge structure. Firstly, the learning result distributions of KSD are classified into six types in this study, and then divided into overall and individual descriptions. Overall description means that the learning result distributions of entire KSD are considered, whilst individual description means the distribution of a certain course unit in the KSD is considered:

1. Complete: overall description, test of all course units passed.
2. Almost complete: overall description, test of over 80% course units passed.
3. Focused: individual description, the test of over 80% nearby course units passed based on a specific course unit already passed; but the test of less than 50% nearby course units passed based on another specific course unit already failed.
4. Dispersed: overall description, the test of over 50% nearby course units failed based on a specific course unit already passed, and these course units accounting for over 50% of course units already passed.
5. Scattered: overall description, the test of over 70% nearby course units passed based on a specific course unit already passed, and these course units accounting for over 50% of course units already passed.
6. Almost Vacant: overall description, the test of over 80% course units failed.

The above-mentioned types of rough italics are threshold values that predefined recommended values, but may be adjusted by the teachers, where applicable. The teachers could list the students based on the classifications. Due to different part of KSD correspond with different type; each student maybe corresponds with over one type. All types corresponding with students represent learning situations of

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

students at present, and all of them are adopted in this study. For example, a student with focused knowledge structure, maybe cause of few pass course unit, with scattered or almost vacant knowledge structure.

Teachers can use knowledge structure type as learning feature to find out specific students. For example, students with good performance but unstable knowledge structure may be found out by "listing the students with scattered knowledge structure". The incomplete knowledge structure make students have high score on the surface, but can not to achieve mastery through a comprehensive study of the subject and learn advanced knowledge. Meanwhile, the students who master at "Data-Definition Language" could be identified by "listing the students focused on Data-Definition Language". That means the students interest on the focused course unit or the course units are easy to learn.

If comparing and evaluating traditionally the "students with scattered knowledge structure" and the "students with focused knowledge structure", the results may be same or similar to each other. But, it is learnt from KSD that the learning status and problems of these two types of students differ a lot, and the teachers have to take different teaching measures. Thus, it is clear that the knowledge structure query and analysis are crucial to on-line learning.

Figure 4 illustrates the examples of classification and the difference according to the aforementioned definitions.

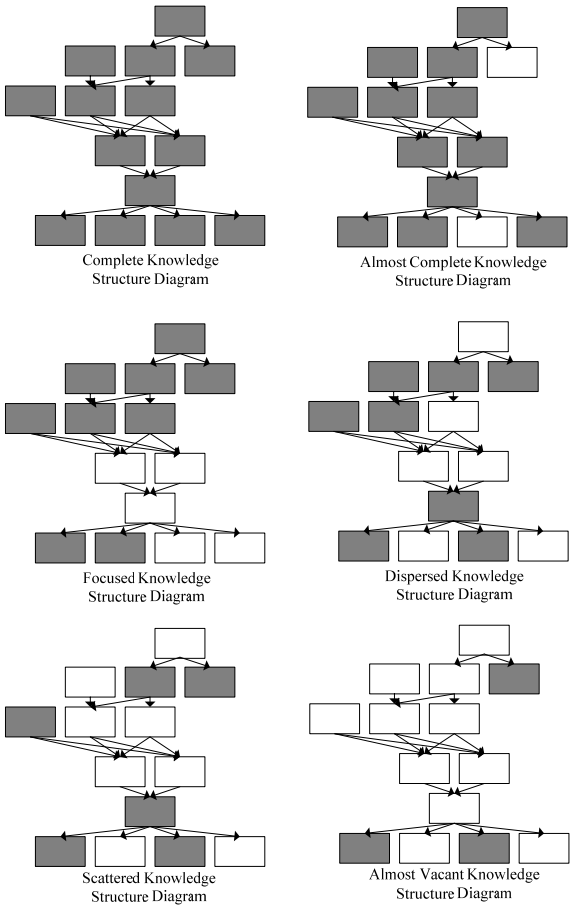


Fig.4 The types and examples of knowledge structure

C. Dual Mode Query

Both learning portfolio and knowledge structure contain learning information of the students, which provide an access to teachers for understanding current learning status and problems of students. So, Learning Portfolio Query and Knowledge Structure Query are developed, allowing users to select easily the data of interest. As learning portfolio and knowledge structure play a big role in learning diagnostics, a Dual Mode On-line Learning Diagnosis System is developed along with learning portfolio and knowledge structure queries, with the system framework shown in Figure 5.

In feature definition layer, the system could judge automatically if the defined learning features belong to learning portfolio or knowledge structure. As knowledge structure is involved, the system will automatically embed structure conversion layer, without switching between two query modes. Furthermore, a hybrid query method is developed, enabling the users to list "the students with score<60 or scattered knowledge structure", that represent students with bad performance. The learning situations of students are shown in learning portfolios and knowledge structures, all students can be found out in different situation.

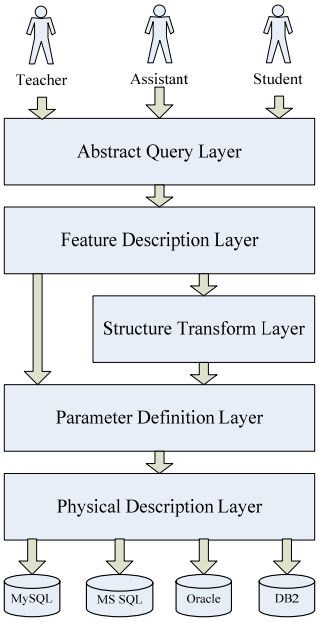


Fig. 5 The framework of Dual mode On-line Learning Diagnosis System

IV. System Implementation

Since this study aimed to assess learning behavior according to learning system, how to flexibly adjust the system framework to easily combine the learning systems becomes the key. In this study, a statistics of distance learning systems of the universities in Taiwan were analyzed. Considering the number of system users and the representative, this study only probed into distance learning systems of the universities. A total of 103 universities and colleges were investigated and the statistical result is shown in Table I. As seen, the market share of two on-line learning systems (Moodle and Wisdom Master Pro) is over 90%. In order to validate the feasibility of the proposed

system, this study tested Moodle and Wisdom Master Pro respectively. The result showed that the execution is successful without the modification of the codes. Thus, the proposed system is proven to be feasible. The following experiment and evaluation is based on Wisdom Master Pro.

TABLE I THE MARKET SHARE OF ON-LINE SYSTEM IN TAIWAN

	System Name	Market Share
1	Moodle	41.18%
2	Wisdom Master Pro	55.88%
3	Others	2.94%
	Sum	100.00%

Using the search for "the students with active learning attitude" as an example, this study described the setting process of learning features. According to our previous studies, active attitude of students is reflected in time of login and time of assignment submission. Using "time of login" as an example, after analysis, it is recorded in UserLog; however there is no data field of time of login in database, so that this study defines a temporal table for storing time of login. System managers first define the learning parameter "time of login" as "(Select UserLog.Username,Count(*) as LoginTimes From UserLog Where Action = 'Login' Group By Username)LoginTimes". And then users can obtain time of login directly. The above SQL instruction shows that the temporal table includes self-set LoginTimes (time of login) and Username (the students' ID). The field Username prepares for SQL instruction, Join. Due to normalization database system, most of learning parameters cannot respectively correspond to certain fields in database. The information is usually obtained through processing and calculation with SQL instruction. In the proposed system, learning parameter setting belongs to Parameter Definition Layer. Since it is the bottom of system setting, it is the only layer for users to use SQL instruction. Thus, in the system, learning parameter setting is not available for common users. This study also constructed the commonly used learning parameters for the users to use directly.

The learning parameter is limited with a boundary and producing a new learning feature that named "login continually". The boundary conditions include "=", ">", "<" and "Like". The users can flexibly set the conditions, as shown in figure 6. The list of the conditions involves the predefined fields.

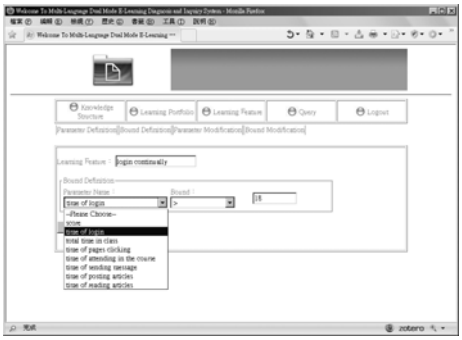


Fig. 6 A screen of boundary definition of learning feature

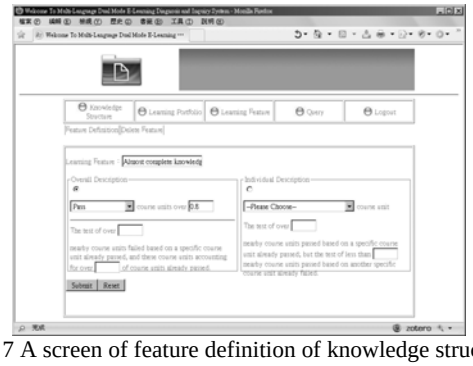


Fig. 7 A screen of feature definition of knowledge structure

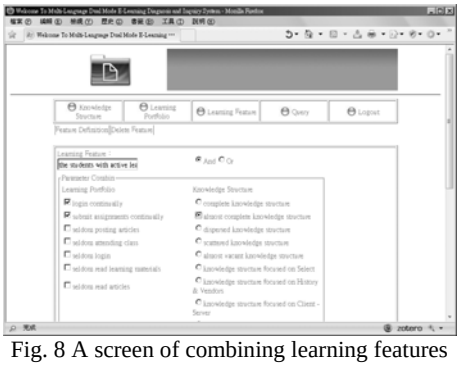


Fig. 8 A screen of combining learning features



Fig. 9 A screen of querying with learning features

As to knowledge structure setting, it includes overall and individual descriptions according to six types of knowledge structure, as shown in figures 4. The learning parameters of knowledge structure are threshold values that defined with rough italics in section 3.2 of this study and shown as input box in figure 7.

As above, learning features can be defined. And then, the users can directly select the learning features defined in the system, modify the features or combine at least one learning feature to produce new learning features. Using figure 8 as an example, users can combine "login continually", "submit assignments continually" and "almost complete knowledge structure" to result in a new learning features "active learning attitude" and the system automatically constructs the related SQL instruction.

Finally, as shown in figures 9, learning feature "active learning attitude" in Query can be selected to recognize the qualified students.

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

V. System Evaluation

This study treated the course "database system" as the major evaluated course. The course was designed for the juniors of Leader University, and it lasted for half year. There were about 70 students who participated in the course. The course requires basic concept of Internet. The course introduces principle of database, ER modal, SQL language, and uses MySQL Server as an example to show the steps of database installation, operation, management and maintenance. Finally, the latest development and security of database is introduced. The course is based on asynchronous distance learning, and the students listen to the teacher lecture through Wisdom Master Pro. The assignments are also submitted through Internet. Since teachers cannot have face-to-face interaction with the students, the online discussion and questions are encouraged. The online behavior of students is also scored to enhance presence and participation of students.

Through learning portfolio checking, the teachers can recognize activities of the students in learning, including assignment submission and online tests. In order to recognize learning difficulties of the students, the teachers rely on the results of online tests in learning portfolio. However, they can only realize learning problem of the students in certain units. For instance, learning result of student A in each unit is shown in the table II. Learning portfolio only shows that the said student passes the tests of eight units, and fails the rest six units. Learning portfolio or test score can only demonstrate that the said student is at medium level; however, the teachers cannot realize the specific problems or remedial approach.

Table II An example of learning portfolio of one student

StID	UnitID	Pass
AXX508603	1	FALSE
AXX508603	2	FALSE
AXX508603	3	TRUE
AXX508603	4	TRUE
AXX508603	5	TRUE
AXX508603	6	TRUE
AXX508603	7	TRUE
AXX508603	8	TRUE
AXX508603	9	TRUE
AXX508603	10	FALSE
AXX508603	11	FALSE
AXX508603	12	TRUE
AXX508603	13	FALSE
AXX508603	14	FALSE

Based on Dual Mode On-line Learning Diagnosis proposed by this study, knowledge structure of the student is reorganized focused on "Data-Definition Language", that means the student is more familiar with "Data-Definition Language" and the related course units. Thus, when planning remedial learning strategy, "Data-Definition Language" can be the main learning subject to lead other units. Thus, the effectiveness of remedial learning can be enhanced.

In order to recognize knowledge structure of failed students, this study analyzed relationship between grades and knowledge structure. In this course, 33 students had scores lower than 60, and 11 of them focused on some course units in knowledge structure. It demonstrates that overall performances of the students are not good; however, they still master certain units. Thus, based on these course units, the teachers can enhance the learning which these students failed.

After combining knowledge structure and learning portfolio, the teacher can further analyzes the students. With regard to knowledge structure, overall behavior of the students can be reorganized in the system based on the combination with learning portfolio. After the query based on the combination of "passive attitude" and "dispersed knowledge structure", there are 42 students according with "passive attitude" and "dispersed knowledge structure" and 49 students according with "dispersed knowledge structure". The repetition ratio reaches 42/49=85.7%. As to the query upon "passive attitude" and "almost vacant knowledge structure", there are 23 students according with "almost vacant knowledge structure" and "passive attitude" and 25 students according with "almost vacant knowledge structure". The repetition ratio reaches 23/25=92.0%. It demonstrates that the students with bad knowledge structure are usually passive. Moreover, knowledge structure and learning portfolio proposed by this study partially reflects the learning result and they do not conflict with each other.

The students with different situations need different remedial strategies. Thus, it is necessary to recognize knowledge structure distribution of students and their learning behavior. With regard to the students with dispersed knowledge structure, the teachers can check their learning behavior in advance. The high ratio (over 85%) demonstrates that the students with bad knowledge structure usually have negative learning performance. Thus, in the learning, the teachers can urge these passive students to learn. For the students with focused knowledge structure, if their grades are acceptable, the teachers have the remedial instruction upon their familiar units. When performance of the students is bad, the teachers can recognize it in advance from learning portfolio.

The proposed system aims to provide a straightforward and simple method to access database. The system evaluation is implemented through expert evaluation since the study is targeted for the teachers. Three experts who teach with on-line learning many years participate in this evaluation. After using the proposed system, three experts fill in questionnaire and interview. The questionnaire and interview will be planned to collect opinions of the experts. The questionnaire designs with five-level Likert scale. The scale range is 1-to-5, 5 represents strongly agree, and 1 represents strongly disagree. According to the result of the questionnaire, most of the scores are above 4, which is positive. The following section will review the items with lower scores, recognize the reasons and indicate the solution.

Table III Questionnaire content

Item	Question	Score
system objective	1. I know the proposed system can help to find out bad performance students.	4
	2. I know the proposed system can obtain students information with learning portfolio and knowledge structure.	4
system convenience	3. The user interface is simple.	3.5
	4. It is easy to know the function of every buttons	3.5
	5. It is easy to operate and obtain required result	3
system	6. The system is stable, less error.	3

function	7. The system helps you to know the learning situation of students	4
	8. The system helps you to know the learning problem of students at any moment.	3.5
	9. The system helps you to know what part do students good at.	4
	10.The system helps you to know knowledge structure of students.	4
system performance	11.The system finishes your command quickly.	3.5
	12.I am satisfied with the processing speed and correctness of the proposed system.	3.5
preference of system	13.The proposed system is useful for teaching.	4
	14.I want to use the proposed system to aid teaching.	4

As to "system convenience", the experts interviewed suggest that the predefined learning features should provide information so that the users can recognize the content of these learning features. In the system, the detail conditions are listed at the following of each learning feature. Using "passive attitude" as an example, at the following of the learning feature, the remarks are added: "time of attending in the course < 47 Or time of posting articles on the forum < 4 Or time of login < 30 Or time of pages clicking < 100 Or total time in class < 90000". Moreover, the experts suggest providing proper help information or step assistance. This study expects to provide professional mode and assistance mode to according to requirements of users. Professional mode indicates all functions for users. Assistance mode leads to simple pages according to different needs. Thus, the users are not confused about so many functions. The users are guided with pictures and descriptions so that the system is more user-friendly.

With regard to "system performance", in order to obtain learning portfolio and knowledge structure of students for users in the same time, the proposed system has to execute a large number of SQL instructions with one clicking. Since the server is only upon the common personal computer, the upgrade of hardware could enhance the system speed.

VI. Conclusions and Future Works

In large classes, teachers cannot completely understand situations of students. Thus, students must immediately comprehend the lecture. Once they fail, they would lag behind other students and even finally give up. In order to assist the teachers with the management of large classes, this study proposes Dual Mode On-line Learning Diagnosis system.

The system can be easily combined with any online learning systems. Through flexible parameter definition, all data in database can be obtained. It supplements learning portfolio of the students in online learning system for the teachers who can understand the students at any time. In learning environment with connected course units, knowledge structure and learning portfolio can complement each other.

The following refers to the main effects and contribution of Dual Mode On-line Learning Diagnosis system designed by this study.

1. The teachers do not need to learn database operation. Through the proposed system, they can obtain data of students from database.
2. In large classes, teachers can completely understand the learning situation of students by learning portfolio and knowledge structure.
3. For the students with abnormal learning, teachers could easily recognize the problem through the system and help the students.

The result of the expert evaluation reveals that they are too many professional terms on the user interface of the system and more steps for learning features. It would enhance the difficulty of the operation. This study expects to provide professional mode and assistance mode according to users needs. Professional mode indicates all functions whereas assistance mode leads to simple pages. The users would not be confused with the plenty of the functions. The user setting is guided by pictures and descriptions and the system could be more user-friendly.

In addition, there are many conditions in the query process and teachers have to set many learning features to find out specific students. The approach can be improved. The system will aim to automatically classify and search for the suitable learning features with recommended boundary according to the change of database and show them in the system. The users do not need to choose from various conditions for setting desired learning features, thus save the time of operating system.

Acknowledgment

The authors would like to thank the National Science Council of the Republic of China, Taiwan for financially supporting this research under Contract NSC 95-2511-S-426-001, NSC 98-2511-S-168-004, NSC 98-2622-E-168-020-CC3. The authors would also like to thank the students who participated in the evaluation.

References

[1] B.S. Jong, T.Y. Chan and Y.L. Wu, “Learning Log Explorer in E-learning Diagnosis,” IEEE Transactions on Education, vol. 50, no. 3, pp. 216-228, 2007.
[2] C. Schau, N. Matter, M. Zeilik and K.W. Teague, “Select-And-Fill-In Concept Map Scores as a Measure of Students' Connected Understanding of Science,” Educational and Psychological Measurement, vol. 61, no. 1, pp. 136-158, 2001.
[3] F.C.I. Chang, L.P. Hung and T.K. Shih, “A New Courseware Diagram for Quantitative Measurement of Distance Learning Courses., Journal of Information Science and Engineering, vol. 19, no. 6, pp. 989-1014, 2003.
[4] G.D. Chen, K.L. Ou, C.C. Liu and B.J. Liu, “Intervention and Strategy Analysis for Web Group learning,” Journal of Computer Assisted Learning, vol. 17, no. 1, pp. 58-71, 2001.
[5] G.J. Hwang, “A conceptual map model for developing intelligent tutoring systems,” Computers & Education, vol. 40, no. 3, pp. 217–235, 2002.
[6] G.J. Hwang, P.S. Tsai, C.C. Tsai and J.C.R. Tseng, “A Novel Approach for Assisting Teachers in Analyzing Student Web-Searching Behaviors,” Computer & Education, vol. 51, no. 2, pp. 926-938, 2007.
[7] J.D. Novak and D.B. Goin, “ Learning how to learn. Cambridge University Press , New York, 1984.
[8] J.F. Sowa, “Conceptual graphs for a data base interface,” IBM Journal of Research and Development, vol. 20, no. 4, pp. 336-357, 1976.
[9] M.A. Ruiz-Primo, S.E. Schultz, M. Li and R.J. Shavelson, “Comparison of the Reliability and Validity of Scores from Two concept-Mapping Techniques,” Journal of Research In Science Teaching, vol. 38, no. 2, pp. 260-278, 2001.
[10] M.N. Yu, “Educational Test and Evaluation: Achievement Test and Teaching Evaluation,” Psychological Publishing, Taipei, 2002.

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf

[11] P.D. Nichols, "A framework for developing cognitively diagnostic assessment," Review of Educational Research, vol. 64, pp. 575-603, 1994.
[12] R.W. Schvaneveldt, "Pathfinder associative networks: Studies in knowledge organization," Belmont. CA: Wadsworth, 1990.
[13] T.E. Goldsmith, P.J. Johnson and W.H. Acton, "Assessing Structural Knowledge," Journal of Educational Psychology, vol. 83, no. 1, pp. 88-96, 1991.
[14] T.Y. Chan, Y.L. Wu and B.S. Jong, "Applying Learning Log Explorer to Diagnosis of E-learning," The Ninth IASTED International Conference on Internet and Multimedia Systems and Applications, pp. 151-156, 2005.

YuLung Wu received the PhD degree in computer engineering from Chung-Yuan Christian University in 2005. He is an assistant professor in the Department of Information and Communication, Kun Shan University, Taiwan. His research interests primarily lies in learning technologies and interactive designs.

Open Science Index, Computer and Information Engineering Vol:4, No:5, 2010 publications.waset.org/7133/pdf