Analysis and Development Issues of a Self-Learning System

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摘要

此論文旨在開發一個以互聯網爲基礎的網上學習軟件供 中學生學習電腦科之使用。雖然現時已有這類網上教學軟體，然而它 們甚少是參照現有的教學理論而發展出來。而這篇論文所提倡的 系統則是採用了Chickering 和Gamson 於一九八七年所提出的"教學上 的七個原則"而設計的。我們採用這個教學模式的原因，乃是在參考過現有的 教學理論後，發現這個教學理論比其他理論更廣泛地包含了教學的所需元素。

這"七個原則" 提倡：(一) 學生與教員的接觸，(二) 學生之間的合作，(三) 活動式學習，(四) 提供回應，(五) 任務的時間性，(六) 訂立較高 期望，(七) 不同天份的學生有不同的學習途徑。採用這七個原則後， 學生可享用一個自我主導、自我評核的網上學習系統。

導師及學生都是我們的目標使用者。通過這個教學系統，導師可以建 立課程的網頁，上載教材，製作測驗及檢察學生的學習和測驗表現。 學生則除了可以通過閱讀教材及互動地參與模擬活動外，更可從小測驗 中作自我的學習成果，即時得到測驗成績，試題闡釋，及了解

自己的 強項及弱項。

設計這個學習系統是用作補足傳統教學模式，而不是將之取代。我們 希望有了這套系統，學習會變得更爲有趣及有效。

Abstract

This thesis aims to develop an internet based learning tool for high school students to study the subject of computer studies. Although several such systems have been developed, they are designed with very little reference to education models. The proposed system is modeled after the Seven Principles model for Education proposed by Chickering and Gamson (1987) [7]. The choice of this model is based on our analysis of the existing models in the literature. The seven principles model is more comperhensive than other models.

The seven principles model promotes: (1) student-faculty contact, (2) cooperation among students, (3) active learning, (4) prompt feedback, (5) time on task, (6) communicates high expectations, (7) respects diverse talents and ways of learning. Using the seven principles as a pedagogical model, students are expected to enjoy a self-directed, self-assessment online learning system.

Both students and teachers are our target users. Through the use of our system, instructors can create the course homepage, upload their courseware, prepare quizzes for students and monitor students' learning and assessment performance. In addition to learning from reviewing the courseware and interacting with simulations, students can take tailor-made quizzes to evaluate their study progress, get instant results and explanations, and assess their strengths and weaknesses.

The proposed system is designed to complement but not to replace traditional teaching approach. With this system, we hope learning will be both fun and effective.

Acknowledgments

I would like to express my sincere gratitude to my thesis advisor, Prof. C.H. Cheng, for his intellectual stimulation, guidance, and support. I would like to thank Prof. W. Lam and Prof. M. Madan for their valuable inputs.

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Chapter 1

Introduction

1.1 Background

Technology gives us different methods of learning in order to acquire knowledge more efficiently and more conveniently. According to Julia Duggleby [16] we can classify different modes of learning delivery into four categories:

- Face to face
- Open learning
- Traditional distance learning
- Online learning

Face to face is the most traditional form of delivering knowledge which has been used for thousands of years. Both learners and instructors need to be present at the same physical location at the same time. The activities include lectures, demonstrations, tutorials, presentations, and seminars. Open training allows learners to take courses in a more flexible way. Learners can still go to the tutoring center and meet the tutor, attend the course which fit their own pace and working schedule. Traditional distance education allows learners to learn at any time in any place[3]. Distance learning delivers modular units through correspondence classes, books, radio and television broadcasts or even CD-Roms. With the help of World Wide Web, we can deliver this learning mode through the Internet. Learners can experience autonomous, interactive and collaborative learning via the web.

Since World Wide Web(WWW) [11] was invented under the base of ARPANet (Advanced Research Projects Agency Network) [2], number of sites has grown from 130 sites in June 1993 to 28 millions sites in March 2001[49]. "The Web marks the end of an era of frustrating and debilitating incompatibility between computer systems. It has created an explosion of accessibility, with many potential social and economical impacts" [27]. Web-based learning is one example of the social impacts. The advent of broad access to the Internet has created a new medium for education and training. Web-based instruction can be delivered in a synchronous (instructor-

facilitated) and asynchronous (self-directed, self-paced) manner. Instruction can be delivered by a combination of static methods (learning portals, hyperlinked pages, screen cam tutorials, streaming audio/video, and live Web broadcasts) as well as interactive methods (threaded discussions, chats, and desk-top video conferencing). [51]

1.2 Motivation and Objectives

Due to limited resources available for primary and secondary schools, each teacher needs to take care of approximately forty students in each class. Under this traditional management, a student may not be able to receive all the information a teacher gives.

In 1998 the government of Hong Kong Special Administrative Region (HKSAR) launched a five-year strategy on promoting Information Technology in Education (ITE) to better prepare the teenagers for the future. However, research[28] shows that there is not enough computer software provided for learning in areas such as computer science. Therefore our aim is to build an on-line learning system for the students.

Our research objectives are as follows:

1. Developing and testing a variety of features of a self-learning system.

2. Developing system based on the self-directed learning and self-assessment

learning.

1.3 Organization of Thesis

Chapter 2 presents several traditional learning models. This chapter reports a selected number of existing computer-based systems and web sites that are representative of the present stage of the field's development. Chapter 3 discusses how the proposed system is implemented. It covers the system architecture and gives the system flow of each operation. Chapter 4 provides a demonstration of the system functions. Finally, the conclusion and future works are presented in Chapter 5.

Chapter 2

Review of Related Work

In the course of our investigation, we found that few on-line learning systems were designed with reference to existing education models. This dis-association may be because these education models were basically developed for conventional teaching. However, we feel that these education models provide guidelines for designing and evaluating on-line learning systems. In this chapter, we will first review some education models. Then we examine several existing on-line learning systems. Finally, we compare various systems using an education model.

2.1 Traditional Education Theory

This section overviews the six prominent learning models proposed by educators and researchers, namely, (1) integrative learning model, (2) problem-based learning, (3) cognitive apprenticeship, (4) conversation model, (5) self-regulated learning, and finally (6) seven principles for good practice for education.

2.1.1 Integrative Learning Model

Clark [8] proposes the integrative learning model. This model involves learner's thoughts, feelings, senses and intuitions. In order to effectively implement this model, a responsive and relaxed learning environment should be ensured. Since children is sensitive to learning environment, "relaxation techniques must be learned to allow the body to cooperate with the mind's energy" [8]. In a workshop like learning environment, parents, learners and instructors maintain an open and cooperative relationship. Normally learners sit at desks and listen to the lecture. However role playing and physically manipulating materials can help transfer abstract concepts in a more concrete level and maintain a higher rate of retention.

Letting learners make decisions and exercise self-control is significant in integrative learning. It promotes alternative thinking when learners perceive

their choice. Empowering language and behavior will also make learners have a feeling of support and exhibit a positive self-concept. Providing some complex and cognitive activities allows the learners to think more, develop their potential by problem solving. The last key of integrative learning model is intuition and integration. It is believed that "learning is subconscious, intuitive abilities need to be developed". As the brain is organized in an integrated manner, the above mentioned key factors should be incorporated into the educational systems to maximize the effectiveness.

2.1.2 Problem-Based Learning

Problem-based learning (PBL) [14] consists of carefully selected and designed problems that requires a learner to use his critical knowledge, problem solving skills, self-directed learning strategies to solve a problem through team participation. Through the process of problem solving the learner has a chance to have a great exposure to particular types of cases and gets a deep understanding of a domain knowledge. Good problem solvers tend to be independent learners [17]. They are able to identify critical and relevant elements and learn from mistakes. PBL is also a kind of role change. The students take more responsibility for their learning resulting in a stronger feeling of accomplishment. At the same time, the instructor only acts as a

guidance provider to help them to achieve the goal.

2.1.3 Cognitive Apprenticeship

Cognitive apprenticeship [9] is an approach stressing that learning is achieved through activities in a social and physical context. Traditional apprenticeship focuses on methods for carrying out tasks in a specific domain. During the process of learning, the apprentice repeatedly observes the master's executing process and then the apprentice performs his/her own work under the master's guidance. Gradually, the master's guidance will fade out. Cognitive apprenticeship proposes a rethinking of apprenticeship into learning in school. Instructors can first give examples to learners how to do a task, then ask the learners to achieve the goal themselves with suitable guidance. When the learners have developed the skill, they are encouraged to compare the differences between their learning process and the instructor's and other learners' performances. Through aiding and challenging each other, both the learners and instructor can develop a broader and deeper capability [36]. It is proved that this model can promote student's higher order thinking skills and switch the learning interaction from teacher-oriented to goal-oriented between teachers and students [23].

2.1.4 Conversational Model

Laurillard [26] proposes a conversational model which states that learning should be discursive, adaptive, interactive and reflective. Discursive learning means instructors and students should have a common goal. They should know each other's learning objectives and achieve the goal together. Adaptive learning is that in the process of learning instructors should adjust the focus of learning base on their conception. When the student is achieving the goal, the instructor should provide feedback to the student's action. Receiving the instructor's interactive feedback, the students should be able to reflect the feedback on the topic goal. In conclusion, it is an education model that suggests learning does not solely depend on students or teachers, but on communication between them.

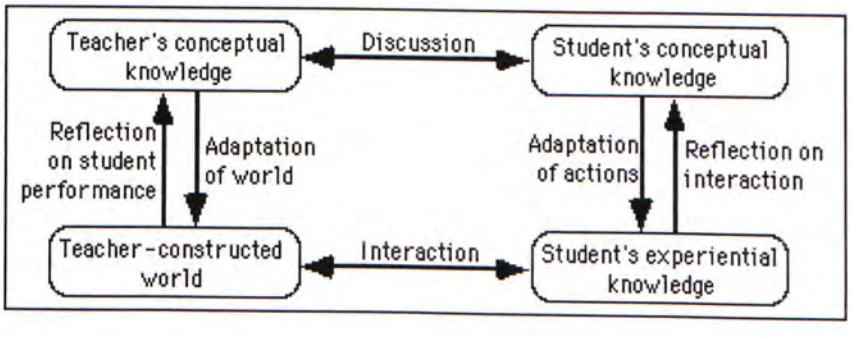


Figure 2.1: The Conversational Model

Fig 2.1 depicts the concept of conversational model. First, a teacher will deliver his/her conceptual knowledge to the students. Then the teacher sets

up the environment or the task. Through interaction the students try to achieve the task and the teacher provides feedback to the students. The students modify their action to better achieve the goal. In the end, the students can reflect the experience into knowledge and the teacher can also reflect students performance into his/her knowledge.

2.1.5 Self-Regulated Learning

Pintrich [34] mentions that self-regulated learning is a new direction for teaching and learning. Self-regulated learning enhances one's reflective thinking which can lead to a better organization of one's knowledge and better management of study time. Distinguishing between effective and ineffective performance, it lets students to find a learning strategy that fits themselves. Schunk and Zimmerman [20] show that students can control their behavior, motivation and cognition in order to make a higher rate of progress towards the goal. Hagen and Weinstein [13] point out that self-regulated students are those with a mastery orientation of focusing on learning and understanding the material, but not those with performance orientation of focusing on just completing their tasks or getting the highest grades. In order to help students develop as self-regulated learners, teachers can be role models of self-regulated learning. Explaining students how teachers think and reason

about the teaching material, teachers' strategies for learning can help students know what is required in the course and thus adjust their learning strategy. Giving students choice and control to make their own decisions in classroom tasks can foster their self-management skill.

2.1.6 Seven Principles for Good Practice for Education

Chickering and Gamson propose "Seven Principles for Good Practice for Education" [7]. It concludes the findings from decades of research on factors that effectively support learning and course development. The principles have been reproduced here for the purposes of exposition:

1. Encourages Student-Faculty Contacts. Communication between faculty members and students can arouse student's motivation and involvement.

2. Encourages Cooperation Among Students. Collaborative learning allows students think deeper in the processing of sharing idea to each other.

3. Uses Active Learning Techniques. Students should not only read the books and memorize all the information but also apply the knowledge in their daily lives to gain practical experience.

4. Gives Prompt Feedback. Providing an appropriate feedback can help learners assess their performance, understand their strengths and weaknesses, and take remedial actions.

5. Emphasizes Time on Task. Define time expectations for students. "Learning to use time productively establishes time management skills, which is a valuable tool for students and professional alike" [39].

6. Communicates High Expectations. Setting a high expectation can let learners acquire knowledge from challenges and sharpen their cognitive skill.

7. Respects Diverse Talents and Ways of Learning. Different learners has his individual talents and learning pace. Through self-reflection and self-evaluation they can develop in their learning style.

Seven principles are widely used as the philosophy of "good teaching and learning" [46]. It is applied as a pedagogical model in university [39] and also used in instructor's teaching method [45]. It is then proposed that these principles can be used on technology media [43]. As seven principles have comprehensively covered different aspects of learning, the system proposed in this research adopts the seven principles as a basis. Chapter 3 will discuss how this system implements the seven principles.

2.2 Online Learning Examples

This section provides a review of nine existing current on-line learning systems.

1. Cheng's virtual learning environment(VLE) [6] supports autonomous, exploratory, interactive and collaborative learning. The system model includes (a)instruction, in which the learning materials and activities are the online course book, assessment instrument and the feedback to learners (b)construction, which is the bulletin board, note book and reflection report (c)cooperation, which involves collaborative work and project based exercise (d)self-management, which allows for the users to administer their personal information. It also embraces Microsoft's Netmeeting as the teleconferencing tool. As shown in Fig 2.2, the VLE design model is based on the World Wide Web providing the guided navigation and communicative infra-structure to the users. The learners can participate different learning activities which are categorized into four learning zones as above mentioned.

2. University of Toledo has an Java applet providing an interactive graphical environment which assists students in the construction and analysis of arbitrary gas turbine systems [35]. The Gas Turbine Simulator (GTS) enables the students to build an engine visually in a schematic

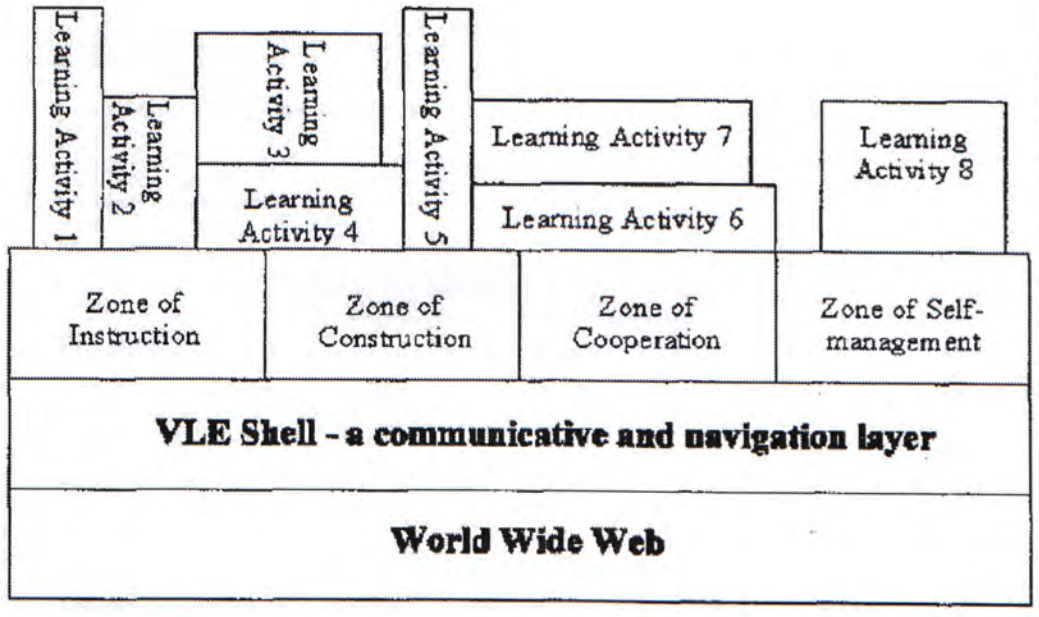


Figure 2.2: The VLE system model

representation. The students can construct an engine by selecting the components from the menu bar and connect them by a drag and drop motion. Fig 2.3 shows an engine component is added to the working area of *Engine Schematic Layout.* Users can define the operational characteristics of several components by inputting appropriate values for parameters. As in Fig 2.4 the *Time-parameter value Graph* can be plotted by entering values in *Time(seconds)* and *Transient Value*, and then click the *Add Point* button. Then any changes will be reflected immediately in the graph. During the simulation, a progress indicators and text-based messages will provide feedback on the progress of the simulation. Since running a turbine is not an easy task, a Help browser

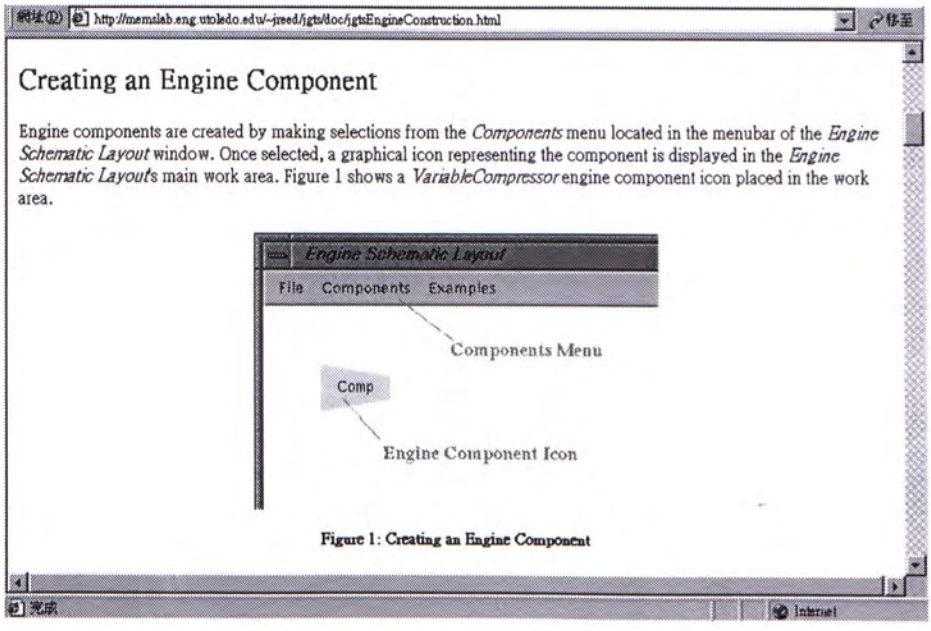


Figure 2.3: Creating an engine component

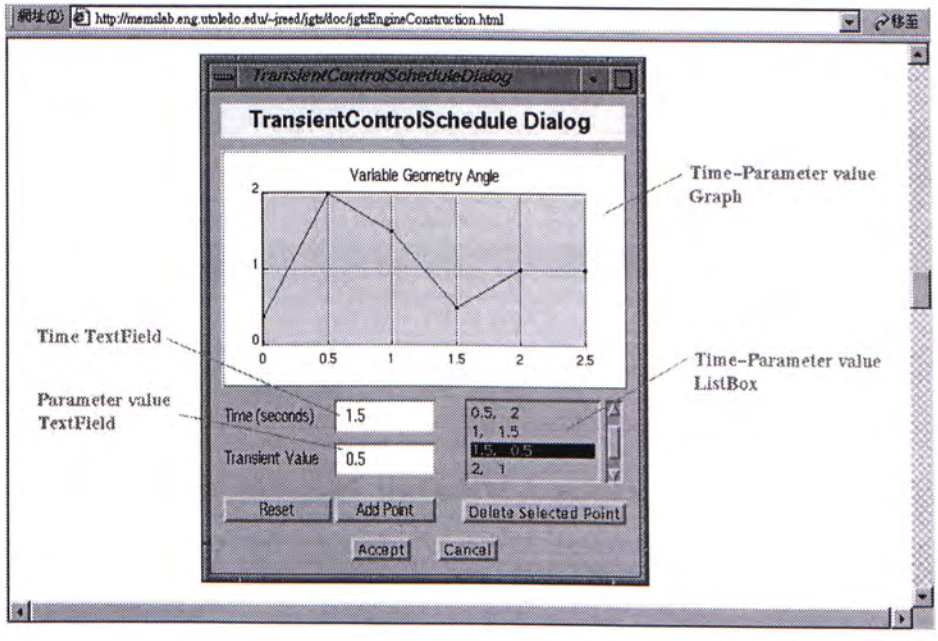


Figure 2.4: Data is reflected by graphical display

is designed to provide online documentation. Since this package is developed with Java applet, it supports multi-platform environment. It also supports software distribution since no installation is required.

3. McIntyre [31] has used web-based interactive learning to introduce the students to C Programming basics. It provides almost complete and functional C programs with a missing statement (Fig 2.5). Students

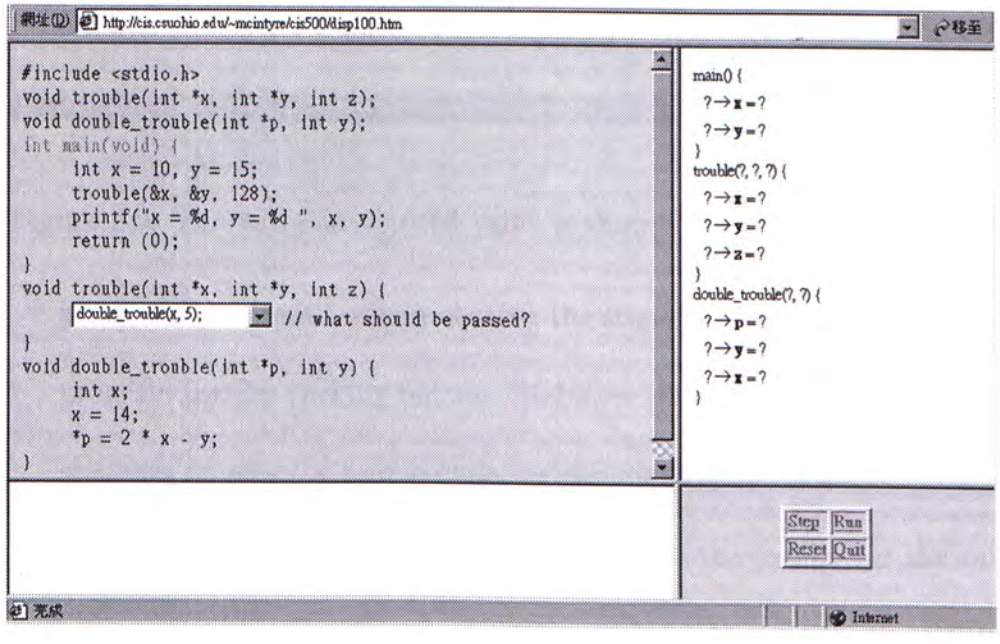


Figure 2.5: Complete C program with one missing statement

need to choose the right statement from the pull down menu. When they click the *STEP* button, the instruction to be executed next is highlighted and the predefined result will be shown (Fig 2.6). Therefore students can easily modify the C program without rewriting and com-

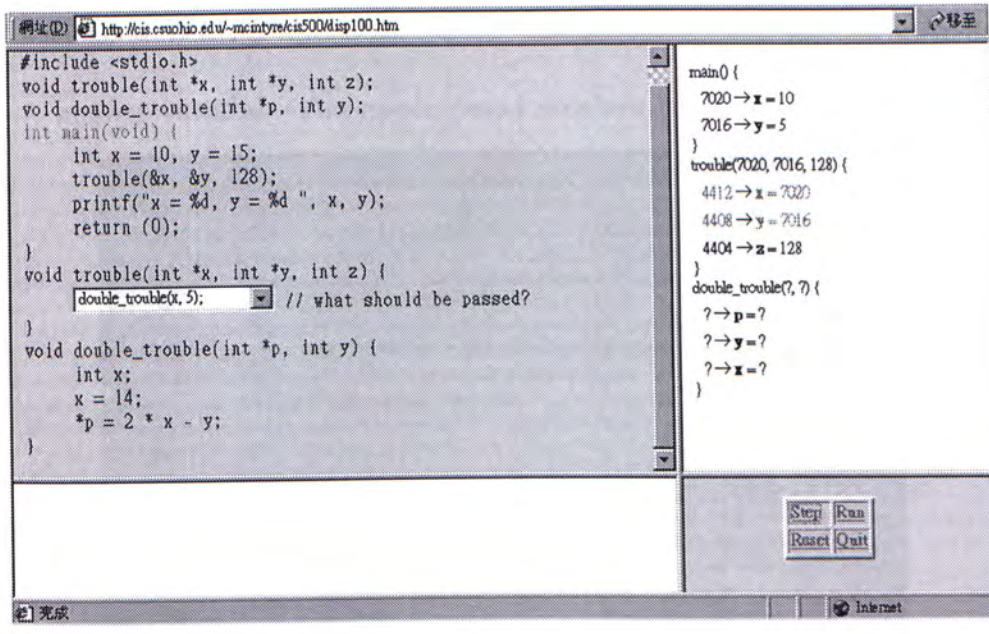


Figure 2.6: The variable's stored value is shown when user clicks STEP

piling the program but can observe the step-by-step effects of modified program just by clicking button. McIntyre [31] believes that letting the students to select a source code segment may help them focus on important issues of programming. He compares the results for the same course taught in a previous semester without this interactive WWW learning. He finds that there is a significant improvement in terms of grades with the assistance of this system in an identical quiz.

4. Rowe's computer-based learning system provides question-answer tutorials, programming tutorials, and animated demonstrations [37]. It is used to provide object oriented programming using C++ and covers

data structures and algorithms. Fig 2.7 shows the part of question-answer tutorial. The upper panel displays the question and user can

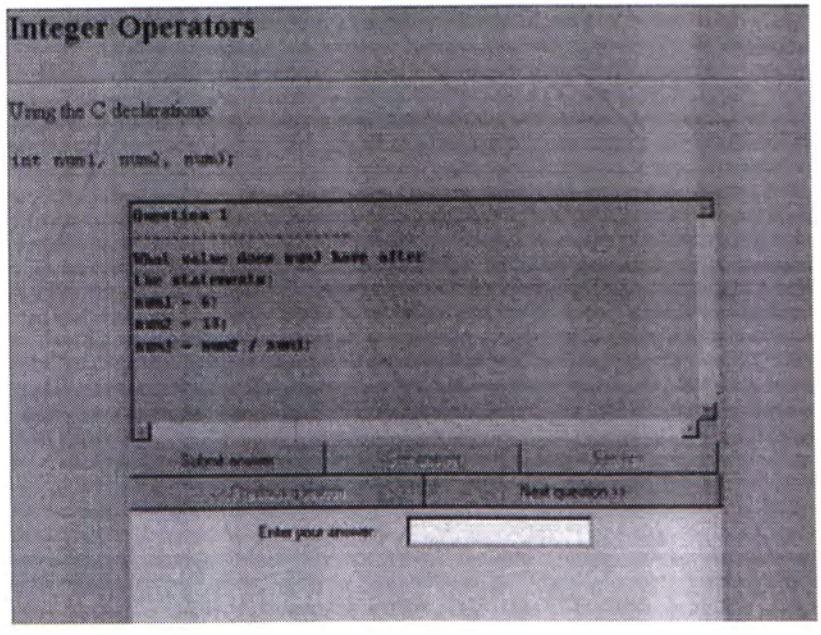


Figure 2.7: Question-answer tutorial

input his answers in the lower panel. After user submitted an answer, explanation will be shown. In programming tutorials, students are requested to modify the provided program in the upper panel and the code is compiled at once, so any error messages will be displayed in the lower panel (Fig 2.9). If the code is correct, comments and solutions will be provided. The system also provides Java animation and images maps for students to learn data structures and algorithms. Students can construct a binary tree by clicking on the image map where the next node should be added.

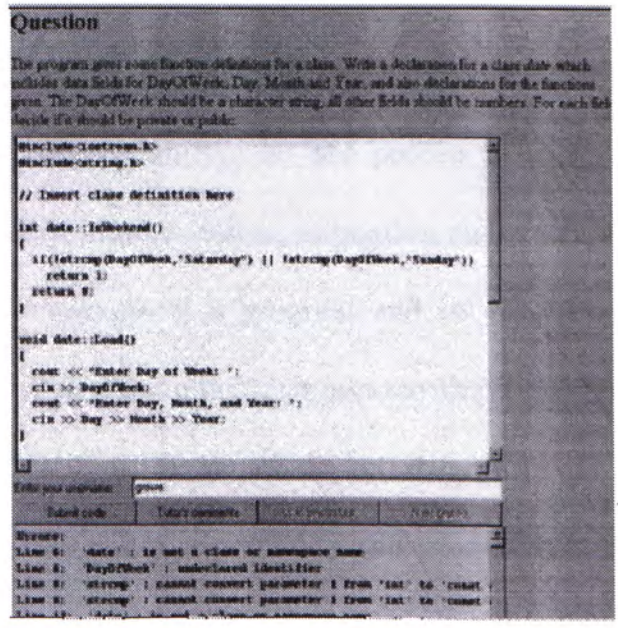


Figure 2.8: Programming tutorial

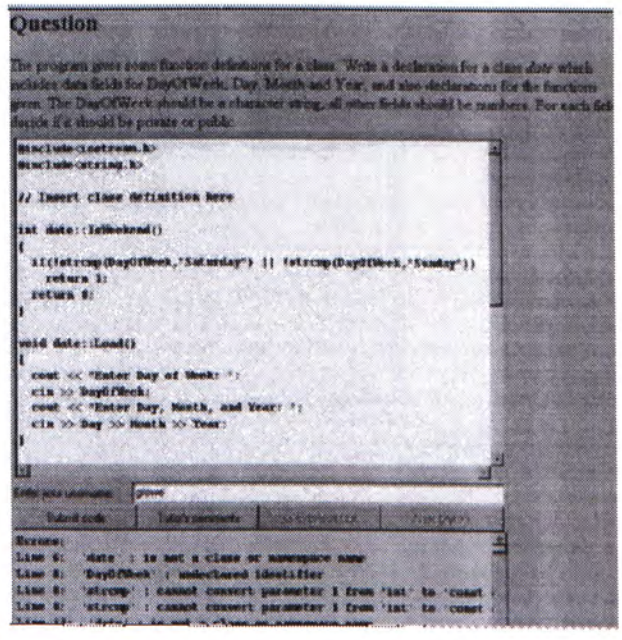


Figure 2.9: Programming tutorial

5. The Internet Software Visualization Laboratory(ISVL) [15] provides mappings between graphical representations and computer programs. Software Visualization(SV) is "the process of using techniques such as typography, graphic design, animation and cinematography to provide representations of a program and its execution". ISVL is to teach Prolog programming incorporated the Transparent Prolog Machine (TPM). Fig 2.10 shows the interface of ISVL. User inputs the query into the query window (1) and presses the *Evaluate* button. Then the result will be displayed at the upper panel (2). Detailed ex-

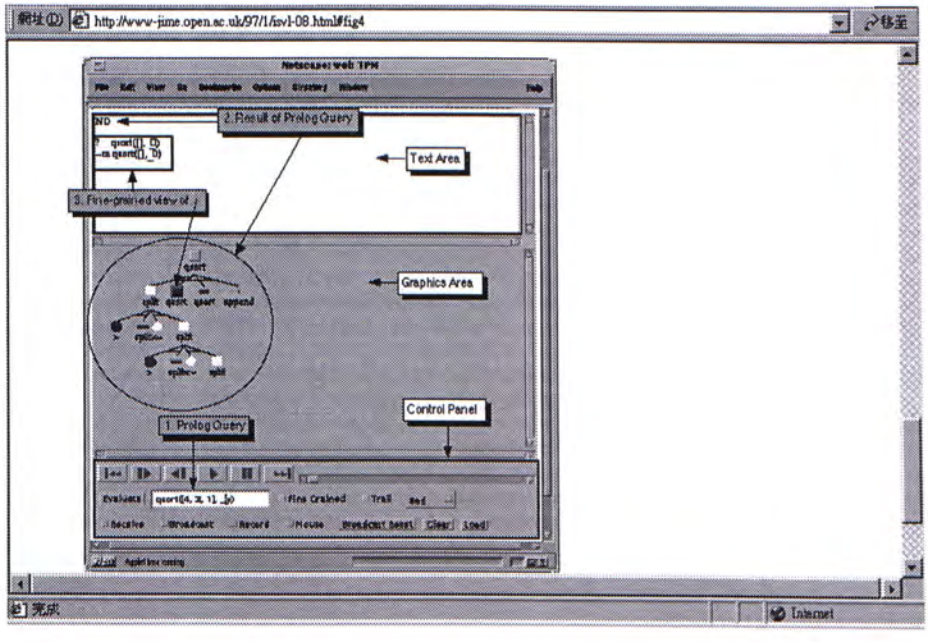


Figure 2.10: The ISVL interface

planation will be shown if the user click either one node in the tree (3). The learners and the instructor are also able to create their anima-

tions and play through using the video recorder style buttons. A user can exchange their animations synchronously and asynchronously so that when learners has problems on their programs, they can "record" their animation and send to the instructor. The instructor can fix the problem and send the results back to the learners. If the instructor finds that there is a common problem among the students, he can also choose to broadcast his version of "movie" to all the learners synchronously. Fig 2.11 describes there is a case that a student named Bill, finds problem with his tree. Bill can creates his own "movie". He can

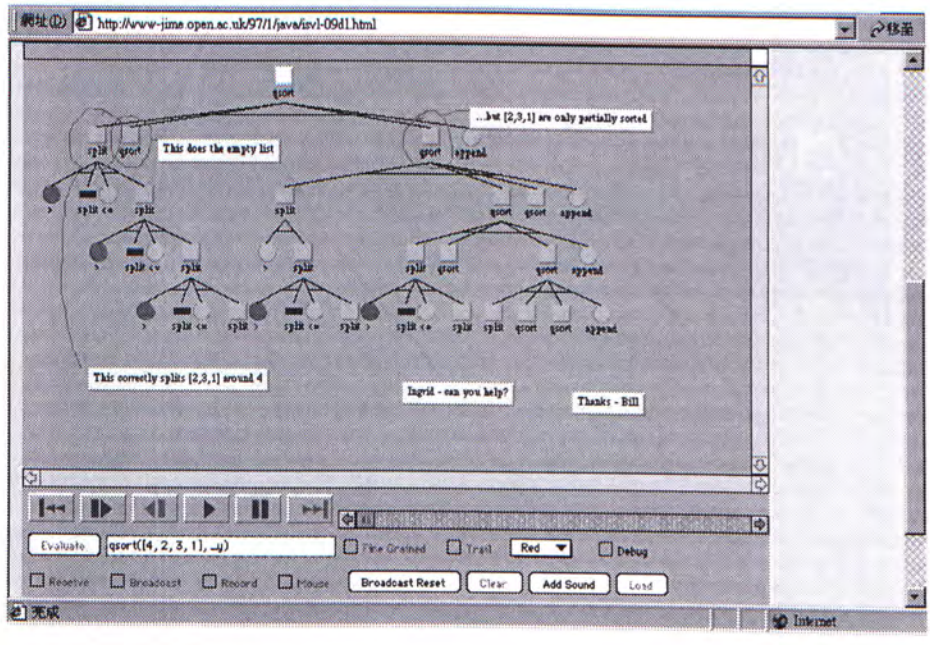


Figure 2.11: Animation made by learners with typed question

click the *Record* button at the bottom of the panel, write down what he currently knows, and ask for help at the bottom of graphics area.

Based on the concept of SV, ISVL visualizes the artificial intelligence programming to help student to grasp difficult programming concepts.

6. Hyper Apuntes [30] is an interactive learning environment which helps the learners to learn fundamental computer programming. The system is built on pragmatic approach which means by examples and exercises, theoretical concepts are brought into practical application. Hyper Apuntes consists theoretical contents, exercises and open discussion areas. Theoretical content contains navigational buttons for surfing around the pages and has active links to related topics, (Fig 2.12). A

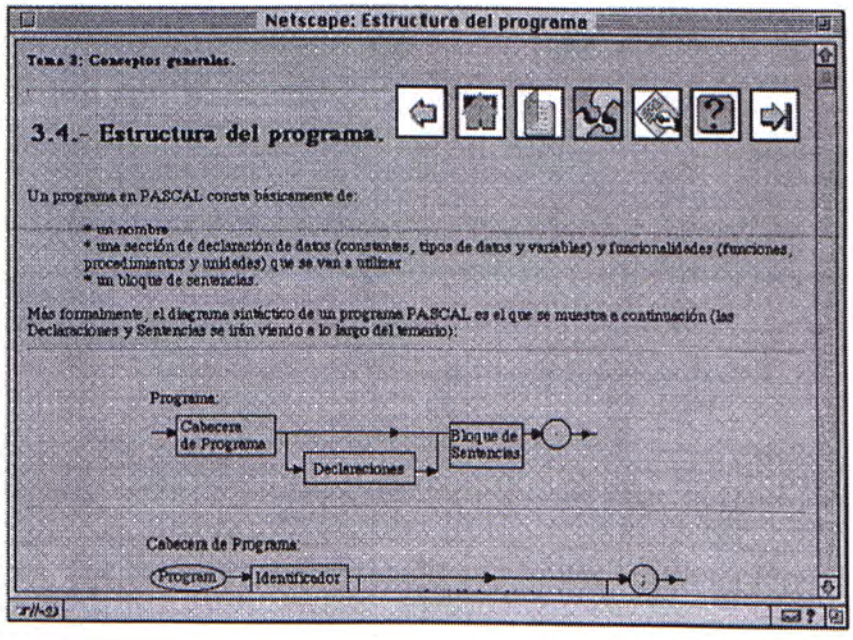


Figure 2.12: Content with navigation bar

searching facility provided for retrieves desired pages within the teach-

ing materials. It also provides multiple choice exercises, immediate grades and solutions. Programming exercises allow users to write a program and have an option to directly activate the Pascal environment. Fig 2.13 shows that student is required to write a program to get the result shown in the browser behind. It is believe that these

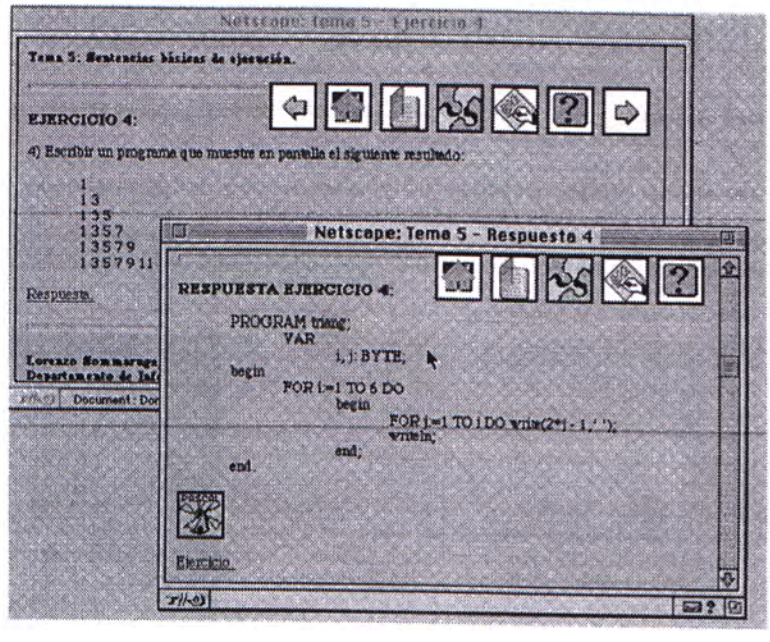


Figure 2.13: Programming exercise

exercises can help students verify their knowledge of the course materials. The learners can use the discussion page to share ideas and post comments. These comments are also useful for instructors as this helps him understand the common difficulties and problems encountered by his students.

7. University of Leicester has been using online, interactive tutorials for several years. The Department of Microbiology and Immunology provides formative online tutorials and summative online tutorials [4]. Its formative tutorials use a more entertaining approach with more pictures and with some short questions to increase the interactivity while learning. For example (in fig 2.14) when it inquires who is the first person to try to prevent smallpox, it does not plainly point out the right person, but tries to ask the reader a short question. Different

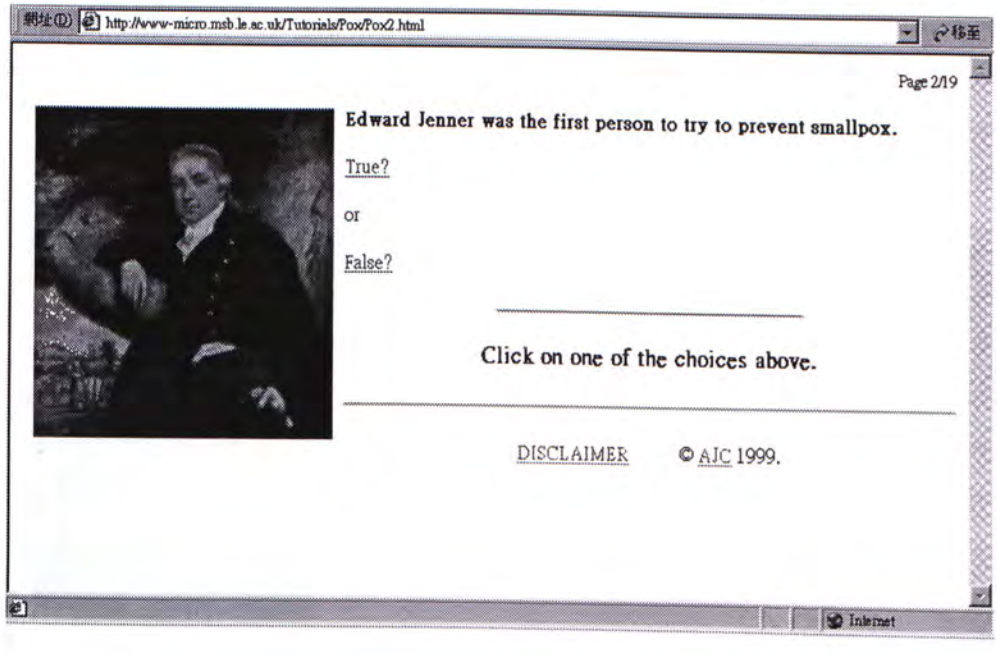


Figure 2.14: Short question occurs frequently in tutorial materials

responses will show you different pages but it will eventually show the reader the right answer (Fig 2.15, 2.16). On the other hand, summative tutorials provide computer-based assessment with multiple choice

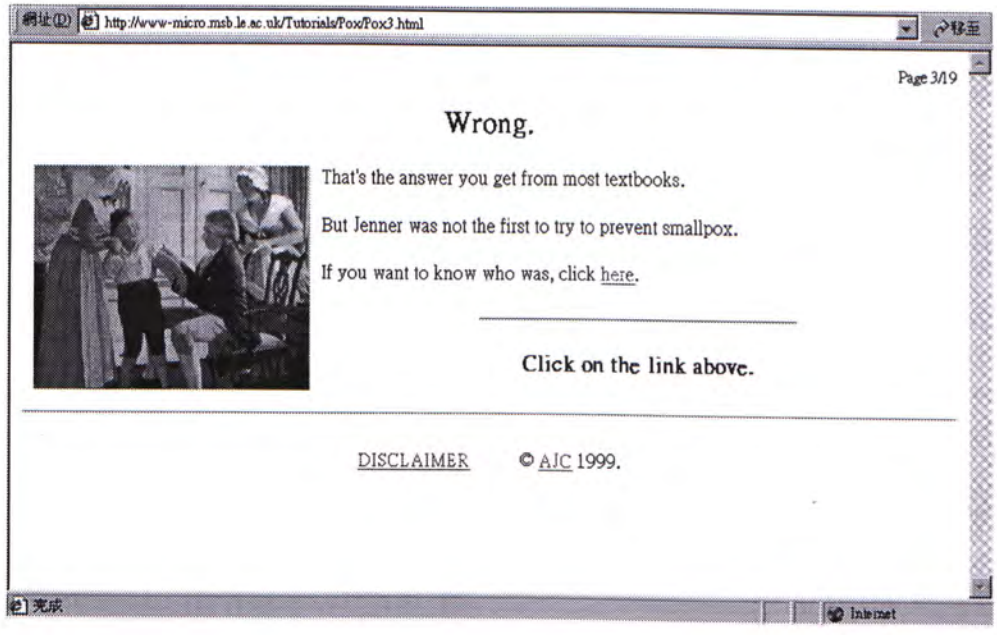


Figure 2.15: The case if the user choose TRUE

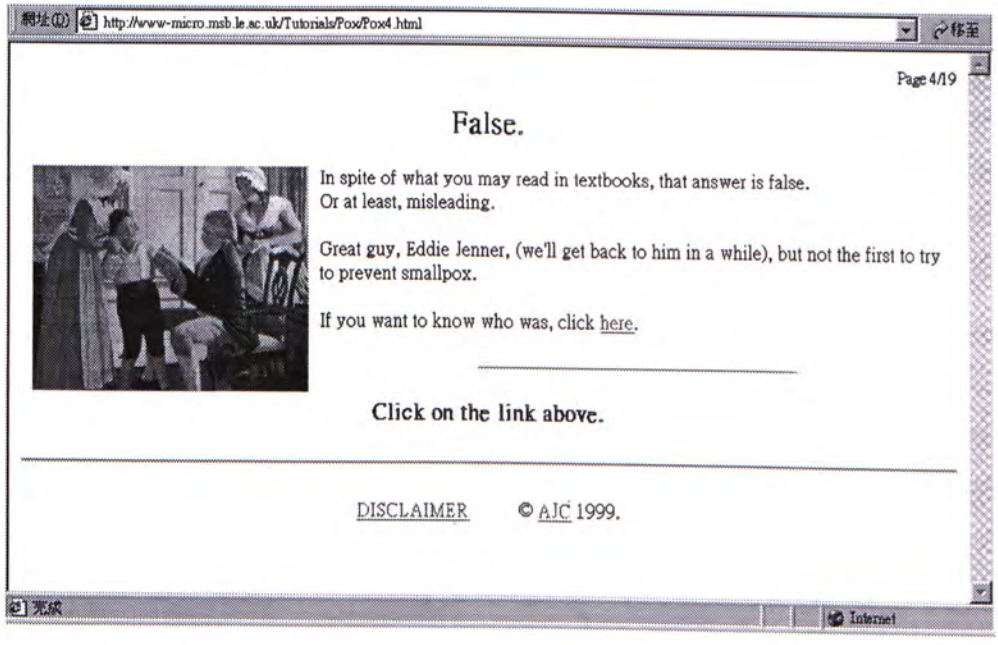


Figure 2.16: The case if the user choose FALSE

questions (MCQs). After the learners complete the MCQs, a personalized report will automatically be emailed to students. It also tracks the users' learning path by putting browser cookies so that instructor will have a better idea of the progress. Applying this formative online tutorial, student's stress can be reduced and the efficiency of marking exercises can be significantly improved.

8. There are some web classroom builders in the commerical market which help constructing and maintaining web-based classrooms. Some familiar systems are WebCT[50], TopClass[48], FirstClass[18]. Since WebCT is more popularly adopted in universities and colleges, for example The Chinese University of Hong Kong[21], The University of North Texas[22] etc, we take WebCT as the baseline model for comparison.

   WebCT[50] is initially developed by computer science faculty under grant from the University of British Columbia in Canada. It is a tool that can facilitate instructors to create web-based course environment. As long as the administrator installed the WebCT in the school, he/she can create accounts for instructors to set up their course webpage. Fig 2.17 demonstrate the page of course settings which allows instructor to input the section title, course title, course code number, discipline and course description. WebCT allows instructor to pro-

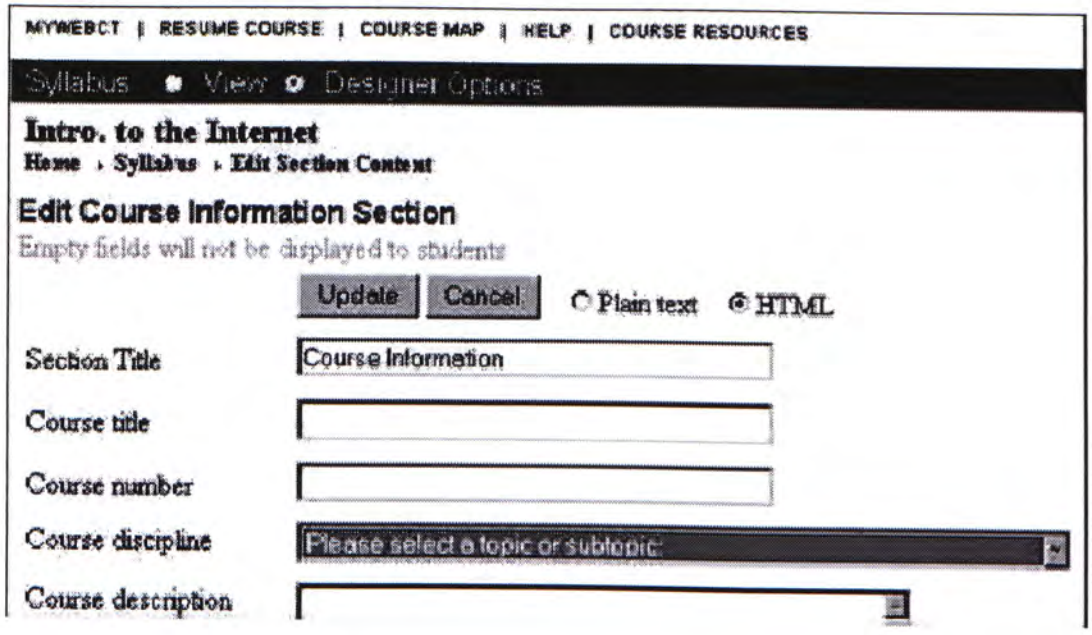


Figure 2.17: The *Course Information* section

vide course materials publishing that include text, images, audio and video . The *Designer Map* is used to manage all the course materials. WebCT encourage students to communicate via email and real-time chatroom, evaluate their learning progress by taking quizzes and doing assignments. They can also get feedback through an *Online Gradebook*, *Self Test* and progress tracking. *Online Gradebook* includes the results from quizzes and assignments. *Self test*s are only simple multiple-choice questions that are automatically marked by WebCT. Progress tracking includes the information of the time when a student last accessed the course webpage, how many pages accessed and the last page visited. Fig 2.18 shows the grade book of a student. It displays the name and

a summary of attendance, assignment and examination results.

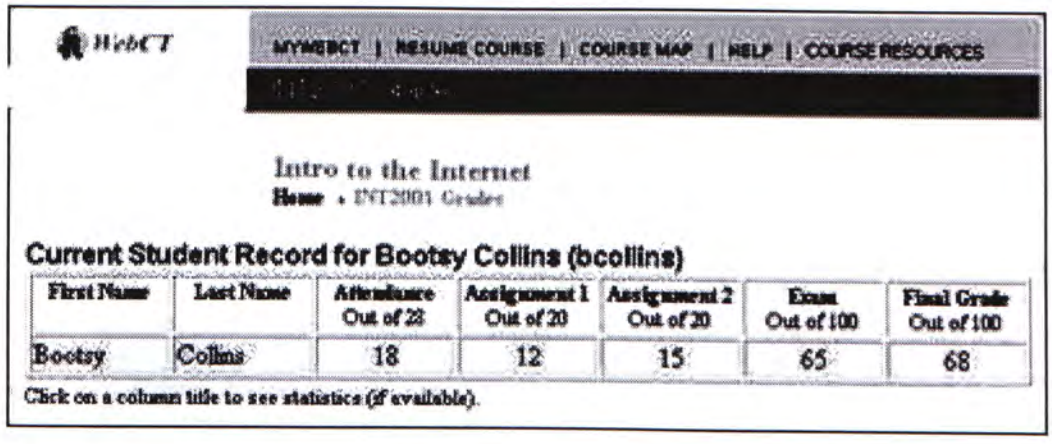


Figure 2.18: The Online Gradebook

9. Student IT Competence(SITC) [10] is a self-learning and test package developed by The Chinese University of Hong Kong(CUHK). It targets to help students acquire fundamental skills of information technology(IT). Students can either access the self-learning tutorials by physically going to the IT training center, downloading the courseware from web or buying a courseware CD. The courseware content are made in Marcomedia Flash format, which consists a large amount of pictures and animations. Therefore students can visually know how to accomplish tasks on operating software and the basic operation of a computer system. At the end of a chapter, there is simple test with answers and explanations for students. Since all students in CUHK need to pass this IT proficiency test, there is a chapter that contains a mock exam and

demonstrate how students can answer the test questions with the aid of animations. When students get well prepared, they can go to the IT training center to sit for a test. All the test answers will be marked by computer. Fig 2.19 shows the interactive learning material introducing the basic components of a set of computer. When the mouse is pointed

Figure 2.19: Interactive learning material

over the monitor, the title is displayed near the monitor. Fig 2.20 describes the explanation of an examination module. Student is asked to save a picture from Internet and paste it in a MS-Word document. On the left of the screen it shows the procedures the student needs to take and the animation on the right shows the steps.

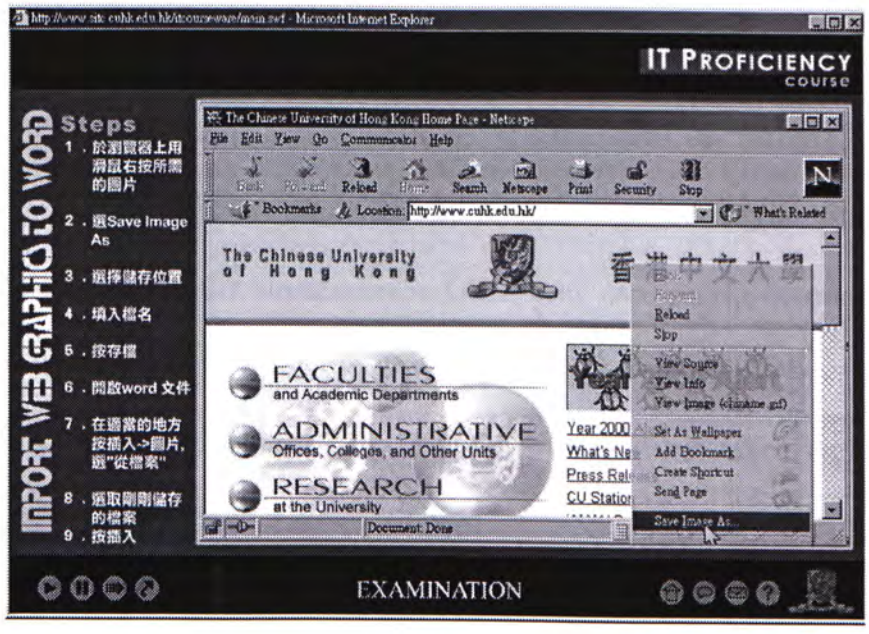


Figure 2.20: Examination module

2.3 Web sites Comparison

We use the seven principles model as an organizing framework to analyze existing online learning systems. This analysis will help us understand the strengths and weaknesses of the various systems.

1. VLE [6] supports several principles. It provides Netmeeting and bulletin board which enables teacher-student, student-student communication. Students may share ideas and negotiate through their involvement in group projects. Interactive quizzes provide active learning and personal reflection report gives feedback for student's learning progress. However VLE has no features to provide time on task, high expectation

and to diverse talents.

2. GTS [35] provides active learning by simulation on turbine engine's components and lets students visually construct an engine. Since students can conduct simulation in GTS, they can get the simulation results as feedback. GTS is built with Java applet so it can reduce teacher or administrator's workload. But GTS has not yet taken care of the remaining features of seven principles.

3. McIntyre's [31] web-based interactive learning allows user to modify C program by just clicking buttons, which is a kind of active learning. When the user requests the system to execute the highlighted instructions by pressing the $STEP$ button, the corresponding results will be displayed as a feedback to user. It fulfills the rule of diverse talent because if a student understands the program, he/she can click the RUN button to execute the program to the end. On the other hand, novices can click the $STEP$ button to follow the program flow step by step. It also provides some relevant hyperlinks for students to explore the information on the Internet which encourages students to acquire more knowledge. This system does not support the other principles.

4. The question-answer tutorial and animated demonstrations in Rowe's [37] online learning system are examples of active learning. Students

not only can get instant feedbacks from quiz results, but also can get another type of feedback from the programming tutorials since the programming code can be compiled, any compilation error are displayed immediately so students can do required modifications if necessary. The materials provided by the system is deemed as a supplement to textbooks. It follows the principle of high expectation because it encourages student to clarify the concepts. However it fails to support the other principles.

5. ISVL [15] allows users to actively create their own animation and send to others, so it provides convenience for both teacher-student and student-student communication. Through visualization students can easily know how the query is evaluated in a tree with explanation on screen, so it supports the feedback principle. ISVL's graphical representation fulfills the time on task because students can send their own animation to their tutors if they encounter any problem. Using graphical representation is more efficient than using texts in email or words on phone. But it does not have any functions for high expectation and diverse talents.

6. Hyper Apuntes [30] provides programming exercises and multiple choices for students. Instant grading and providing solution can be taken as

feedback. Open discussion area fulfills the first two principles of communication because students can share ideas and teacher can know student's difficulties and problems from the discussion. Searching facilities and navigational buttons can help users get to the desire page quickly, which improves the learning efficiency. Yet it has no elements catering for the other principles.

7. Cann's [4] series of online tutorials at the University of Leicester fulfills the principle of active learning, giving prompt feedback and diverging talents. Its interactive summative tutorial notes provide some short questions for users to answer and more to different pages. All these materials are written in Javascript so learner's learning path is recorded for the use of diverse talents. It provides multiple choices for assessments and learners can get a personalized report about their quiz result. This system does not adhere to the others principles by providing features critical to their implementation.

8. WebCT [50] provides email and chatrooms for communications between teachers and students. Its course materials includes multimedia like videos and audio supporting active learning. Given explanation in each quiz and the *Online Gradebook* prompt feedback on students performance. The hierarchical list of course pages and nativagation bar let

student find the desired page easily. Allowing instructor to set the goal of the page gives clear expectation to students. Providing sufficient URL links to Internet can help students to learn supplementary knowledge. Since WebCT is a generic web-builder system, instructor has the freedom to choose which component features are going to provide to students. Therefore if instructor provides all the above mentioned features in the course, WebCT has fulfilled most of the seven principles except the principle of diverse talents.

9. SITC [10] uses multi-media to provide active learning, like animation and audio transcription. Explanation and result in quiz and mock examination give feedback to students. There is an icon connected to the SITC newsgroup that facilitates for teacher and students discussion. The navigational bar in the main panel increases students learning efficiency since user can easily reach different material. Nevertheless it has no functions for high expectation and diverse talent because there are no student profile for to the students.

As mentioned above, each of the existing systems have their unique and characteristics and strengths. However they do not provide a comprehensive self-learning environment for students. Table 2.1 summarsied the extent to which these systems implement seven principles. The seven principles are

shown in columns while the systems or the name of authors are shown in rows. A "N/A" in the cell means that a particular principle is not available for that system.

	Student-Faulty Contact	Cooperation Among Students	Active Learning	Prompt Feedback	Time on Task	High Expectation	Diverse Talents
VLE [6]	Netmeeting	Bulletin board, Group project	Interactive quiz	Reflection Report	N/A	N/A	N/A
GTS [35]	N/A	N/A	Simulation, Visual Construction	Get immediately feedback by simulation	No installation	N/A	N/A
McIntyre [31]	N/A	N/A	Modify existing complete C program by clicking button	Different web page will be displayed by different answers	N/A	Relevant hyperlinks	Step-by step or run to the end
Rowe [37]	N/A	N/A	Animated demonstrations	Embedded compiler give instant feedback to programming tutorial questions	N/A	Provide textbook's missing material	N/A
ISVL [15]	Student-made animation	Information Broadcasting	Algorithm Visualization, video recorder style execution	graphic representation and explanation	graphic representation better than texts/words	N/A	N/A
Hyper Apuntes [30]	Open discussion	Open discussion	Programming exercises	Immediate grade and solution will be given	Navigational button, searching	N/A	N/A
Cont'd ...							

Cont'd ...							
Cann [4]	N/A	N/A	Interactive summative tutorial notes	Personalized report about quizzes result	N/A	N/A	Track learning path
WebCT [50]	Email, chatrooms	Email chatrooms	Multimedia course materials	Gradebook, explanations in quizzes	Navigational bar	Course goal, extra hyperlinks	N/A
SITC [10]	Newsgroup	Newsgroup	Animation, Audio transcription	Explanation and results in quizzes	Navigational bar	N/A	N/A

Table 2.1: A summary of how existing system implement seven principles

2.4 Chapter Summary

In this chapter we reviewed six prominent learning models proposed by educators and researchers, namely, (1) integrative learning model, (2) problem-based learning, (3) cognitive apprenticeship, (4) conversation model, (5) self-regulated learning, and finally (6) seven principles for good practice for education.

We also reviewed several existing on-line learning systems and analyzed their characteristics. As seven principles have comprehensively covered different aspects of learning. We use this model as a framework to analyze these systems. We find that these systems do not provide a comprehensive self-learning environment for students.

Chapter 3

An On-line learning model

This chapter describes the system design of the proposed online self-directed learning system. The first section shows how the proposed system uses the seven principles. The second part deals with system design.

3.1 Conceptual Design

As mentioned in Chapter 2, although there are a variety of systems providing different special features for online learning, few of them address all the issues related to the seven principles. Based on our observation, the seven principles comprehensively combine the elements that effectively promote learning and development. We attempt to show how the seven principles are adopted in designing this system to ensure a comprehensive online

learning experience.

1. Encourages Student-Faculty Contacts

"Faculty concern helps students get through rough times and keep on working" [7]. The Internet can strengthen faculty interactions with all the students. Communication technologies complements face-to-face interactions in and outside of classes in which they facilitate students' access to faculty, help them share learning resources, and provide joint problem solving and shared learning opportunities.

"Communication technologies increase access to faculty members, help them share useful resources, and provide for joint problem solving and shared learning can usefully augment face-to-face contact in and outside of class meetings" [46]. Therefore a web-based newsgroup is provided in the proposed system. From the newsgroup, an instructor will get a better idea of individual's progress and also of his/her strengths and weaknesses. Students will get encouragement and insights from the instruction by interacting directly with the instructor in the newsgroup.

Some students are too shy to speak in the presence of others, are reluctant to ask questions, or challenge the teacher directly. We provide an email list of all instructors and students. Publishing instructors' email addresses on web makes faculty members more accessible to the students and encourages stu-

dents to ask questions in order to improve their understandings. Email has been recognized as an efficient tool for online communication since the time taken is instant and communication is done in a less formal way. Gandolfo [19] suggests that email can promote effective contact since screen is a more "neutral zone" than the faculty member's office. The instructors have direct student contact, and can provide individual feedback to students. Dropping letters to each other, peer and student-instructor communications can be easily built.

2. Encourages Cooperation Among Students "Sharing one's ideas and responding to others' improves thinking and deepens understanding" [7]. It is believed that collaboration learning increases students' success. The above mentioned functions: newsgroup and email are techniques that offer room for cooperation among students. The instructor may pose some topics in the newsgroup and encourage students to discuss. If students run into problems in understanding the course materials, they may raise questions or share their own experience in the newsgroup. Students may also develop friendship from these peer cooperations. Research shows that although male students are more dominant in face-to-face tutorials, online discussion does not exist gender differences [29]. Therefore newsgroup can be a valuable tool for learning. The email list improves students communication just like know-

ing others' telephone numbers. When students find pedagogical resources on the web, they can share them with each other immediately if they know other's email addresses.

3. Uses Active Learning Techniques

Students should not only read books and memorize all the information but also need to apply the knowledge in their daily lives to gain practical experience. Learning on the Internet provides a lively learning environment. The instructor can provide hyperlinks to relevant web sites when teaching a subject.

Suitable animation is more interesting than the traditional textbook's presentation in which concepts are presented in text or in static pictures. For example, rather than memorizing or cramming definitions or methods, students learn vividly how a set of numbers can be hashed into a hash table through animation.

Wulff [54] describes the word *Interactivity* as "a process of initiating an engagement or dialogue with learning resources that allows for an active role on the part of the student in constructing knowledge and participating in the evaluation of learning outcomes". Therefore we believe that performing interactive exercise with a computer is also a form of active learning. Since exercises can help learners consolidate the concepts acquired by studying,

this system supports self-assessment. There are pools of quizzes prepared for each chapter. When a student has finished reading a chapter, he/she may take a quiz corresponding to the chapter. If the learner wants to have a short revision of several chapters, he/she may choose the *Composite Quiz*. In this case, the scope spans over chapters that the learner choose. Our system only supports multiple choices at this time. In order to provide different questions for different sessions and prevent student cheating by memorizing the questions all the quiz questions are dynamically retrieved from a pool of questions. Moreover, the order of the choices in each question is also randomly generated.

Providing four options in multiple choices questions does not prevent trial and error. For example in the case of McIntyre's [31] exercise as shown in Chapter 2, a student is required to fill-in a missing statement in a C program. In this situation if we only give the student four choices to choose, this does not provide enough alternatives since everyone's programming style can vary a lot. However if the system lets the student to have free-style input, it will be hard to assess the answers automatically. Therefore we provide a modified multiple choice approach. A combination of several multiple choice boxes are used for one question. If there are 4 choices in each separate multiple choice box, n choice boxes in a question, there can be 4^n combinations of answers. Under this scheme, we can reduce the possibility of answering by guess.

4. Gives Prompt Feedback

It is believed that feedback gives a clear indication of students' progress and their next targets [5]. In order to give feedback to students immediately after a student has finished a quiz, the answers are marked automatically. The system provides a short report indicating which answer is right or wrong. Student can also further investigate each question by referring to the provided explanation. In our system different comments will be given according to different quiz results, e.g., "Congratulations! Well done!", "Good! Keep it up!" or "You better hurry...". These comments can encourage students to do better and to improve.

In the provided personal report, students can not only monitor their pace of courseware reading, but also check their quiz performance. Revising the past quiz questions and explanations helps them prevent from making the same mistakes again.

This proposed learning system supports several kinds of multiple choice questions requiring a student to (1)choose the only one correct answer, (2)choose all correct answers, and (3)choose several answers to modified multiple choice questions. There is a question analysis in the personal report showing the students' strength and weaknesses on different types of questions. It shows how many questions are answered correctly.

5. Emphasizes Time on Task

One element of effective learning is efficient time management. New technologies like computers and the Internet help us improve our time management. For example, Word processing helps us to edit a passage tidily and spreadsheets help us manipulate data. We can save our time by learning at home.

Most quizzes in basic online learning systems are marked automatically. This frees instructors from marking the massive amount of assignments or examination papers. It also lets students know their result immediately. Results are stored explicitly so that an instructor can monitor students' progress efficiently.

In addition to these common features that help learners to manage their time, our proposed system provide a chapter's estimated reading time at the front of each chapter. There are times that the learners may not spend their time in a chapter wisely. Giving the suggested learning time can address the problem. The procedures to determine the estimated time can be divided into two phases. When a course is initiated, the instructor may suggest the estimated study time based on his/her experience. When the course has been around for sometime, the instructor may fine tune the estimated study time for a chapter based on the actual time his/her students have spent on those

coursewares.

6. Communicates High Expectations

At the beginning of each chapter, the learning objectives of the chapter is provided. This will give students an idea of what they should learn after reading that chapter. Having a clear picture of chapter's learning goals helps students focus on important areas and concepts.

Providing suitable hyperlinks over the Internet encourages students to explore knowledge in addition to the provided materials. It is believed that students can learn more from searching relevant information distributed across the Internet. However Paul [24] observes that because of the enormous volumes of data on the web, students have difficulty finding appropriate data and distinguishing which is truly valid and useful. Therefore in our system instructors are encouraged to provide relevant links to students so that the students can acquire more knowledge efficiently. The instructors can add relevant hyperlinks in the course materials or when they set quizzes.

7. Respects Diverse Talents and Ways of Learning

The Internet provides different ways of learning. Course materials can be presented in text, static pictures, animation, audio or video clips. There are various ways for students to adopt knowledge via an online learning system.

In order to fit students' learning pace, each question in our system is associated with a level of difficulty. Similar to some public tests, for example, the GMAT Computer Adaptive Test [42, 44], the difficulty level of question may vary according to the student's performance. Therefore the difficulty of questions would adapt to the student's current result. After checking a certain number of answers, if the student has done very well, the system will pick some difficult questions for him/her in order to arouse his/her interest to the topic. On the other hand, if the student's performance is just fair, the system will pick some easy question in order to encourage the student to keep trying.

Table 3.1 summarizes how the proposed system implements seven principles.

Seven principles	System Features
Student-Faculty Contact	Discussion board, email list
Cooperation Among Students	Discussion board, email list
Active Learning	Quiz(dynamic-generated, modified-multiple choice), animation and simulation among learning materials
Prompt Feedback	Quiz with feedback, personalize reports
Time on Task	Estimated studying time
High Expectation	Set goal for each chapter
Diverse Talents	Adaptive question generation

Table 3.1: A summary of how the proposed system implement seven principles

In addition to the above mentioned features to support the seven princi-

ples, there are other functions that are essential in our online learning system.

In order to let students know their learning progress and performance, our system gives each student a student record. Each student needs to register to initiate an account using the course webpage. Thereafter, students can check their registered personal information in case there are any errors or modifications.

Once a student open an account, he/she can enjoy various features provided by our system. Our proposed system is a self-directed learning system. A list of available courseware is posted so that he/she can read the lecture notes at his/her own pace. When he/she has finished reading a chapter, the system will record at the student's personal report. Therefore he/she can easily check which chapters he/she has read and adjust his pace of learning.

Our proposed online-learning system provides some features for instructors to maintain the system. There are several areas reserved for the instructors. They include the area of course material maintenance, quiz design and student performance monitoring.

Instructors can upload the teaching materials on the system. Nowadays creating a simple webpage is not a difficult task. The simplest method is to write html coding. Text editors like Microsoft Word can be used to convert a document file to html format. Softwares such as Frontpage, Netscape Composer, Macromedia Director, NetObjects Fusion, etc can be easily used

to create html files. Once instructors have prepared the notes, they can upload the notes to their coursepages.

Since self-assessment plays an crucial role in self-learning system, our system can provide a convenient way for instructors to create the quizzes. An instructor only needs to input the required fields. The question will be generated and stored in the quiz database. This proposed system provides a user-friendly querying environment for the instructor to monitor students quiz performance. By typing in different retrieving criteria (see detailed description of the criteria in the next chapter with screen captures), the instructor can find out the relative performance of the test taker.

Our system needs an administrator to work on the back end. Since temporary the server side of the system runs on Unix platform, an administrator should install the system by putting all the required Java files into the course account, run the setup package which generates several course page files and create tables in the database.

Fig 3.1 summarizes the provided functions. When the user logins, he/she will have an access to the system. An instructor can choose to upload courseware, create quiz, or monitor student's learning performance. A student can study courseware, take quiz or check his/her study progress. The bottom of the Fig 3.1 shows the functions that both instructors and students can access such as discussion board, list of email address and other relevant information.

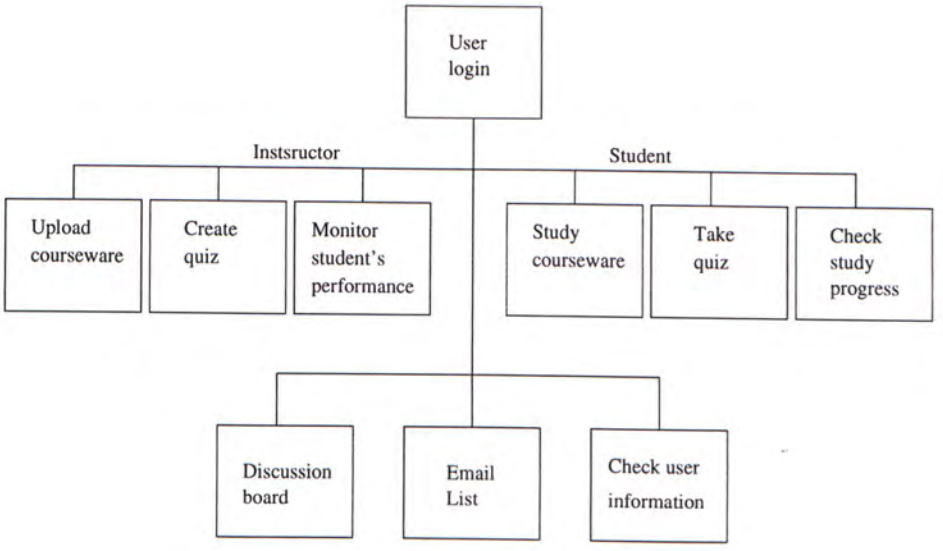


Figure 3.1: System functions

3.2 Software architecture

The proposed system uses a client/server architecture. As Fig 3.2 shows, instructor's and student's browsers are the client terminals. They can access the system through the Internet or Intranet with Hypertext Transfer Protocol(HTTP). On the server side there is a HTTP server running with Java Servlets programs. The HTTP server handles the common static webpage transference. The Java Servlets programs are to generate dynamic html files, connect to the database so as to transfer data to and fro the database via the connection pool according to the client request.

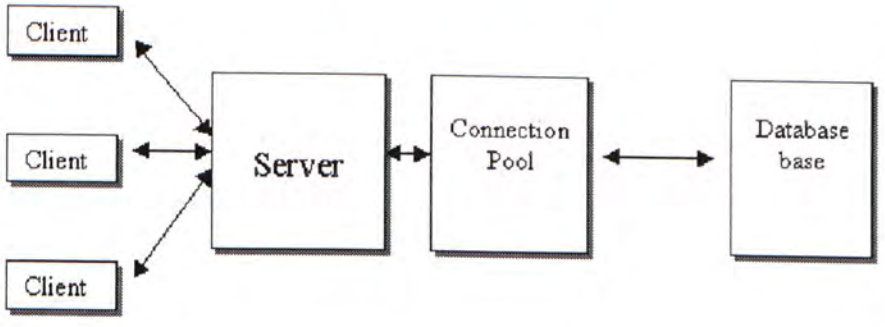


Figure 3.2: System Architecture

Java Servlets [41] are small programs that extend a web server's functionality. They can deal with data from corporate databases, generate dynamic content and manage user's state information [47]. Servlets not only inherit the large set of Java package and divide different object into classes, they

can also be more efficient than traditional Common Gateway Interface(CGI). This is because when there are N requests to a CGI program, the program code needs to be loaded into memory N times. On the other hand a single instance of servlet can handle these requests by using N threads which can save memory and give a faster response [38].

As shown in Fig 3.2, the web server communicates with a connection pool instead of directly making connection to the database. Since running an online learning system always requires to connect to server's database, for example to load user's profile or to retrieve quizzes, it is time-consuming to open a connection to a database, to allocate memory resources, to authenticate the user, and to set up the security measures [53] when a client request arrives. Therefore a connection pool method is adopted [52]. When the system is booted, it first makes a certain number of connections at once. Then when a client requests to run a query, it can request a previously prepared connection from the pool. After the operation is finished, the Servlet returns the connection to the pool. These connections can be reused and hence, this approach saves the time from making a new connection all the time.

3.2.1 Authentication

Since it is a self-directed learning system, each student has his/her personal profile. Before students access the system resources, they should login to our system.

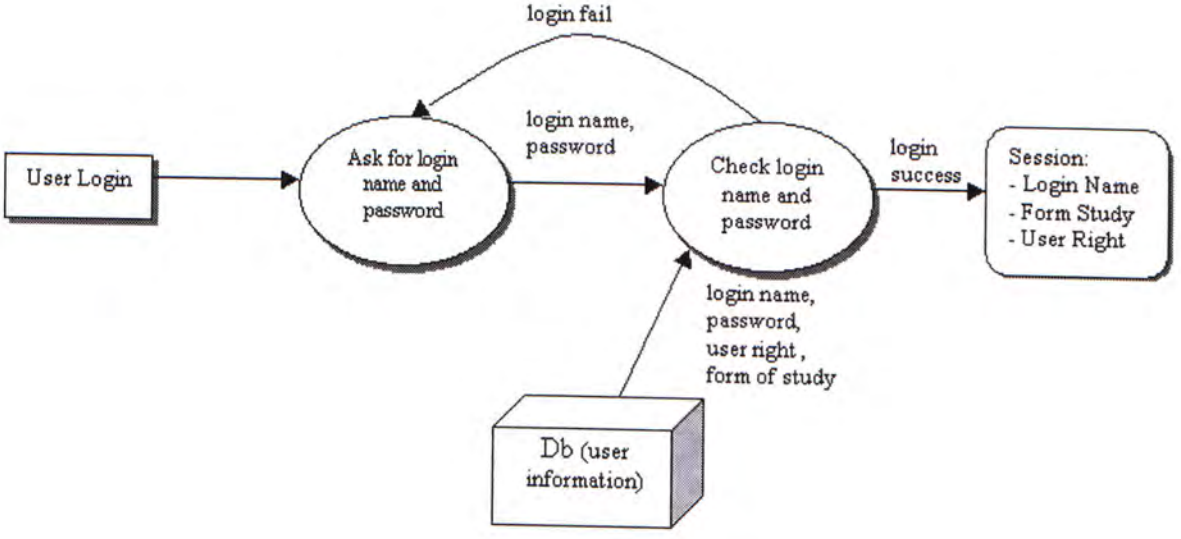


Figure 3.3: Process of Login

Fig 3.3 shows that when a user accesses the page for login, the user is asked for the login name and password. If the login is successful, the user can access various system functions. The system stores the user's login name, user right and study form(if student) for a session. Since html is stateless - after sending a user an HTML page, the web server retains no memory of that user. In order to keep check of the series of requests from the same user across a period of time, servlets provide a session, which is some data on

the server to store objects. Using the session, we can store personal data on the server instead of passing the data through parameters in URL. In this case, data is hidden. In this process the login name is stored to keep track of the learning process, *user right* is used to prevent students from using instructor's utilities, and *form of study* is convenient for the users to take appropriate quiz.

3.2.2 Courseware studying

After login, students can access the courseware provided on the web. We encourage students to perform self-assessment through our system. Therefore both students and instructor can monitor the studying progress. As described in Fig 3.4 our system will monitor whether the session is created by checking the login name. If a null value is returned, student is required to login. Once the student has login by checking the session, our system will retrieve the course materials for the student. At the end of a chapter, the student will be asked whether he/she has completed the chapter. If the student has only browsed through it or only finishes a part of it, he/she can respond negatively. If the student has finished reading the chapter, his/her studying report will be updated. Therefore students can check their progress in their personal report easily and know which chapters they have finished revising.

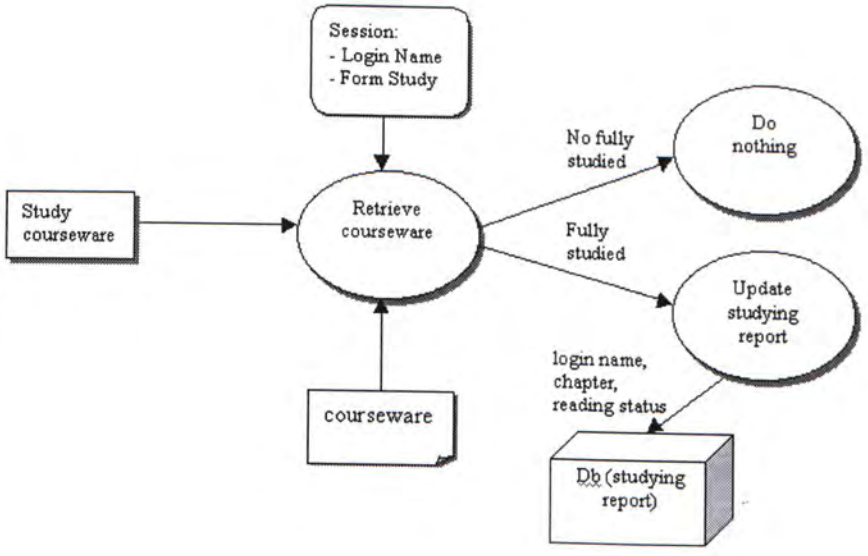


Figure 3.4: Process of course studying

We keep the courseware in their original format on the hard disk of the server. The instructor can prepare his/her material either in simple html, pictures, animations or any audio/video files.

3.2.3 Quiz retrieval

The difficulty of a quiz is designed based on a student's performance in a previous quiz. As shown in Fig 3.5 there are two processes in quiz retrieval. When the system gets the scope of quiz, year of study of the student, and there is a login name in session (means the user has login), it will retrieve quiz from a database. All the model answers will be stored as a session so that students have any access to the answers. On the other hand, students'

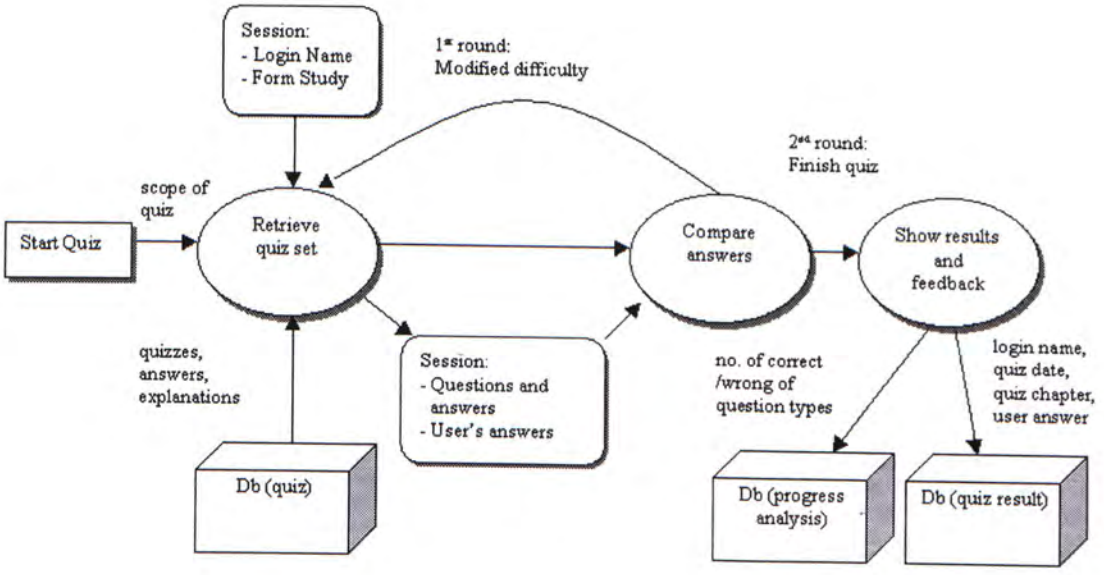


Figure 3.5: Process of quiz retrieval

answers are also temporarily stored for assessment.

Quiz comes in two phases. The first phase involves questions on the core concepts. Based on the performance of the participant in the first phase, questions in the second phase are designed to help the participant better understand the topic. For example, at the end of first phase, if the rate of correct responses of user's reply is higher than a pre-set value, the level of difficulty of the questions in the second phase will be revised accordingly. After the student has finished two phases, a result report with comments and explanations will be generated immediately. The quiz result and the performance of different types of questions are stored for use.

3.2.4 Performance Monitoring

In our proposed online learning system, each student has a personal progress report. Fig 3.6 shows the process involving performance monitor-

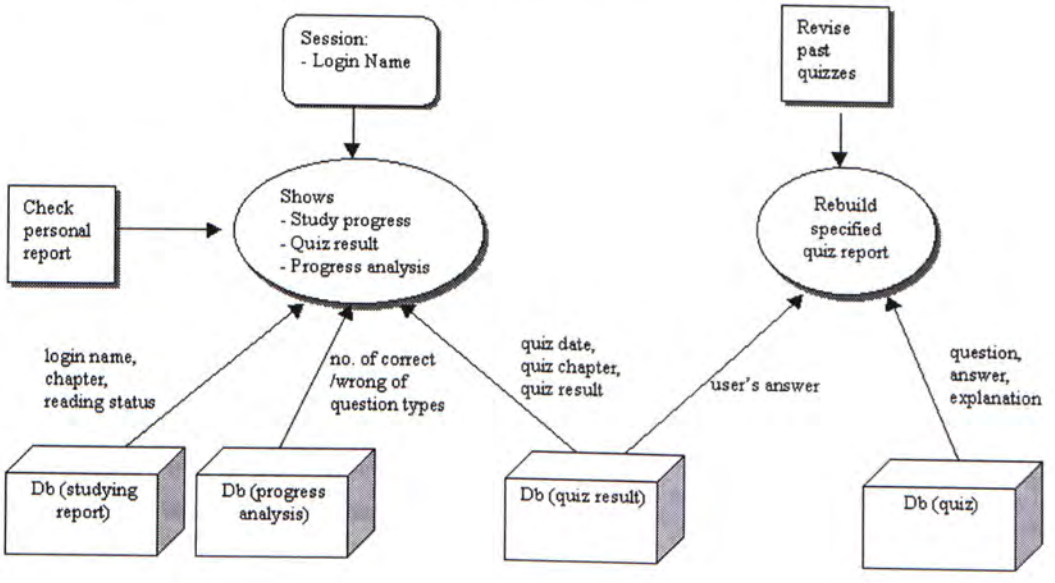


Figure 3.6: Process of performance monitoring

ing. On obtaining the login name from the session (when the user requests to see his/her progress, the studying progress) assessment performance and analysis report are retrieved. The studying progress shows whether the chapter of courseware has been read. The quiz report generates the date of the quiz taken, the chapter(s) assessed, and the score the student obtained. The assessment analysis shows the student performance on different types of questions. If students want to further revise the quiz taken, they can click on the relevant quiz record, then the questions, answers and explanations are

displayed.

3.3 Chapter Summary

In this chapter, we have described in detail the features and architecture of our proposed on-line system. The discussion board and email list fit the principle of student-student and student-faculty communication. Quizzes, animation, and simulation are provided to facilitate active learning. The feedback in quiz and personalized reports provide feedback on a student's performance. Giving estimated studying time provides efficient learning. We set goal for each chapter and give hyperlink to student for high expectation. The proposed stem also provide adaptive question generation during quiz for diversifying talents.

Our online system uses a client/server architecture. Client can connect the web server through HTTP. On the side of web server, with the help of Java Servlets each user's profile can be maintained when the user is connecting to the server and users can retrieve any datafiles to and from the database efficiently. At the end of this chapter we explained several functions performed by the system.

Chapter 4

Demonstration

In this chapter, we take a walkthrough of our proposed proposed online learning system. We assume that students study Computer Studies. In particular, we target the syllabus of Hong Kong Certificated Education Examination(HKCEE) [1].

HKCEE is a Hong Kong public examination that is normally taken by students at the end of his/her five-year secondary education [33]. Computer Studies is one of the areas in HKCEE, which is designed for students to recognize the applications of information processing, to learn the computer applications packages, to understand the basic organization of a computer, and to develop programming techniques.

Fig 4.1 shows the main page of the system. There is a menu in the frame on the left for the ease of browsing across the webpage and below the menu

is the scrolling news that reminds students of some special events.

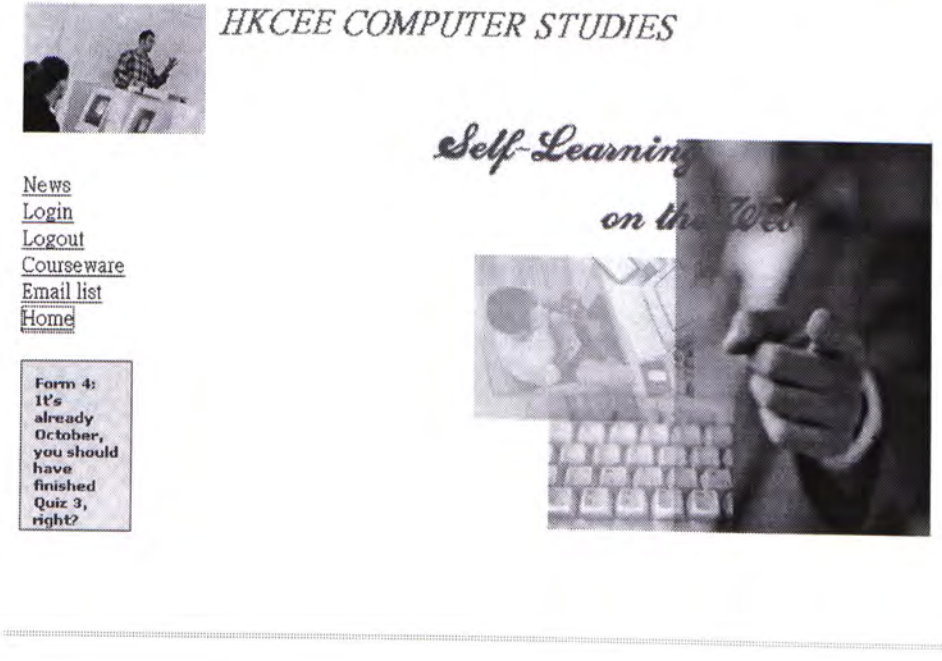


Figure 4.1: Proposed on-line learning system

4.1 Account Management

As mentioned earlier, each user has an account. The users(either students or instructors) must login to the system by identifying themselves. Fig 4.2 shows the login page. An existing user is required to input his/her login name and password. For security reasons, the field of password is encrypted. New users are requested to register a new account by clicking the *Sign Up* button on the page of login. Fig 4.3 shows the page for signing up. After users have logged in, they can view their registered information as

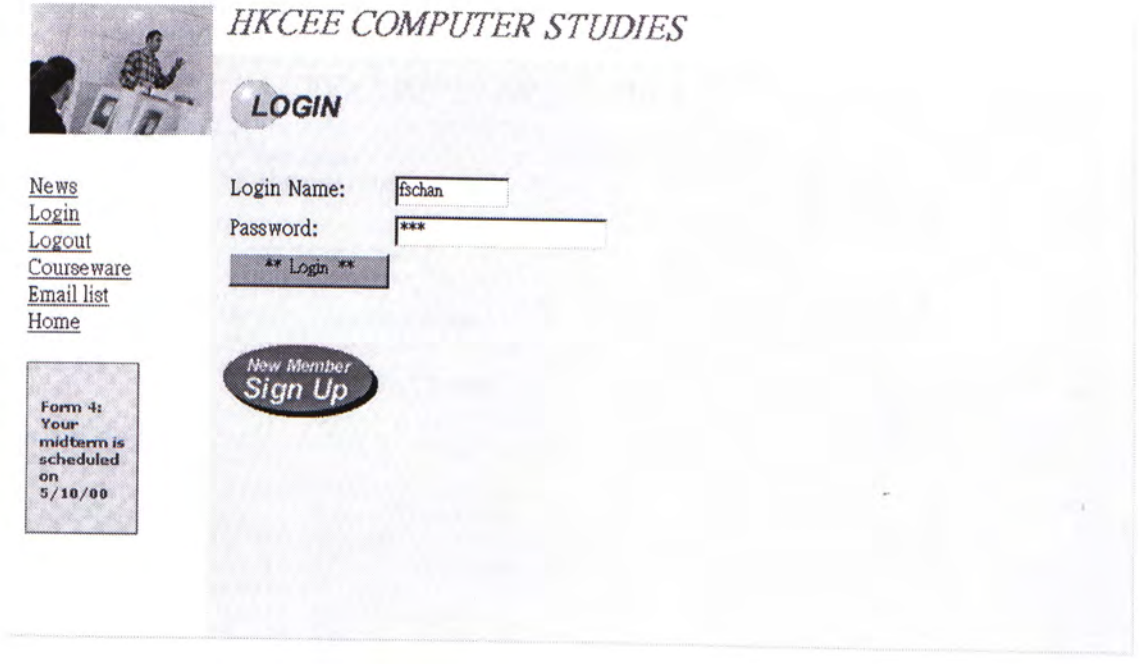


Figure 4.2: The login page

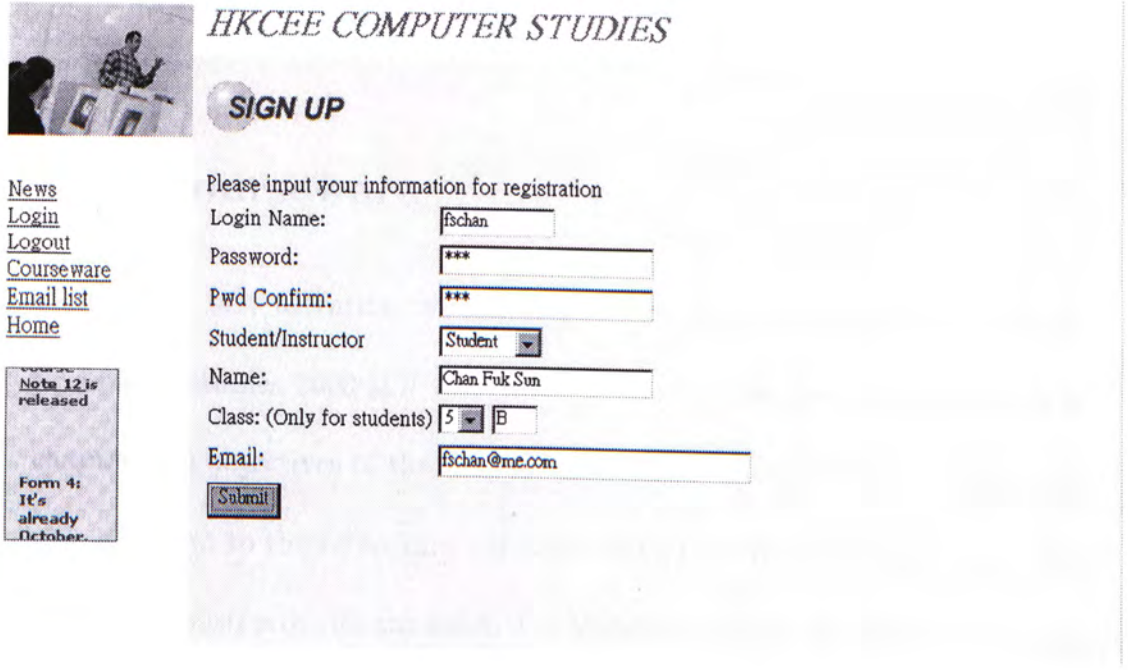


Figure 4.3: The sign up page

shown in Fig 4.4.

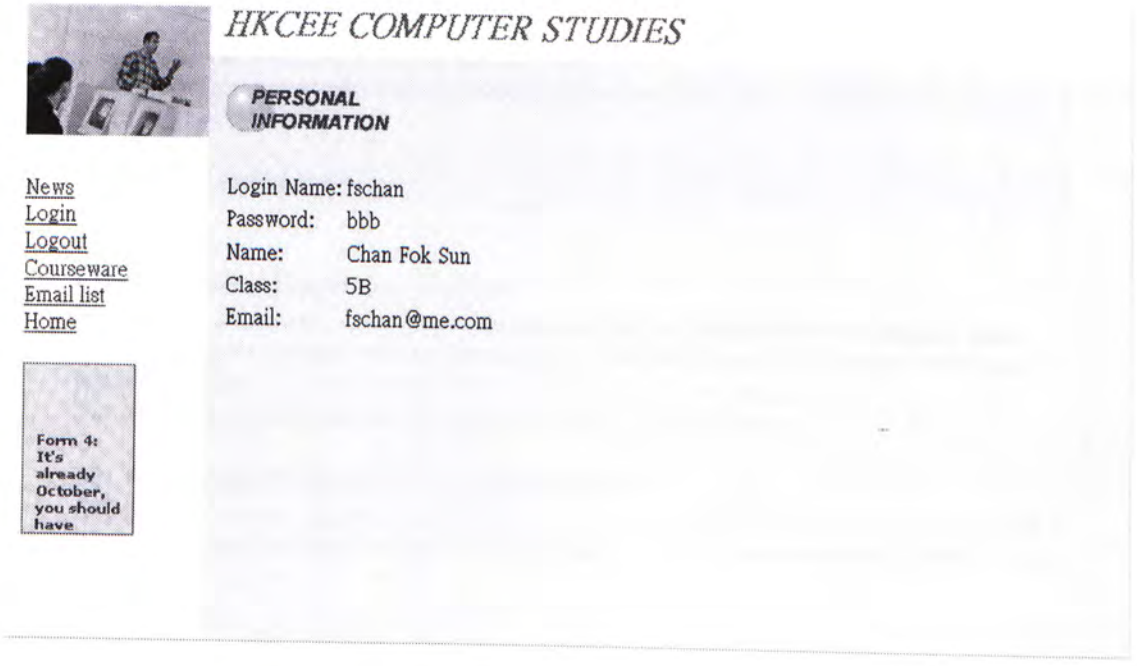
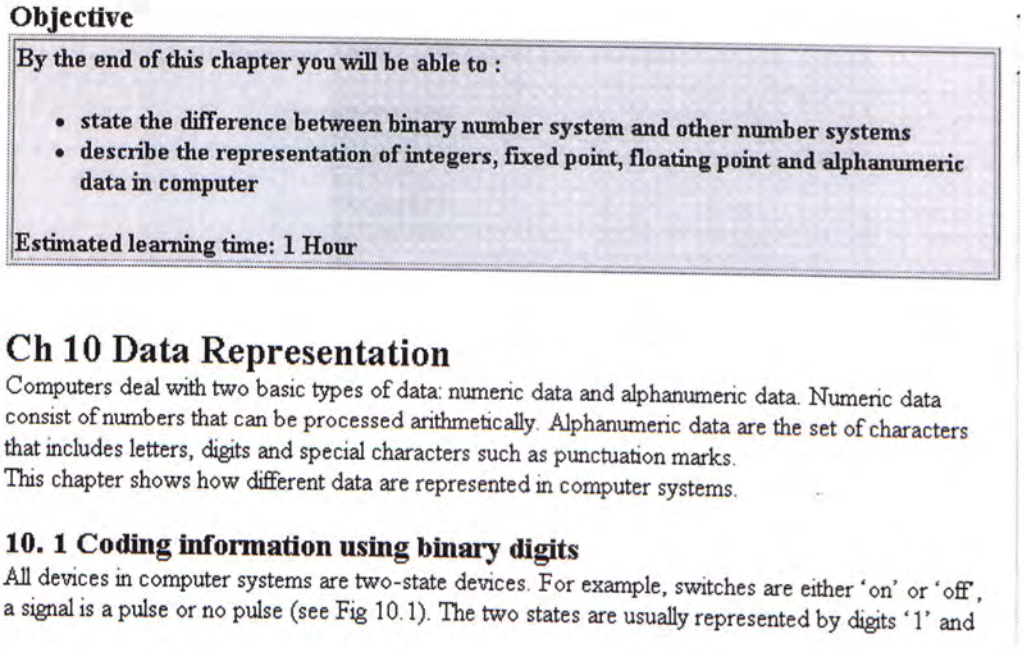


Figure 4.4: The personal information page

4.2 Courseware

In our demonstration, we take 3 chapters from the content of textbook Computer Studies 2000 [25]. As shown in Fig 4.5, at the beginning of each chapter, the objectives of the chapter are stated. Therefore the students can pay attention to the important concepts when they read the materials. The courseware also provides the estimated learning time for the students so that they can manage their time more efficiently.



Objective

By the end of this chapter you will be able to :

- **state the difference between binary number system and other number systems**
- **describe the representation of integers, fixed point, floating point and alphanumeric data in computer**

Estimated learning time: 1 Hour

Ch 10 Data Representation

Computers deal with two basic types of data: numeric data and alphanumeric data. Numeric data consist of numbers that can be processed arithmetically. Alphanumeric data are the set of characters that includes letters, digits and special characters such as punctuation marks.
This chapter shows how different data are represented in computer systems.

10. 1 Coding information using binary digits

All devices in computer systems are two-state devices. For example, switches are either 'on' or 'off', a signal is a pulse or no pulse (see Fig 10.1). The two states are usually represented by digits '1' and

Figure 4.5: The objective and estimated time

Among the courseware, animation and interactive simulation is provided. Visually transforming conceptual algorithms and arithmetic operations into animations and simulations help students learn in an easier and more efficient way. Fig 4.6 - Fig 4.9 shows the snapshot of an animation step-by-step showing how to convert a binary number into a decimal number. After the question is shown for a while, a hint is shown in the animation (Fig 4.6). Then it starts to work out the question with comment next to it (Fig 4.7). Repeat the steps and the result is shown as Fig 4.8 and Fig 4.9. Fig 4.10 - Fig 4.13 are snapshots of an interactive simulation. This simulation helps learners learn how a program is executed in a simple model computer(SMC) to work

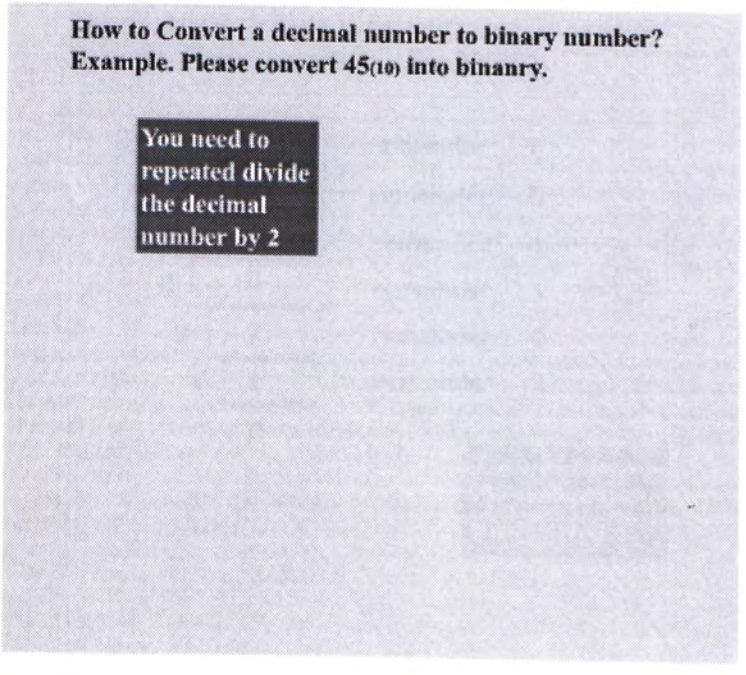


Figure 4.6: The animation - question and hint

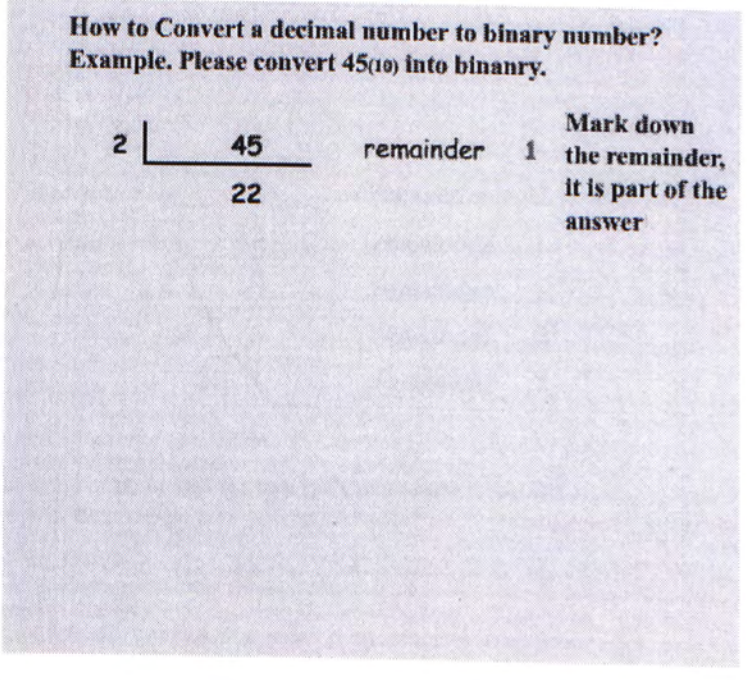


Figure 4.7: The animation - solution

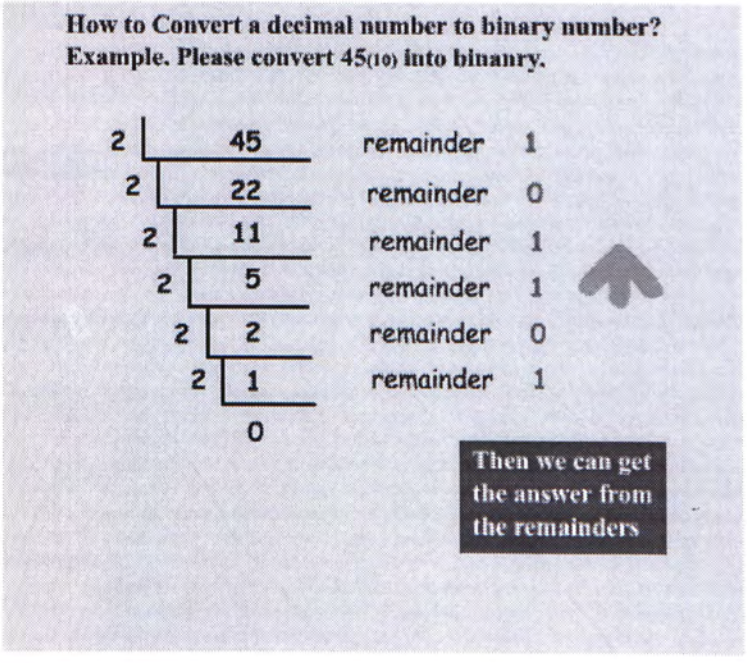


Figure 4.8: The animation - final step

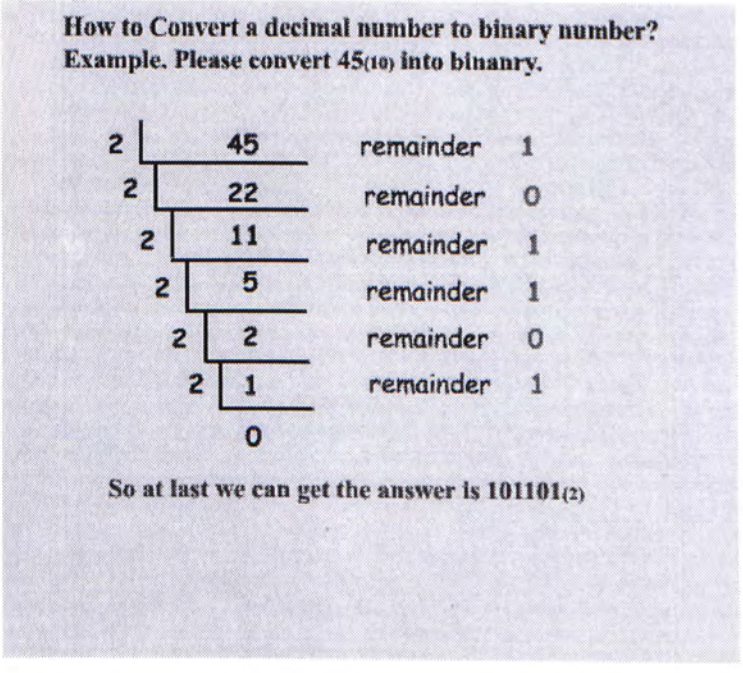


Figure 4.9: The animation - result

out the sum of two numbers. During the simulation there are some arrows showing the data flow between different operation block. At the bottom there is the transcription telling what step the program is executing. At the right bottom corner, there are the navigation buttons letting students to go on the next step on their own pace. This simulation includes 3 phrases: (1)load the first data from memory to ALU (Fig 4.10 and Fig 4.11) (2)load the other data (Fig 4.12) (3)sum the data and put back to the memory (Fig 4.13).

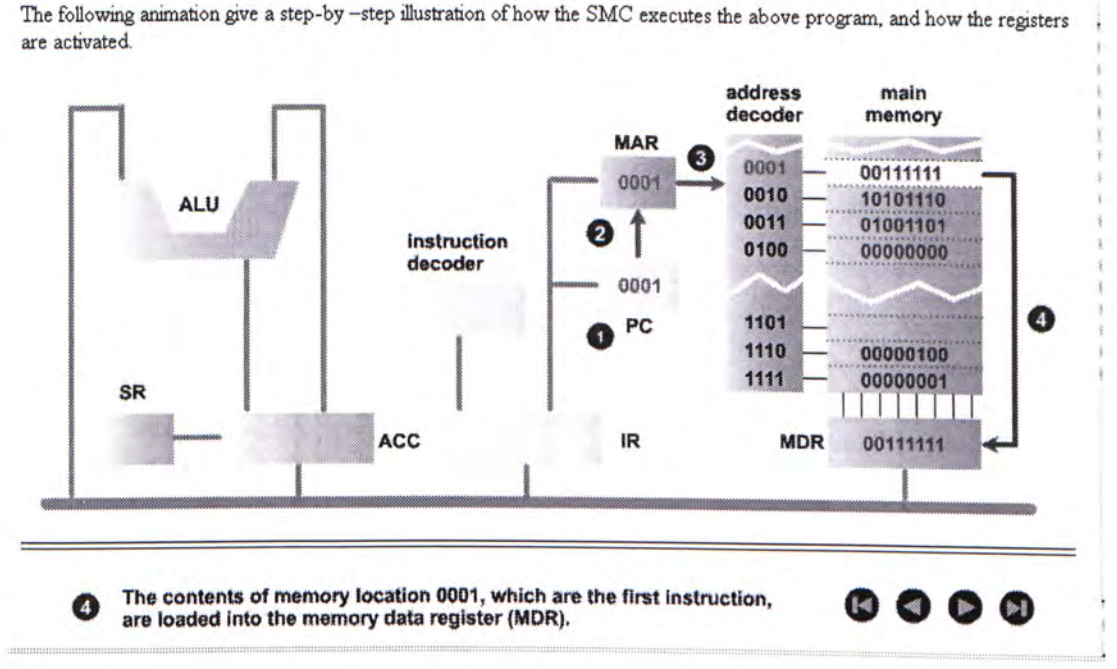


Figure 4.10: The interactive simulation (phrase 1 step 4)

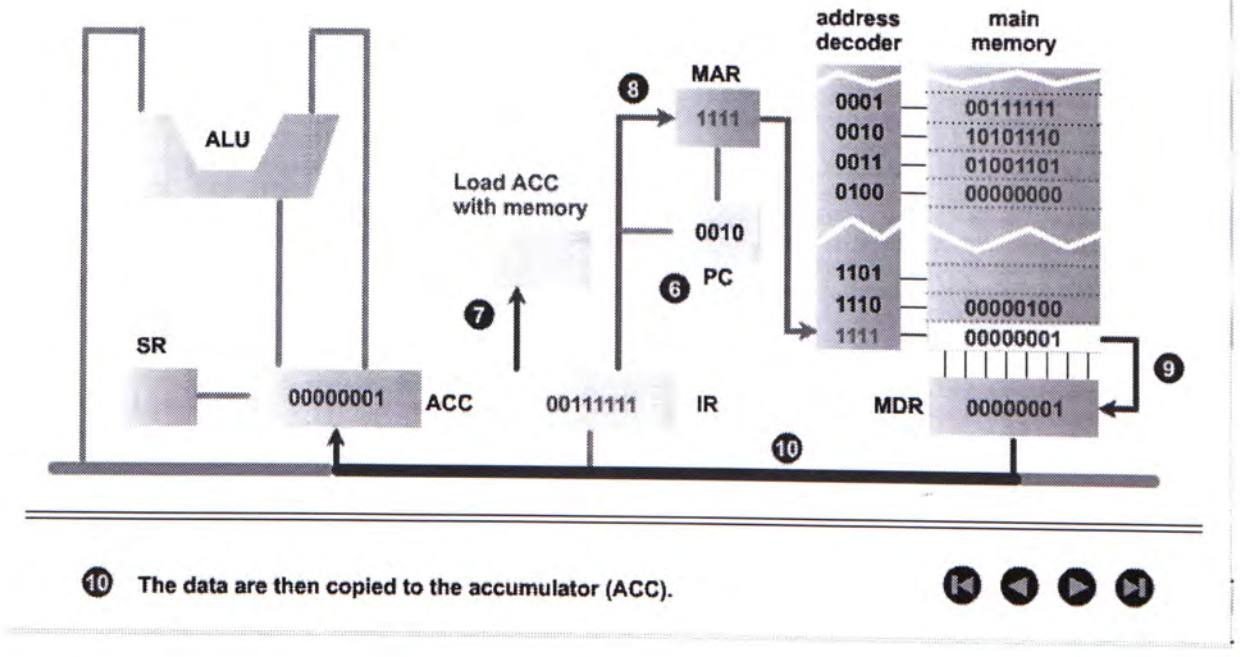


Figure 4.11: The interactive simulation (phrase 1 step 10)

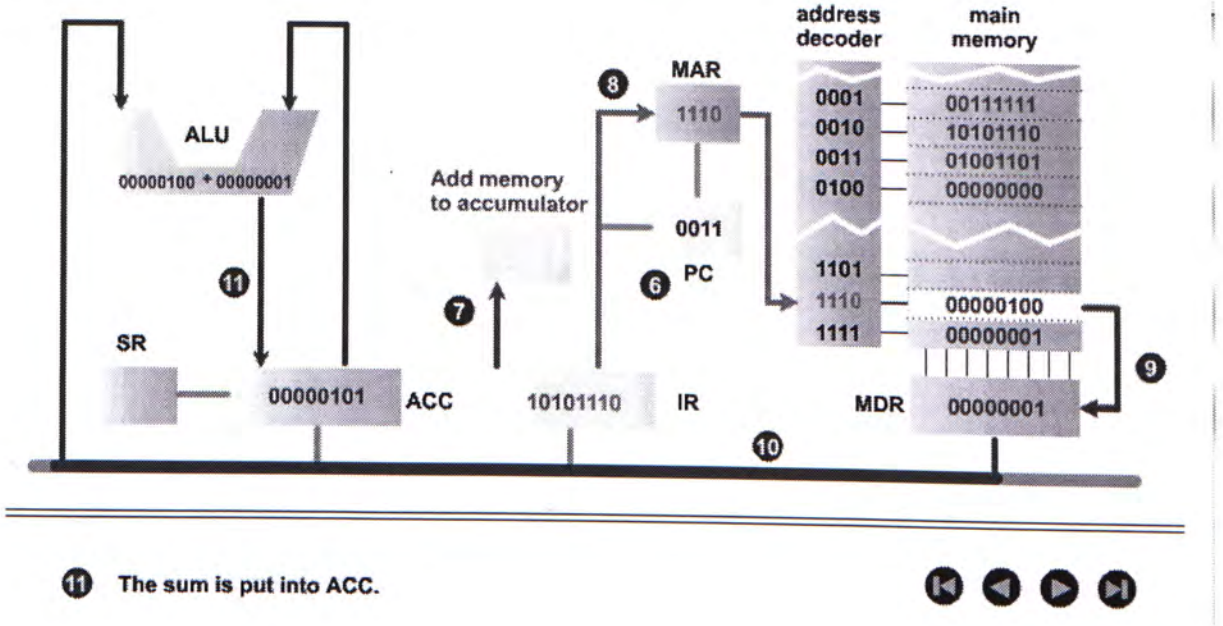


Figure 4.12: The interactive simulation (phrase 2 step 11)

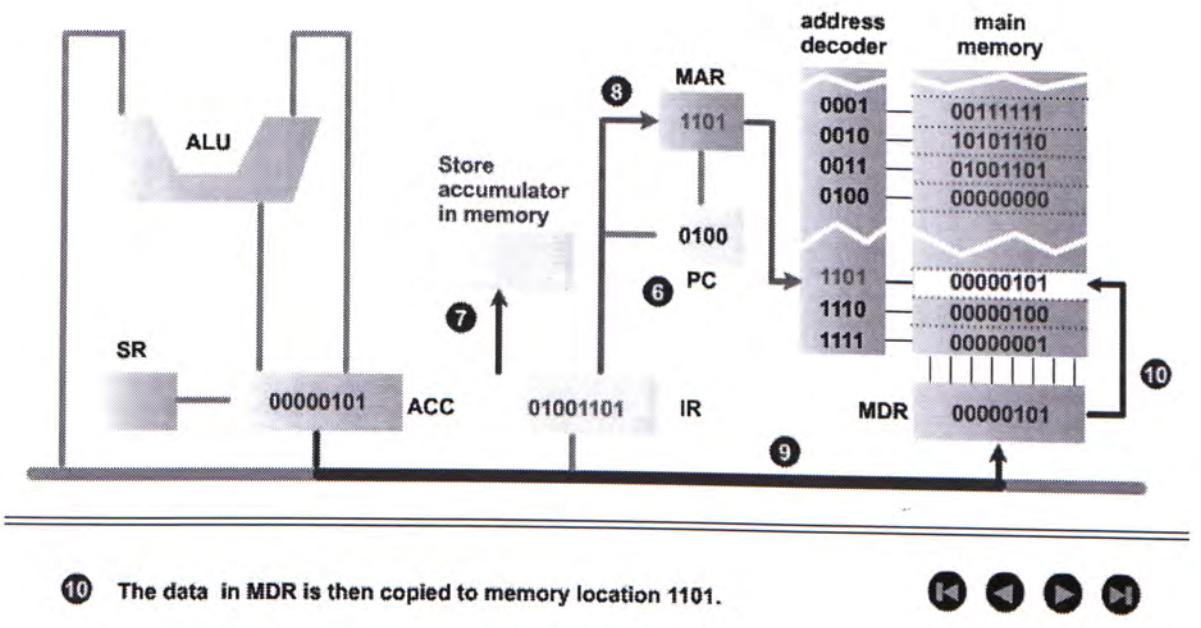


Figure 4.13: The interactive simulation (phrase 3 final step)

4.3 Quiz

Students may assess their understandings by taking quizzes in this system. A student can either taking a test on one chapter or a composite quiz covering several chapters. (Fig 4.14). At the bottom of the quiz page, there is a section giving instructions of the quiz. When the student is ready, he/she then clicks on *Start*. All the questions will be retrieved from the pool of questions located in the server. As mentioned before, there are three kinds of multiple choice questions: (1)choose the only one correct answer (Fig 4.15), (2)choose all correct answers (Fig 4.16), and (3)modified multiple choice (Fig 4.17).

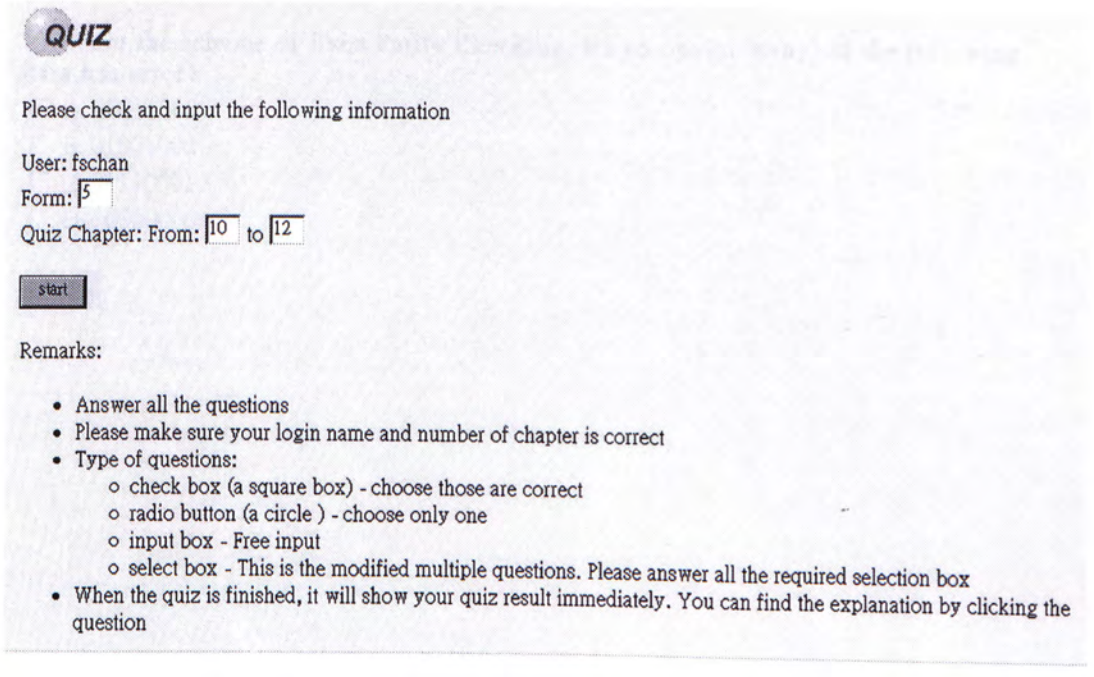


Figure 4.14: Take quiz and read the instructions

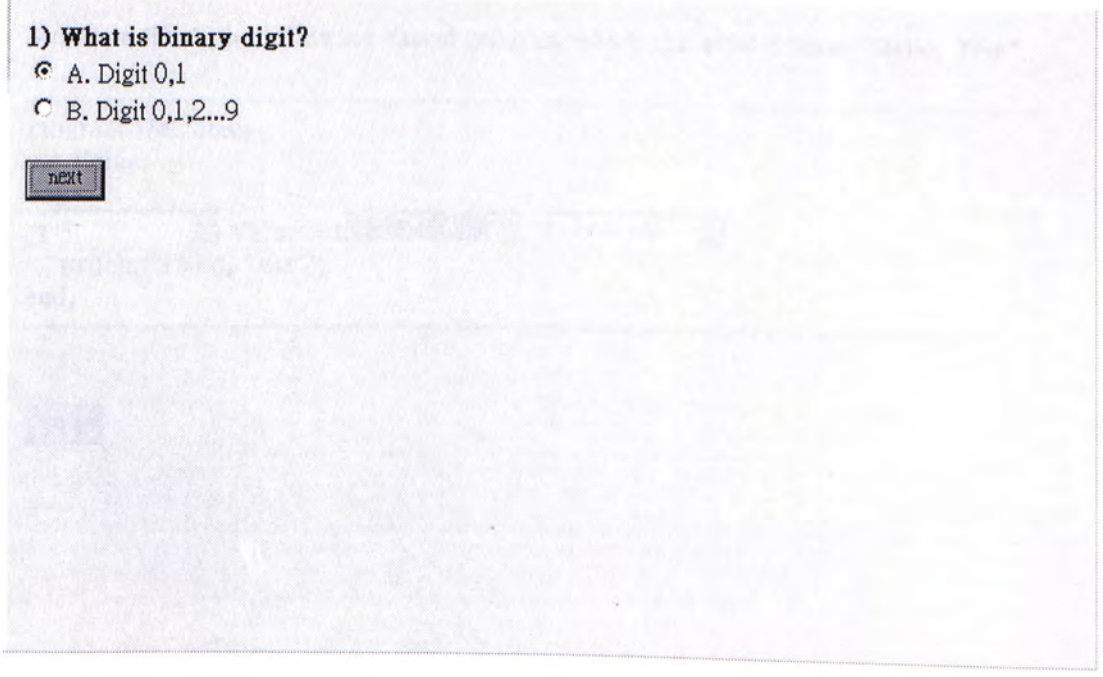


Figure 4.15: Choose the only one correct answer

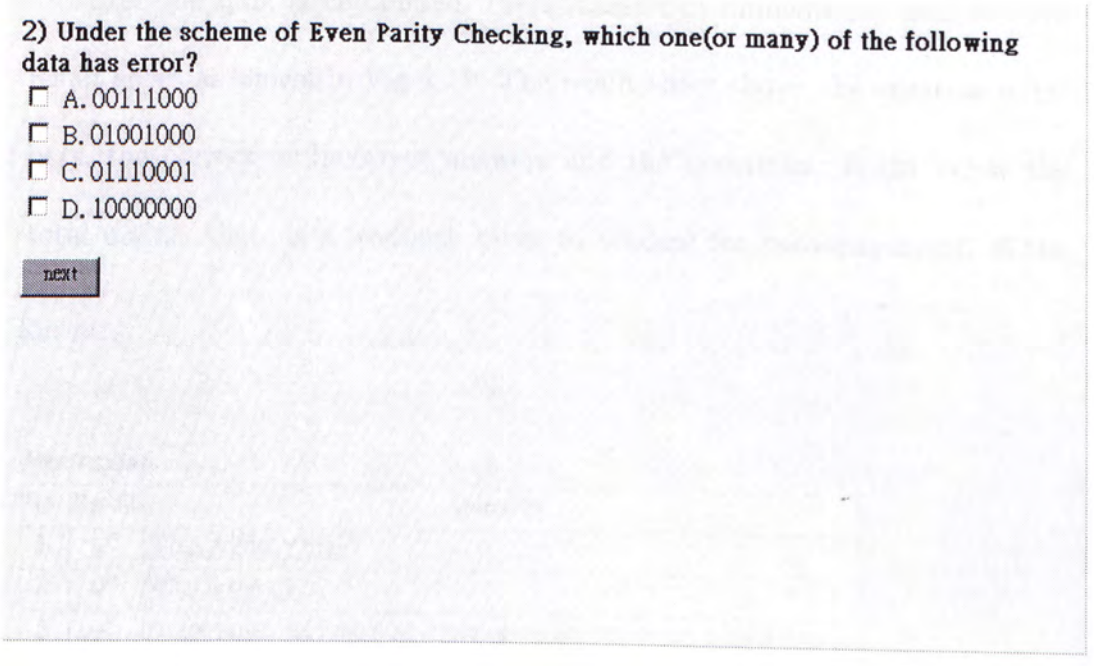


Figure 4.16: Choose all correct answers

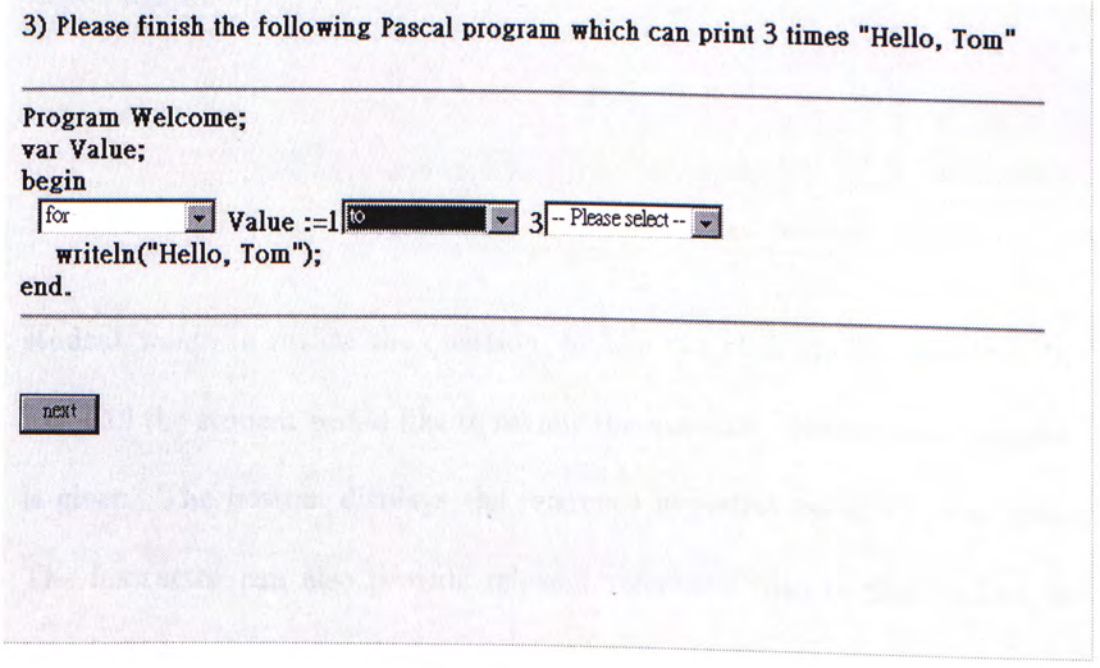


Figure 4.17: Modified multiple choice

After the quiz is completed, the student can immediately gets his/her result sheet as shown in Fig 4.18. The result sheet shows the question numbers, the correct or incorrect answers and the questions. Right below the total marks, there is a feedback given to student for encouragement. If the

Result:

User: **fschan**

No.	Result	Question
1	✓	What is binary digit?
2	✓	What is the CPU?
3	✓	Please finish the following Pascal program which can print 3 time ...
4	✗	(for testing, this is a level 3 Q)In floating point representatio ...

Marks = 75

Good. Keep it.

Figure 4.18: The quiz result

student wants to review the question, he/she can click on the question. In Fig 4.19 the student would like to review the question, the suggested answer is given. The bottom displays the reference hyperlink related to the quiz. The instructor can also provide relevant reference links to the student to help him/her learn more.

There are some questions that contain numeric data. In order to pro-

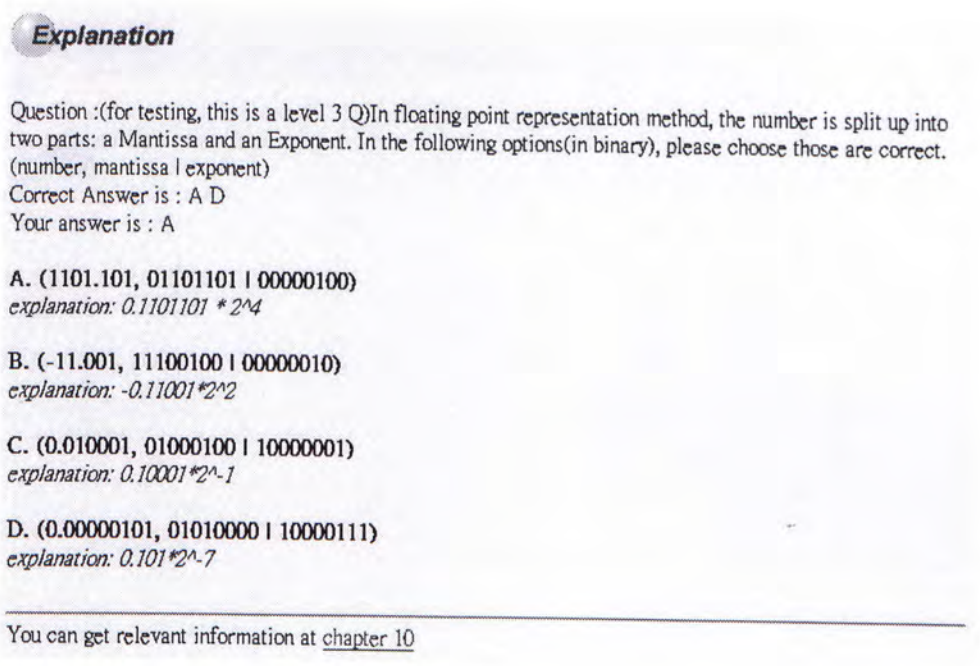


Figure 4.19: Explanation of the finished quiz

vide a dynamic question to students and prevent students from memorizing the data, these numeric data can be dynamically generated. In this demonstration, the conversion problem is dynamical. A student may be asked to convert a dynamically generated number between the binary, octal, decimal or hexadecimal systems. Fig 4.20 and Fig 4.21 show how the question and explanation for converting an octal number to a hexadecimal number. Fig 4.22 - Fig 4.23 shows the student is required to convert a decimal number to an octal number.

Students can check their studying progress in the progress report. In the case of Fig 4.24, the *Study Progress* shows a student has studied chapter

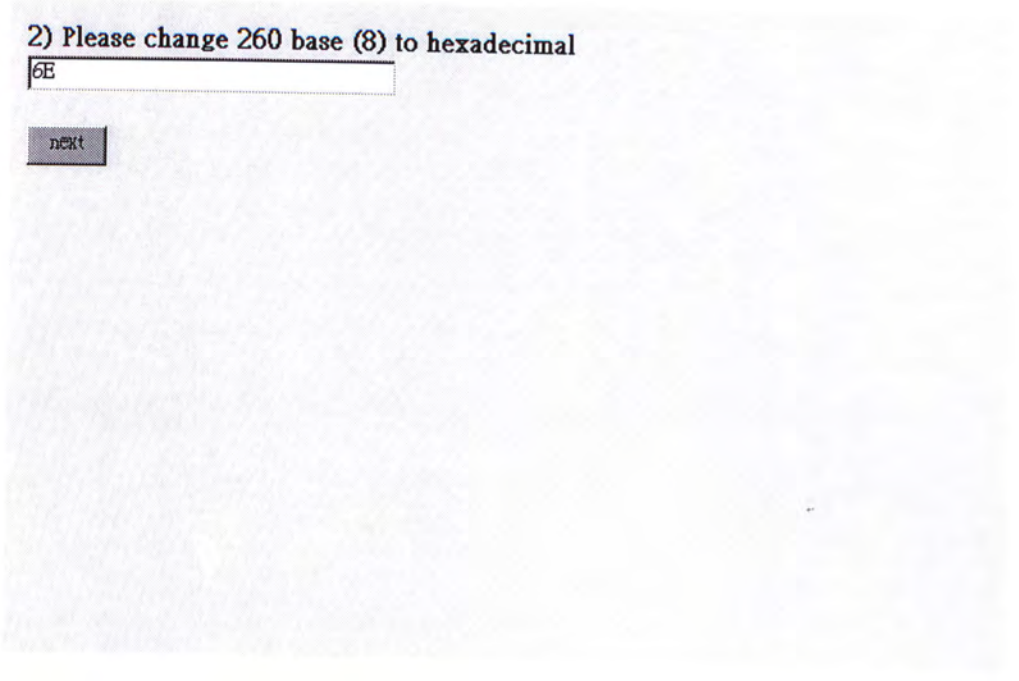


Figure 4.20: Convert an octal number to hexadecimal number

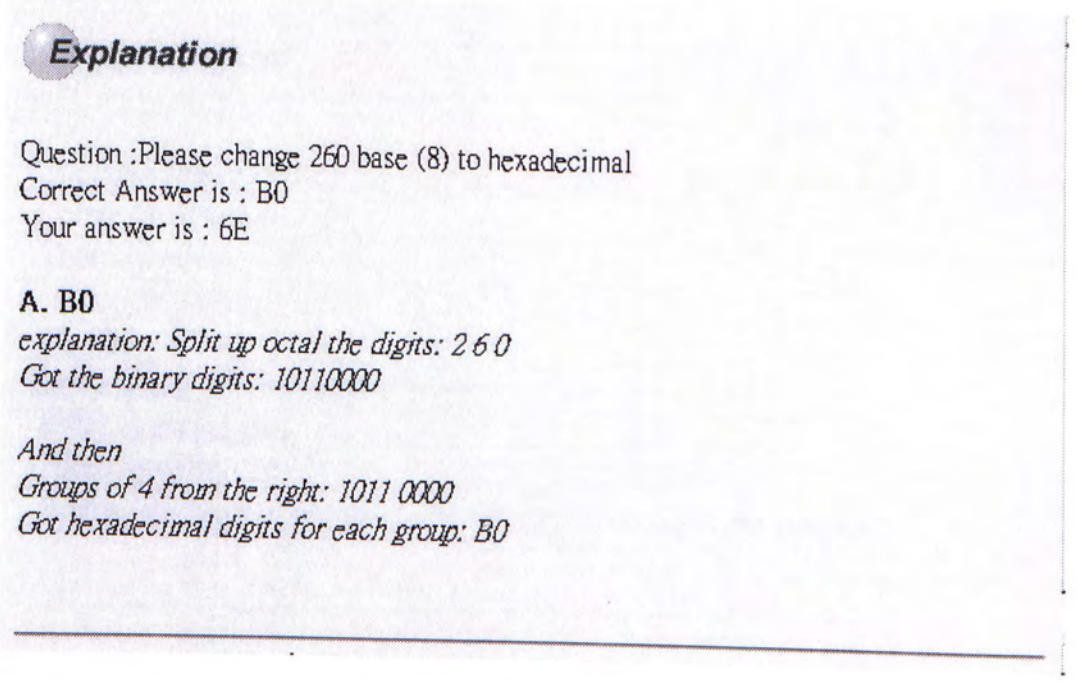


Figure 4.21: The explanation

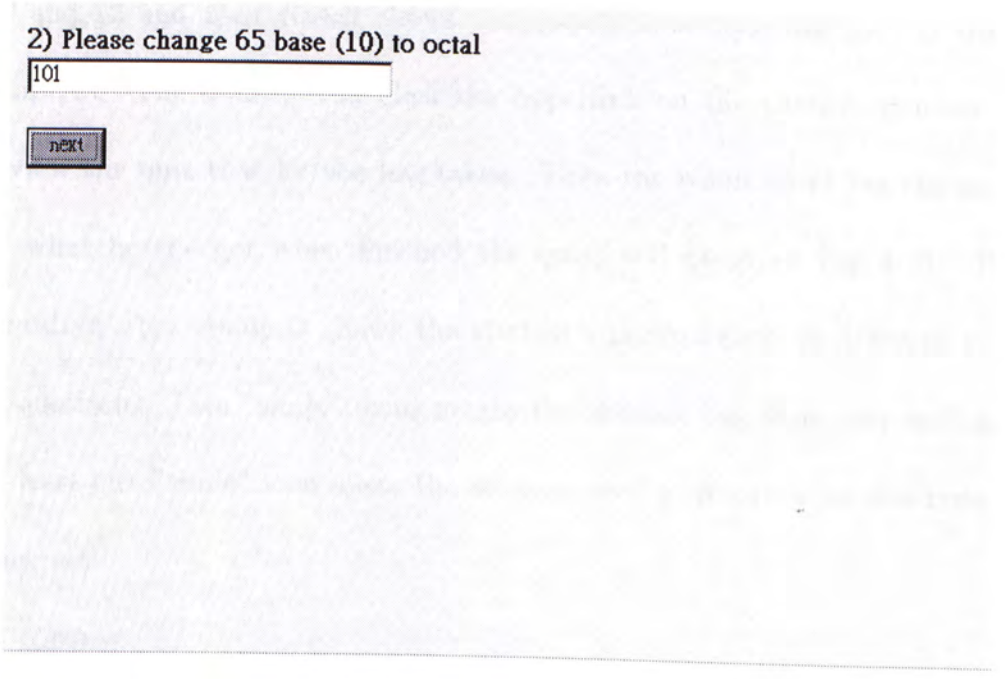


Figure 4.22: Convert a decimal number to octal number

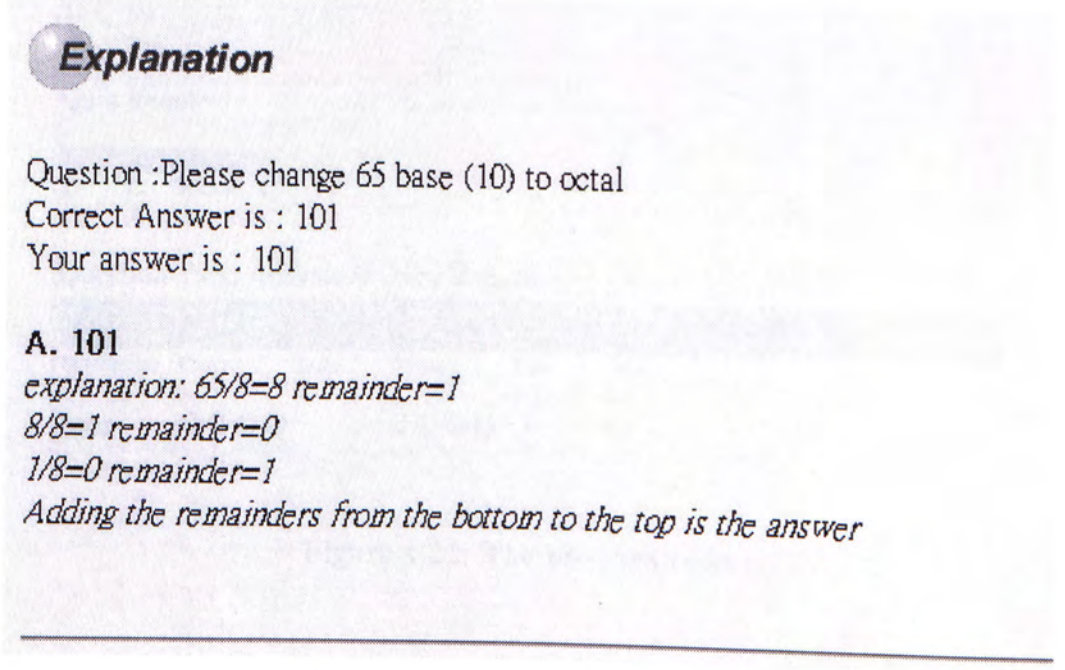
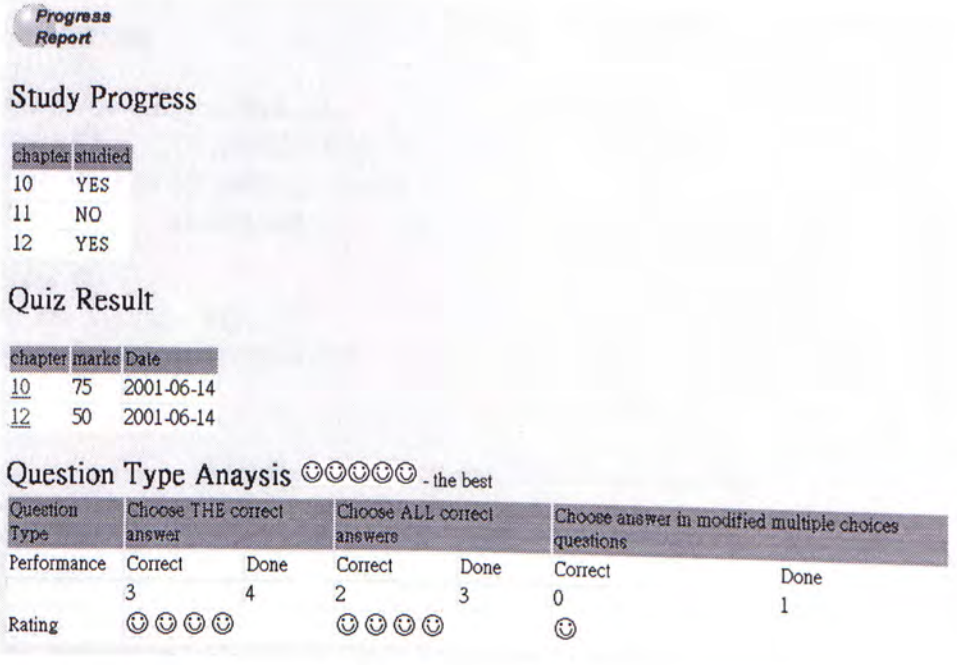


Figure 4.23: The explanation

10 and 12 and *Quiz Result* shows that he/she has taken the quiz of these chapters. The student can click the hyperlink on the chapter number to review the quiz that he/she has taken. Then the result sheet (as the same as what he/she got when finished the quiz) will be given Fig 4.18. The *Question Type Analysis* shows the student's performance on different type of questions. Five "smile" icons means the student has done very well and at least one "smile" icon mean the student need to improve on this type of question.


Progress Report

Study Progress

chapter	studied
10	YES
11	NO
12	YES

Quiz Result

chapter	marks	Date
10	75	2001-06-14
12	50	2001-06-14

Question Type Anaysis ☺☺☺☺☺ - the best

Question Type	Choose THE correct answer		Choose ALL correct answers		Choose answer in modified multiple choices questions	
Performance	Correct	Done	Correct	Done	Correct	Done
	3	4	2	3	0	1
Rating	☺☺☺☺		☺☺☺☺		☺	

Figure 4.24: The progress report

4.4 Email address list and newsgroup

As mentioned in Chapter 3, an email address list and newsgroup encourage students to have peer collaborations and student-faculty member contacts. Fig 4.25 shows the email address list of each registered user. Stu-

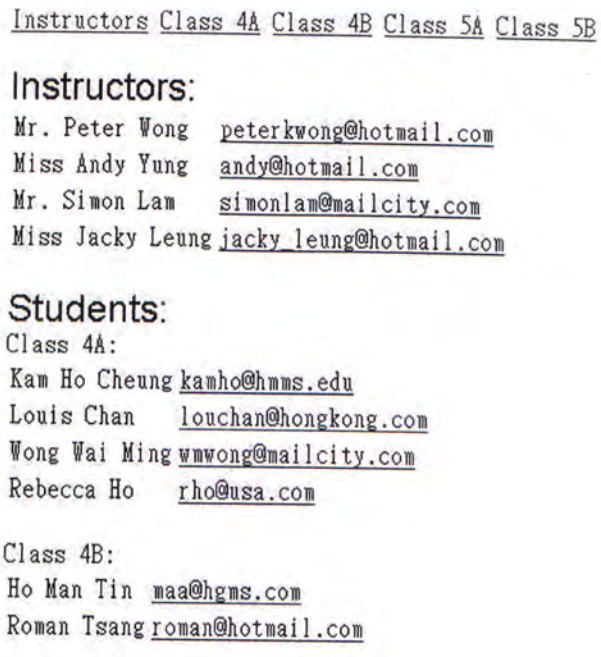


Figure 4.25: Provided email address list

dents can easily contact each other by clicking on the address to launch their email editor. Fig 4.26 is the discussion group that provides a place for the users to exchange ideas. Students can post message when they face any problem, or instructor can post discussion topic for students.

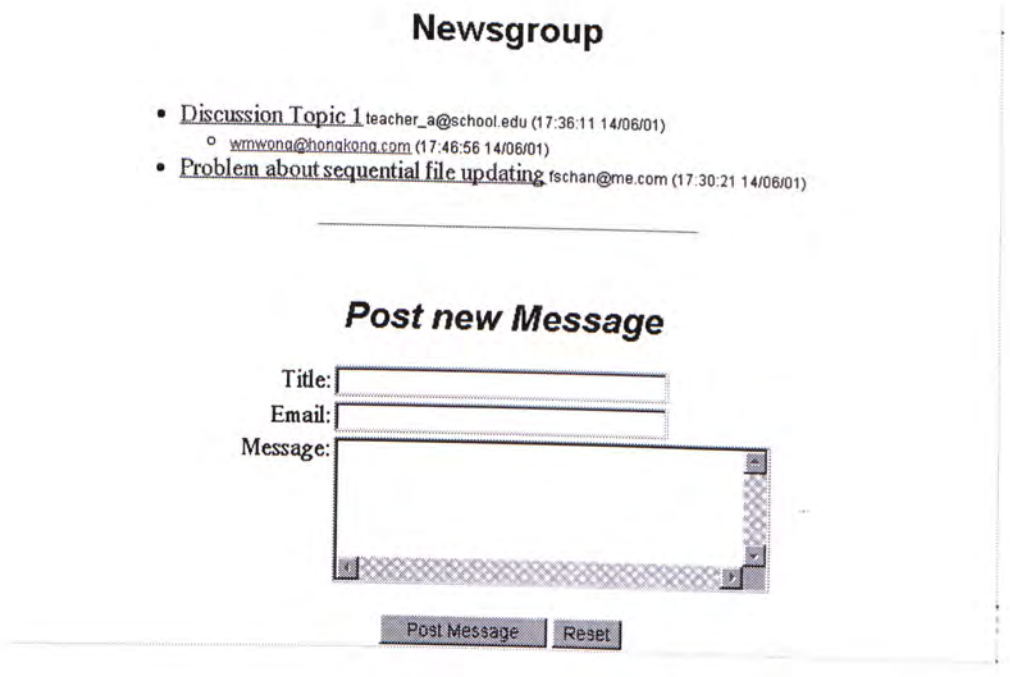


Figure 4.26: Discussion Group

4.5 Instructor Area

There are several areas restricted for instructors only. One of these areas is the area for preparing quizzes. Fig 4.27 shows how the instructor can create a quiz. The instructor needs to choose the type of a question. Other required properties are the questions, the answers, the explanations, difficulty level, the chapter of the question belongs to, and any reference materials or hyperlinks. The page of making modified multiple choices question is similar except the option of providing 3 sets of answers.

This system provides user-friendly functions for instructor to efficiently monitor students' quiz performance. The instructor can retrieve the quiz

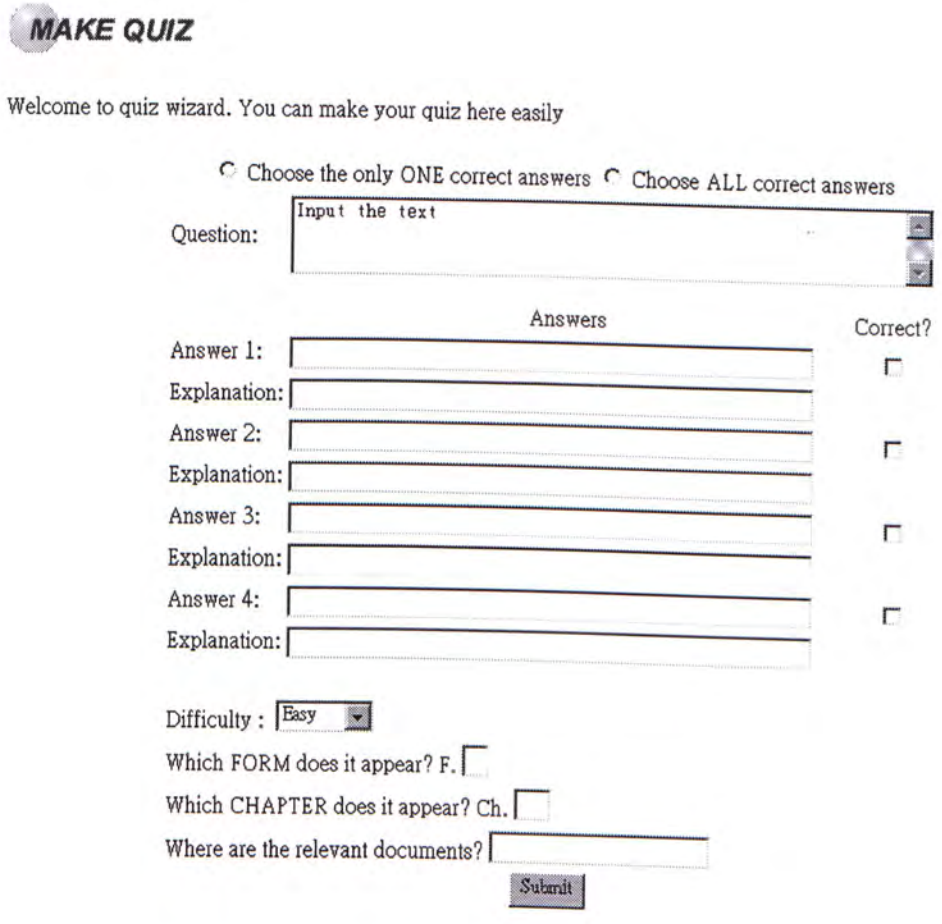


Figure 4.27: The quiz making

record by different properties: student's studying year, class or name, range of quiz result, quiz chapter, or date. If the instructor inputs nothing in the properties, all the quiz result will be retrieved. Fig 4.28 shows the instructor would like to know who a score less than or equal to 50 in a quiz, Fig 4.29 shows the query result.

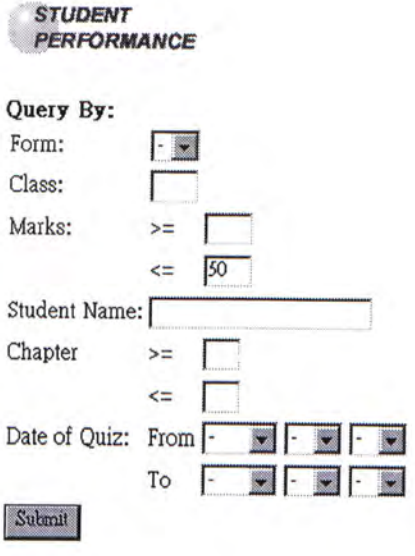


Figure 4.28: The performance monitoring

If the instructor want to upload some materials to the webpage, the upload function shown as Fig 4.30 is provided. The instructor is required to input where this material belongs to. There is a button marked *Browse*. Clicking this button will launch a file selection box to user and the user can choose the file located in his/her local computer. When a file is chosen, the

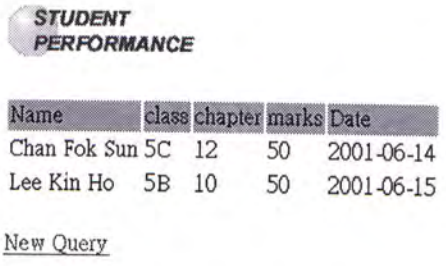


Figure 4.29: The performance monitoring

fill path of the file is inputted into the text box automatically. Once the instructor clicks *Upload*, the file is transferred.

4.6 Chapter Summary

In this chapter we summarize the functions of the on-line learning system. We have described the functions such as the account management, courseware, quiz, email and newsgroup and instructor area.

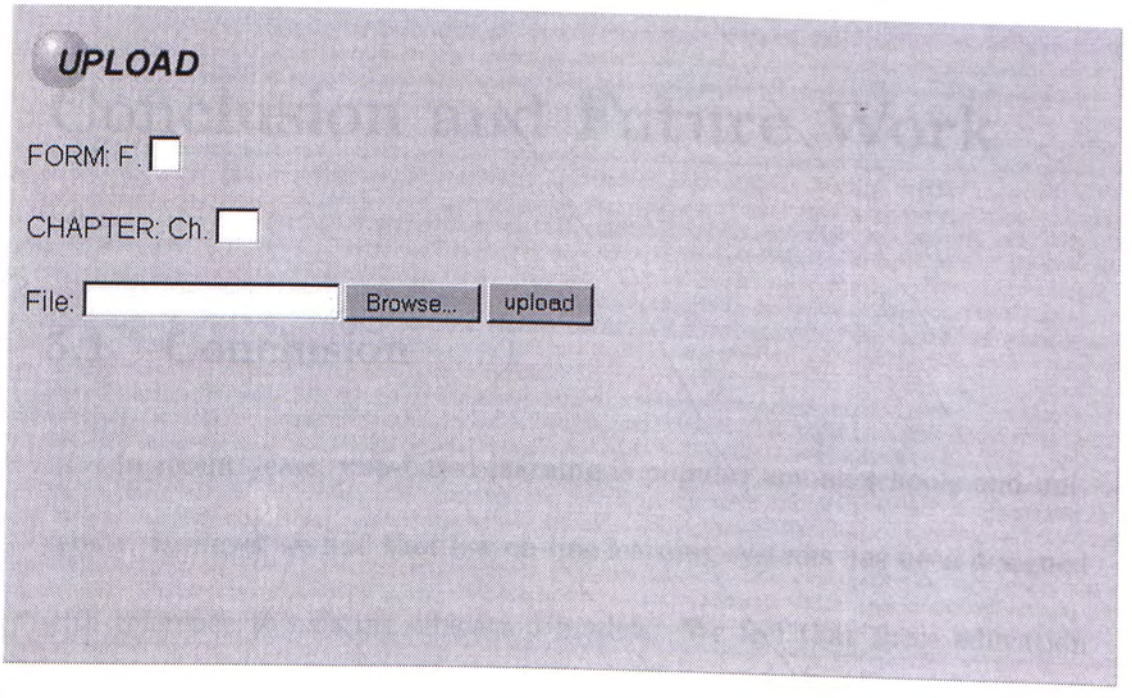


Figure 4.30: The upload function

Chapter 5

Conclusion and Future Work

5.1 Conclusion

In recent years, web-based learning is popular among schools and university. However we find that few on-line learning systems has been designed with reference to existing education models. We feel that these education models provide guidelines for designing and evaluating on-line learning systems. Therefore we look into six important learning models proposed by educators and researchers, namely, (1) integrative learning model, (2) problem-based learning, (3) cognitive apprenticeship, (4) conversation model, (5) self-regulated learning, and (6) seven principles for good practice for education. The seven principles appears most comprehensive and broadly cover the most essential aspects of education. When we evaluate several existing systems us-

ing the seven principles framework, we find that these systems do not fulfill all the seven principles. In this research, we propose a framework for an on-line learning system that implements all the aspects of the seven principles. With the help of the principles, we hope to provide an efficient learning environment for the learners.

In our proposed system, a variety of features that support seven principles are provided. Discussion board and email facilitate student-student and student-faculty communications. Self-assessment with quiz, animation, and simulation encourages active learning. The feedback system in the form of quizzes and personalized report provide feedbacks on student's performance. By analyzing student's quiz results, the system gives valuable advice helping students study on their own pace. Estimated studying time encourages efficiency in learning. Setting goal for each chapter and providing hyperlinks give high expectation to perform and achieve. The proposed system also generates adaptive questions adjusting to students' study level so that diverse talents with different study plans can be catered.

This research aims to build a comprehensive and multi-function learning environment for improving and enhancing classroom learning experience. In addition to traditional delivering and learning during classroom teaching, our system with the enhanced features is a complementary learning instrument to traditional classroom teaching. Students can conduct self-directed

learning and self-assessment by using this system. This system serves as an on-line learning model for web-based teaching developers, since we consider incorporated the seven principles in our fundamental system design concepts.

Our proposed system has the following strengths. After reviewing several pedagogical theories, we used a predominant theory, the "Seven Principles for Good Practice" as a framework in developing this on-line self-directed learning system. We believe that pedagogical theories also apply to the on-line setting. In addition, this system can easily be adopted to subjects. When an instructor needs to create a new course in the system, he/she can create a new set of coursewares using HTML editors. Once the course materials have been created, the instructor uploads the materials to the course webpage. The system provides an user-friendly interface for making quizzes. Self-assessment plays an important role in this system. In our proposed system, the questions and order of choices are dynamically generated. In order to encourage students to think thoroughly in answering each question instead of wild-guess, we propose the modified multiple-choice approach. Moreover each student has his/her personalized report to give a clear picture of his/her studying progress and assessment results.

5.2 Future work

In this thesis, we developed a framework for developing an on-line learning system and built a prototype. We expect that in the future this prototype can be evaluated and modified by instructors and high school students. Their feedback can help system developers to further improve this system.

Due to time constraints, this system aims to demonstrate only the basic features and interface for implementing the seven principles without going into great details. Therefore there are rooms for further enhancements.

Currently we have some animations and simulations in the course materials. In order to provide more audio and visual aids and encourage active learning, future system developers can incorporate multimedia components such as audio and video clips.

Web-conferencing can be integrated into the system. Net-meeting softwares such as Microsoft Netmeeting [32] and CUseeMe [12], and Internet telecommunications software such as MediaRing Talk [40] are available for web-enable, real-time interactive communications. As broadband Internet services become mature, the limitation of bandwidth is a less concern in adopting Internet conferencing and telecommunications.

The quiz retrieval mechanism is another area for improvement and future development. The existing system does not allow students to take a quiz for

a chapter for more than one time. However future system developers may give instructors the flexibility to set the number of times each student can take a quiz for a chapter. The concept of letting student to decide the level of difficulty of the questions encourages students to self-direct their study and to set high expectation for themselves.

Moreover a studying agent can be built. This agent takes care of a student's studying progress. If a student's performance result cannot meet a pre-set passing level, it will send an alert to his/her instructor. A Student can also set the learning target at the beginning of the course. Therefore at a certain time this agent can give an alert to the student what he/she should have done at that time. This studying agent helps the student adopt a better time management and meet his/her goal in every milestone.

In addition to developing more features for learning purposes, we may enhance the course maintenance functions in our system. An instructor can modifies or deletes the quiz and uploads materials in a more user-friendly interface. Since students may always ask similar questions, an auto-reply system may be built. Once analyzed the keywords in the email, the system is able to retrieve and send pre-written messages to students automatically. For frequently asked questions, this auto-reply system that provides instant responses is particularly useful in reducing instructor's workload.

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