THE DESIGN AND IMPLEMENTATION OF A CUSTOMIZED, WEB-BASED LEARNING ENVIRONMENT

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Abstract

In the near future, the World Wide Web (WWW) is expected to be used widely as a new and strong educational media. The advances in multimedia technologies of Internet bring an alternative way for teaching and learning. However, most developing web-based education environments, distant-learning and virtual-learning online sites, are still limited to the dissemination of teaching materials. Neither the strengths of Internet have been maximized nor the functions have been fully utilized, for instance, to support interactive, customized and collaborative learning.

To cope with this situation, we develop an integrated customized learning environment, Virtual Campus, that can adjust each student's study in his own learning pace as well as provide a tailor-fit study guide. Virtual Campus is an on-line place in the net that providing adequate up-to-date demanding learning materials and personal study guides. Eventually, Virtual Campus can be an ideal studying environment for the 'life-long' learners. The major goal of Virtual Campus is to deliver the 'own-paced' material to the right person in any time.

Virtual Campus is different from the other web-based learning environments in the way that we exploit the Internet technologies to customize the web-based learning. The main contribution in our work on web-based education is that we develop a prototype to make it simpler for teachers and students to take educational advantage of the WWW for customizing learning.

論文題目：一個用户化網上學習環境的設計及實施
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摘要

在不久的將來，萬維網 (World Wide Web, WWW) 將會被廣泛地使用並作爲一個全新和強而有力的教育媒體。互聯網 (Internet) 的多媒體發展，帶來了一個與傳統截然不同的教育及學習方式。但是，多數建設在網上的 (Web–based) 教育環境，仍然受制於單向性傳播教材，未能完全有效地利用互聯網的長處及用作來支援互動和切合個人需要的合作性網上教育。

爲了改善這個情況，我們發展了一個用户化而綜合性的學習環境 ––虛擬校園 (Virtual Campus)，它能根據個別學生的學習進度來調整他的學習方式，及提供一個度身訂造的學習導引。虛擬校園是網上一個提供最新和渴求的學習素材及提供個人學習導引的地方。及後虛擬校園將會是長期求學者的理想學習環境。虛擬校園的主要目標是能隨時傳送合乎個人學習進度的教材給合適的人。

虛擬校園和其他網上學習環境不同的地方是我們盡量利用互聯網的技術來作出網上學習的用户化。我們的工作對於網上教育作出的重要貢獻是發展出一個原型，使到教師們和學生們能容易地利用互聯網的優點來用户化其學習方式。

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Chapter 1

Introduction

1.1 Web-based Education

The Internet[1] is a global network connecting millions of computers that allows its users to share information and to communicate interactively. Thousands of schools, universities and learning institutions are impressed by this technology and numerous educational related web sites are launched [49] [18] [15] [32] [42] [63] [71]. The Internet is regarded to a new and strong educational media undoubtedly.

Traditional on-campus teaching is based upon lectures, which beside oral presentations include slides, experiments, etc. Presentations and public online discussions are unique in the sense that nothing is recorded for playback or future use. In contract, the World Wide Web[2] (WWW) technology provides a platform for delivering not only text materials that a student might need, but also multimedia requirements as well, including audio and video streams of lectures. In addition, it also provides a transparent access to information ignoring the geographical distribution. This penetrating power is adequate to enable on-line learning systems to deliver education widely. For example, learners can view the

[1,2] A brief introduction of Internet technology is discussed in Appendix A.1.

on-live lecture anywhere through the web in real-time manner [37].

We are convinced that the Internet is teaching and learning resource of unparalleled potential. On one hand, students are keen in this new technology, and feel very interesting in the new communication mode. When they are surfing the Web, they learn updated new things soon, get the most updated all-kinds information shortly, and make universal net friends, which is a new kind of learning mode that different from the traditional learning in school. On the other hand, teachers are also amazing this rich-resource Internet and deciding how to utilize this treasures to enrich their teaching life, however they found difficulties in adapting the fast-moving trend and applying related technology. For example, teachers are not yet prepared to use the Internet effectively, as teacher education programs have not tended to teach such program [20]. Moreover, in-service training to help teachers learn to integrate these web tools into their classrooms has not kept up with the need [47].

Abundant on-line courses attest the value of the Internet in enhancing distance learning. However, most of these programs lack for real-time interactivity found in a classroom. They generally use email and web pages in place of printed material. In other words, they only enable dissemination of teaching materials, and inadequate facilities are used to support students. Moreover, these Web-based courses are absent of "flexible": neither are teachers nor the delivery systems can adapt the course presentation to different students for different need [5]. Hence, many researchers have tried to use emerging computer and communication technologies to construct effective teaching and learning environments.

1.2 Customized Web-based Learning

In sprite of applying awesome technology to education, we notice that learning process under the Internet environment is different from those in traditional classroom which is an interaction between teacher and students. The question, "How can fully utilize the Internet in order to delivery the right information to the right student at a right time", is located. We found that only "translating" the used classroom stuffs, says blackboard and written notes, to Internet is not sufficient, as there still have much room to improve the education flow. Then we define and model this new learning process as well as magnifying the power of the Internet. We develop a learning environment, Virtual Campus, by making use of the asynchronous and programmable nature of the WWW, aim to provide support not only to learning materials generation and dissemination, but also to collaborative teaching and learning. Specially, we emphasize on customizing the learning progress for each student.

In the Virtual Campus, student can fully engage in the learning process through an interactive, dynamic environment. The on-line materials for each student are scheduled personally depending on his/her studying pace. Student will be expected not to waste his/her time learning irrelevant or already known material and minimize students failing to understand (or misunderstand) the material. In short, students have to take more responsibility for their learning, the pace of that learning will have a more natural rhythm dictated by the individual student's needs instead of an imposed schedule.

Customization hardly brings to reality in the existing educational system. Most of the teaching materials are planned in a non-dynamic order and delivered to a class of 20-40 people in order to improve the effectiveness, especially in Hong Kong. The issue, "How to measure effectiveness and what constitutes a quality education", however are subjects of much controversy. Effectiveness can be defined in terms of the extent to which a course achieves a set of learning goals for the learner [53]. In general, each person can have his/her own desired goal.

From a practical point of view, customization places plenty of burdens and pressures to the instructors/teachers. They have to select the teaching materials before class that based on their experiences from their students or the scheduled syllabus that try to meet the mass learning goals. It is difficult to be customized for each student. For example, instructor/teacher is presenting these materials to students in the lesson, while he is receiving different responses and queries from students. It is hard to handle all those questions immediately when the course is running. In these situations, most students always just sit there passively, and some may be already "tune out" [53].

Nevertheless, technology shifts the educational paradigm, which bring more personal assistance to those students with special need. Cowart & Schalock [14] described the trend as "full inclusion from the child's perspective, that is, where a teacher adapts the learning environment to meet the diverse needs and backgrounds of the children being taught". Fortunately, customization can be brought by the Internet technology automatically. Given the information provided from each student and his/her academic record, the intelligence scheduler self-produces a periodic preliminary study plan for each student, which is laborsaving. After reviewing by an experienced consultant and interchanging opinions with the particular student, a customized tailor-made timetable is generated. Together with the flexible Internet individual study environment, delivering right material to the right person at a right time can be realized in the coming future.

It is important that allowing the receivers (student/learner) adjusting their learning rate based on their abilities and interests, rather than totally controlled by the sender (instructor/teacher). In this information explosive decade, a person is hardly surviving as if he is stopping learning new things. That means the

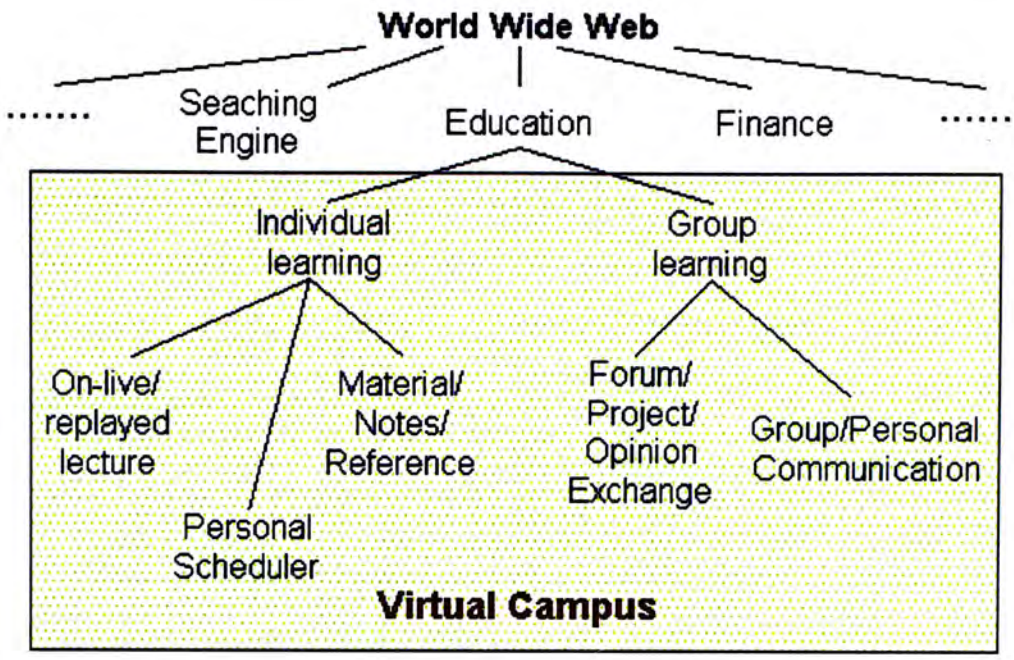

Figure 1.1: Overview of Virtual Campus

society pushes people to be a life-long learner. Although it is not an easy task requiring self-discipline and continuity, customized study planing service promotes the learners' convenience. In addition, consultant acts as a personal supporter givingan extra advice to students.

Other than individual learning, Virtual Campus also supports group-paced learning as well. The collaborative facility allows students to accomplish group projects or discussions. The power of the Web not only restricts to transmit information to the student, but also provides forums for exchange. When group members participate and share their knowledge, the knowledge base increases and members continue in benefit [26]. This kind of real-time communication is not restricted to the peer interaction (student/student). The active participation of students and instructor in the shared task of seeking to understand and apply the concepts and techniques that characterize the subject area [53] shortens the distance between students and instructor.

In summary, Virtual Campus provides a place for parties, instructors/consultants and students. It constructs a learning environment (shown in Fig 1.1) providing the appropriate learning tools to achieve sensory and communication compensation. Particularly, the Campus supports both individual and group learning through the Internet. An user-friendly interface of Virtual Campus acts as a gateway for teachers/instructors fully utilizing the Internet conveniently without knowing too much technical details. On the other hand, Virtual Campus also concerns students' personal requisiteness in favor of leading the study life more fulfilling and gratifying.

1.3 Thesis Overview

In this chapter, we have introduced the contribution we present in this thesis, which is customized web-based learning and timetable guideline. In Chapter 2, we summarize the brief issues in web-based education, which give us more background information. In Chapter 3, we introduce the automated timetabling, which also give some background in generating customized learning schedule for individual. In Chapter 4, we briefly introduce Virtual Campus, which is aimed to provide customized learning through the Internet. We also discuss the design consideration in implementation. In Chapter 5, we investigate the system architecture issue detailedly. We focus on system architecture in each functionality provided in Virtual Campus. In Chapter 6, we introduce the Web-based Learning Scheduler (WL-Scheduler), which used in generating a conflictless timetable in Virtual Campus. In Chapter 7, we focus on another sub-system, Multimedia Web Presentation System (MWPS), which responses for the delivery of web-based learning material. In Chapter 8, we show a partial screen shot of student to illustrate some functionality in Virtual Campus. We conclude our work in Chapter 9.

Chapter 2

Web-based Education

> "95% of people think that learning about new thing boosts their confidence. [3] "
>
> "Seven in ten adults (71%) think that learning can lead to a better quality of life. [29] "
>
> "93% of people believe that it's never too late to learn and 83% believe that learning will become more important in the next millennium. [40]"

In this Information Age, learning opportunities span a lifetime - from childhood to adulthood. Constant refreshing our skills and knowledge to keep up with new technologies and trends as well as effective obtaining and applying the right knowledge and information, becomes a key competing advantage. Hence, life-long learning becomes unquestionable significant.

The Internet is not only an incredible resource that allows learners to explore information, but also can be alternative learning environment besides traditional schooling to delivery education. Moreover, web-based learning eliminates the barriers of time and distance as well as creating universal, learning-on-demand opportunities for public.

2.1 Impact on Traditional Learning

In the human history, besides the paper and printing technology, information technologies (IT) might have created the most significant impacts [4] [23]. Among all the IT, Internet and WWW technologies probably have the highest potential in pushing the paradigm shift in education [50].

The growing participation of Online-learning systems speeds up the popularity of web-based education. There are numerous advantages for delivering instruction through the Web. List some of them for references:

- High Interactivity;
- Highly massive accessibility;
- Workspace orientation, putting workplace aside;
- All-around ability of multimedia presentation;
- Efficient distribution and updates of information.

Obviously, the increasing popular Internet usage brings us not only a new way of information assimilation but also a change in the social structure of mankind. How to apply the Internet and WWW technologies to support teaching and learning is one of the most frequently and widely discussed topics over the Internet, newspapers and conference.

Alavi et al. [2] suggest that computer-mediated collaborative learning is superior to the traditional modes of learning because it facilitates active learning and construction of knowledge. Similarly, Leidner and Jarvenpas [41] point out that technology can be used to transform education and to re-examine the efficacy of the traditional modes of delivery of educational material, which are bounded by termporal and spatial constraints. They further suggest that technology can influence the pace and content of learning, as well as the purpose of instruction.

In summary, the emerging research shows that computer-mediated learning environment has great potential in facilitation of collaborative learning, in promotion of the learners' autonomy in controlling their own learning pace, and in enhancement of the instruction design.

2.2 Theoretical Perspectives on Teaching and Learning

Gagne [44] gave a precise definition of learning which address the fundamental theory of learning.

> "A process of which man and the animals are capable. It typically involves interaction with the external environment (or with a representation of this interaction, stored in the learner's memory). Learning is inferred when a change or modification in behavior occurs that persists over relatively long periods during the life of the individual."

The Chair of the National Advisory Group on Continuing Education and Lifelong Learning, Professor Bob Fryer gave a modern definition for the 21st Century. [24]

> "Learning is a process of active engagement with experience. It is what people do when they want to make sense of the world. It may involve an increase in skills, knowledge, understanding, values and the capacity to reflect. Effective learning leads to change, development and a desire to learn more."

In other words, learning is an interactive, dynamic, and active feedback process with imagination driving action in exploring and interacting with an external environment [51].

> "Every learning environment has an implied method of information presentation. Learning activities are based on a belief of how students best learn. [22]"

As technologies are applied to educational field, we briefly introduce two out-standing theories out of many philosophical doctrines: behaviorist and constructivist theories of instruction and learning. Moreover, we take a look on collaborative learning in Internet.

2.2.1 Behaviorism Versus Constructivism

Traditional classroom instruction can be viewed as a strong application of behaviorist theory. The theory believes the behavior of the organism (the student) can be shaped to achieve desired changes (learning). Behaviorists believe the accumulation of knowledge is preparing the student for predicted future needs as well as view the teacher as the manipulator of the environment. Therefore the role of teacher regards as the source of information. Consequently, behavioral objectives are identified, lessons are planned, instruction is delivered, guided practice is provided, retention and transfer of learning activities is encouraged, and testing the information taught is the standard means of assessment.

In direct contrast to the behaviorist viewpoint is the perspective espoused by constructivists, who view education as inseparable from ordinary life. Through developmental exploration and play, students choose learning activities related to individual interests. The students discover rules and concepts during the course of interactions in an environment that learning how to think. The teacher learns along with the students and becomes a guide, a facilitator, and a supportive partner in this educational process. Education is considered to be a guided

Bahaviorist	Constructivist
Teacher-centered	Learner-centered
Teacher as expert	Teacher as member of learning community
Teacher as dispenser of information	Teacher as coach, mentor, and facilitator
Learning as a solitary activity	Learing as a social, collaborative endeavor
Assessment primarily through testing	Assessment interwoven with teaching
Emphasis on "covering" the material	Emphasis on discovering and constructing knowledge
Emphasis on short-term memorization	Emphasis on application and understanding
Strict adherence to fixed curriculum	Pursuit of student questions highly valued

Table 2.1: Comparison of behaviorist and constructivist perspectives

tour of preparatory experiences in which students' practice making decisions by simulating real-world situations. The teacher becomes the facilitator of education by selecting the experiences that offer the appropriate practice to the students. In this way students construct their own knowledge and gain skills that will be needed in a future environment.

In short, constructivism encourages the learner to pose a problem and then solve it, while behaviorism sees the role of the teacher or other external source to pose the problem to be solved. Table 2.1 summaries the difference between behaviorist and constructivist perspectives.

Implication for Learning-Environment Design

Winn [76] suggests that traditional instruction design is only good for improving automatic performance. To attain genuine comprehension, students are required to construct their own knowledge. He further proposes a consturctivist's design framework:

1. Use 'empty technologies', technologies that are not designed with any particular content or instruction method in mind such as the hypermedia systems. The design shell provides support for flexible navigation and sharing;

2. Create interfaces that should be user customized, consistent and as transparent to the students.

Moreover, Knuth and Cunningham [39] identified three dimensions of learning environment which can be well supported, namely, information, processes and reflexivity. Knowing how to learn is more important than knowing what to learn.

2.2.2 Categorization of Individual, Group and Collaborative Learning

Individual learning is an personal process in which students work individually at their own level and rate toward an academic goal. In contract, group or collaborative learning is an interpersonal process in which students work together cooperatively to complete a problem-solving task designed to promote learning.

Individual learning

Learners are self-study the referencing relevant examples and readings. The learning efficiency strongly depends on the ability of the learner. He may need more time to understanding a new area if he gets a good reference; otherwise he has a chance to misunderstand the concept or idea.

The main advantages are low cost and high personal flexibility. Learners can learn different things in their own free time and own specific ways.

Group learning

In the daily-classroom learning, teacher and students form a large group, communicating in a real time manner. And teacher always leads the class, so this kind of learning named as teacher-centered education. In the same way, small learning group will be formed when the students are working in the project discussion and opinion exchanging. Though the peer interaction, students have a chance to learn how to be a leader, understanding how to give satisfactory responses and pinpoint feedback to others.

The major advantage of group learning is the directed communication, as members are face-to-face talking to each other. In this way, teachers can heed the tiredness and distractions from the students and alter the teaching pace and contents to comfort them [75]. However, this two-way feedback interaction costs relatively high transaction and opportunities costs, as both parties need to overcome the geographically distribution by mean of transportation. Although applying electronic conferencing facilities can save much transportation time and cost, it still cost relatively high operational expense [19].

Collaborative learning

Comparing to group learning, the teacher's role is no more the process controller but an active participant in the learning process instead. Knowledge is not something that is "delivered" to students. On the contrary, it is something that emerges from active dialogue among those who seek to understand and apply concepts and techniques [31].

The main advantages are comparatively more favorable to students. As Alavi et al [2] point out, ample evidences have shown that collaborative learning is superior than the traditional modes of learning (e.g. individual or competitive learning situations) in terms of learning achievement, student satisfaction with the learning process and outcomes, and quality of interpersonal relationships and the emotional climate. However, it needs extra effort to make the collaborative learning environment complete. Simply placing individuals in groups and telling them to work together as reminded by Johnson & Johnson [35], does not in and of itself promote productivity. For example, the group size must be small, each of the member should have some prerequisite social skill, a great deal of effort is needed to maintain the group's dynamics, to access each member's work and to monitor the overall progress.

Implication for Learning-Environment Design

Web-based Education can be a hybrid of the above learning types, as well as the web-based learning environment takes cyberspace in stead of classroom. Adopting the highly flexibility and interpersonal relationship, learners grant freedom to adjust their own learning paces with clear direction and befitting assistance. This student-centered approach allows learners re-create the campus in home or anywhere.

Hence, the numerous studies of student needs are undergone [19]. The following areas are found that can be improved in the web-based educational environment:

- Pre-entry educational and vocational guidance
  Pre-test is given to each student to access their present level and re-schedule the materials for him/her. Another test will be given after some time to test the acceptability of the student, then may need to change the content of material or re-arrange it again to optimize the learning efficiency.
- Orientation into learning methods
  To enable students to gain the maximum from the variety of learning resources available
- Preparation and development in learning skills
  Enable students to become independent (autonomous) learners
- Monitoring and support of student progress
- Study planning with providing personal support throughout learning pro-

Type of organization	Providing services
Grass-roots volunteer efforts	• Blue Web'n Library [70] • Netday [34] • School.Net [63]
Academic institutions	• NovaNet of North Carolina State University [33] • The World Lecture Hall at University of Texas [10] • ElectronicCourse of The University of Connecticut [48] • The Virtual Collaborative University at The University of North Texas (UNT) [67] • Virtual Classroom at New Jersey Institute of Technology [31]
Commercial sectors	• The Virtual University [72]
Commercial products	• The FirstClass [12] • Misk.edu [55]

Table 2.2: Examples of research on Internet-Based Learning

cess

- Personal counseling
- Support for students with special requirements

2.3 On-line Eduation and Web-based Learning System

As mentioned before, many learning institutes in North America and Asia apply technology to support education in the new era (more examples showen in Table 2.2). Some of the results are promising. For example, through the use of a vitual classroom, researchers at New Jersey Institute of Technology have shown that computer communication is possible way of delivering effective teaching. In particular, the results of their empirical studies have pointed to the superiority

Component	Purpose
On-line lecture notes	providing with teaching material
Messages exchange	achieve communication and collaboration purposes
Discussion	enabling real-time chat or threaded discussions
Interactive quizzes and self-assessment	• determining the learning ability • real-time marked automatically
Course generation	• gathering material by content provider • allowing instructor to modify or re-sequence the material
Course management	having a database management system helping to organize the course materials
Student management	having a database management system helping to organize the student information

Table 2.3: The current components provided in Internet-based schooling

of the virtual classroom for well-motivated and well-prepared students provided that they have access to the necessary equipment [30].

In general, the trend of schooling operation provided by Internet-based learning system comprises of the components shown in table 2.3, which is adequate but not customized.

Moreover, many of these systems in Table 2.2 place much emphasis on the courseware production and the Graphical User Interface. In spite of providing fancy interface and abundant course materials in multimedia format for the on-line learners, they seldom provide customized learning guidance.

Feature	HTML	Java Applets	Scripts	Plugins
Dynamic Media	launch only	arbitrary control	launch only	arbitrary control
Interactivity with user	forms with server support	flexible within regions	forms on client side, with some event handling	flexible within regions
Generate HTML on the fly	no	no	yes	no
Complexity	moderate	traditional programming	moderate	building a plugin is quite complex, authoring plugin data can be done at a high level

Table 2.4: A comparison of WWW authoring technologies

2.4 Technologies used in Web-based Learning

The web browser is the basic tool for interactive access and display of data from worldwide sources in Internet. A brief comparison [78] of WWW authoring technologies is summarized in table 2.4.

The primary language for authoring on the Web is HyperText Markup Language[1] (HTML) [73]. HTML is text-oriented language, and supports two dimensional layout specification (e.g. the layout of still images).

An authoring technology which is widely available on the WWW is scripting. The scripting languages can integrate easily with HTML forms, and most form-based processing is done with scripts. Scripts are programs which can be distributed on web pages as source code and interpreted by the client side browser or resided on the server side and invoked by the client. For example, JavaScript [13]

[1]The detailed explanation is discussed in Appendix A.1.

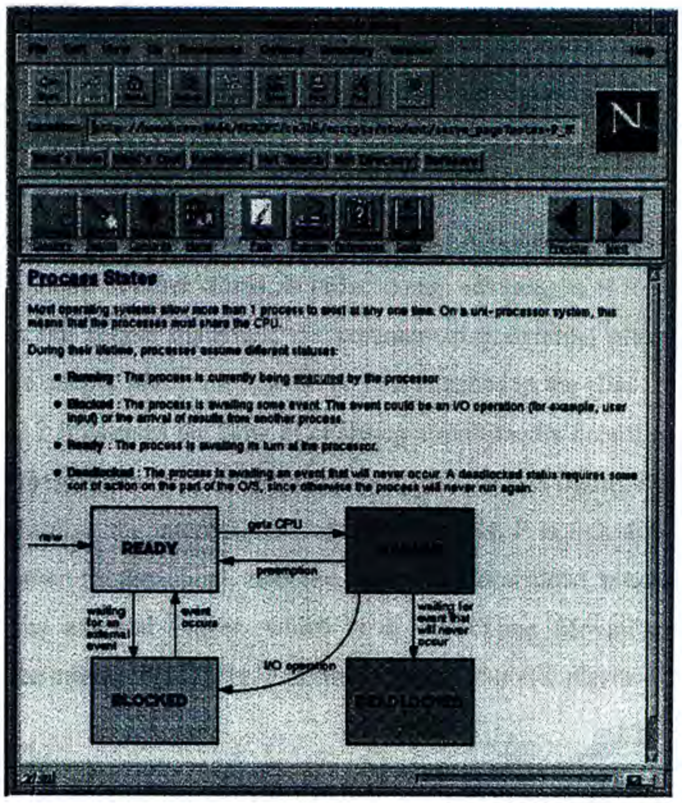

Figure 2.1: Example of Structural and Navigational Hypertext Courseware

provides full programming functionality to HTML from in a browser's environment. When CGI [69] script accepts a simple HTML form from the web client, and returns resulting page back to client.

The online coursewares using the above technologies to build, are called hypermedia presentation, which emphasize on presenting material structurally and navigationally [27]. Figure 2.1 shows an example which developed and adopted by the University of British Columbia in teaching operation systems.

Plugins are code libraries, dynamically linked to a WWW browser at runtime. The plugin API is intended to allow a WWW browser to support a new data format without requiring a modification or re-release of the browser itself. The browser recognizes a particular data format by its filename extension, and then passes the data along the plugin module for rendering. A helper application is an alternative to a plugin, in which the browser involves an independent application to render an unknown data format. In the case of helper applications, the

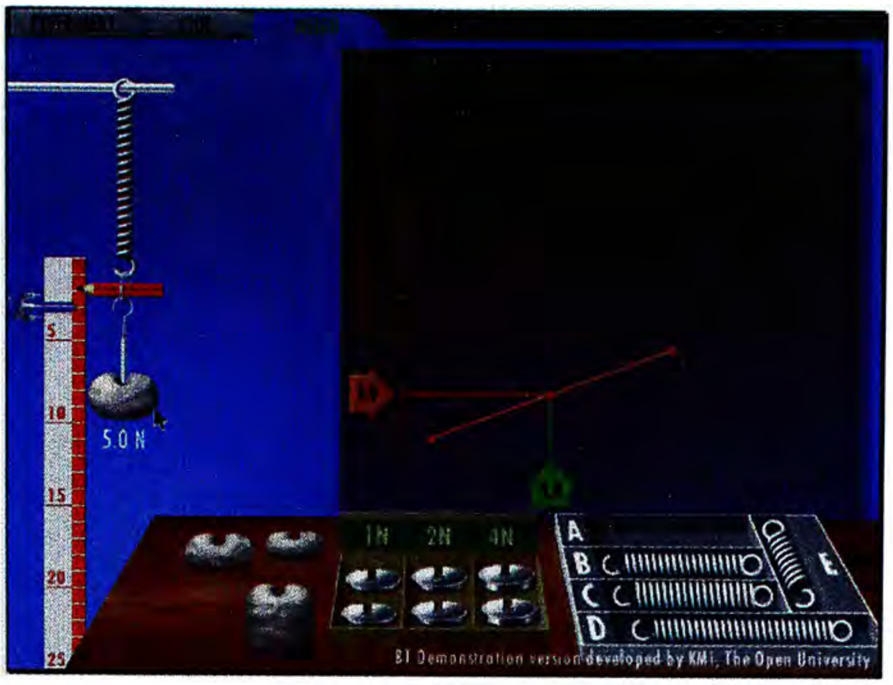

Figure 2.2: Final result of the experiment

rendering is always separate from the browser window, and thus is not integrated into the presentation of the rest of the web page. Some popular data formats for which plugin have already been built include: MPEG, AVI, MIDI, WAV, AU, TIFF, PDF, OLE/Active X and PowerPoint.

Notably, the Shockwave [45] plugin can render output files from Macromedia's popular multimedia authoring tools, Director and Authorware. Multimedia developers can therefore build presentation using these high level tools, and have the results be immediately accessible on the Internet. Figure 2.2 gives a snapshots of experiment mode of the Virtual Spring Collaborative Microworld (VSCM) [19]. First, it allows the children to create a table of observations by choosing a spring, adding different masses to it, and recording the extension and then plotting a graph. Finally it turns the plotted graphs of different springs to a newton-meter.

Java Applets are small programs written in a platform independent bytecode, which can be referenced by a WWW page. The client-side browser downloads and executes the applet upon accessing the page. It also can access local resources like

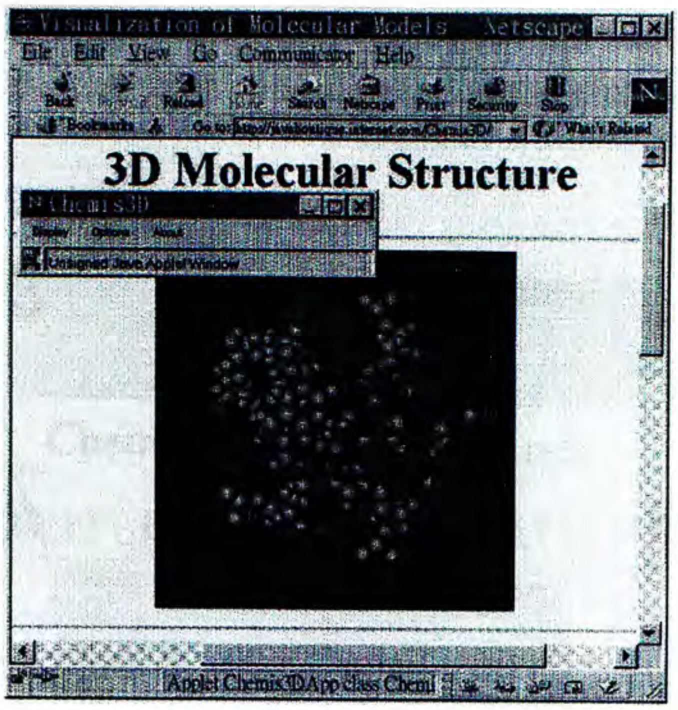

Figure 2.3: Standalone Java Applet for Visualization of Molecular Models

audio speakers, although security concerns limit the generality of the access. An example is shown in figure 2.3 which is the online 3D Visualization of Molecular Models and developed by Kaleicom Inc. [9].

Chapter 3

General Automated Timetabling

Personal timetable indicates a series of corresponding continuous learning activities for each learners in Virtual Campus, which is related to his/her interesting topics and based on his/her peculiar studying pace. This scheduling system can be viewed as an information system, which consist of gathering interesting subjects of students, available periods of teachers and students, generating conflict-less timetable for teachers and course, marking events in corresponding timetables, etc.

Particularly, generating conflict-less timetable is a kind of automated timetabling problem, which has been traditionally considered in the operational research field. Recently, it has been tackled with techniques belonging also to artificial intelligent (e.g. genetic algorithm, tabu search, simulated annealing, and constraint satisfaction). In this chapter, we survey some general formulation of the problem and various techniques and algorithms used to pursue solution.

3.1 Timtabling Problem

The timetabling problem consists of fixing a sequence of meetings between teachers and students in a prefixed period of time, satisfying a set of constraints of various types. Commonly, a manual solution of the time-tabling problem ususally requires several days of work. In addition, the solution obtained may be unsatisfactory as crushes may be obtained.

Hence, a large number of variants of the timetabling problem have been proposed in the literature since 1963 [28]. Basically, we classify the timetabling problems in three main classes [59]:

1. School timetabling
   The weekly scheduling for all the classes of a high school, avoidng teachers meeting two classes in the same time, and vice versa;
2. Course timetabling
   The weekly scheduling for all the lectures of a set of university courses, minimizing the overlaps of lectures of courses having common students;
3. Examination timetabling
   The scheduling for the exams of a set of university courses, avoiding to overlap exams of courses having common students, and spreading the exams for the students as much as possible.

However, such classification is not strict, in the sense that there are some specific problems that can fall in between two classes, and cannot be easily placed within the above classification. For example, the timetabling of a specific high school which gives large freedom to the student regarding the set of courses can be similar to a course timetabling problem.

3.2 Formulation and Solution Approaches

Based on difficult approaching, a timetabling problem can be formulated diversely. Table 3.1 shows three general formulating approaches.

Feature	Search Problem	Optimization Problem	Underlying Problem
Approach	Satisfying all constraints	Satisfying all the *hard* constraints and minimizes (or maximizes) a given objective function which embeds the *soft* constraints	Deciding if there exists a solution in the case of a seach problem, and deciding if there exist a solution with a given value of the objective function in the case of an optimization problem
Variants		Applying optimization techniques to a search problem	almost all variants are NP-complete and an exact solution is achievable only for small cases (e.g.less than 10 courses) [52]

Table 3.1: A comparison of formulating approaches

Most of the early techniques [60] were based on a simulation of the human way of solving the problem. This techniques, direct heuristics, were based on a successive augmentation (i.e. a partial timetable is extended, lecture by lecture, until all lectures have been scheduled). Later on, researchers started to apply general techniques to the problem. Numerous algorithm based on integer programming, network flow, and graph coloring used to tackle the problem. Recently, some approaches use AI search techniques, for example simulated annealing, tabu search, genetic algorithms and constraint satisfaction. Table 3.2 gives a brief partial literature surveys of automated time-tabling problem.

Moreover, discussion about completely auomation of time-tabling remains a controversial topic. The arugments are twofold: On one side, there are reasons that make one timetable better than another one that cannot easily be expressed in an automatic system [38] [7] [17] [77] [46]. On the other side, since the search space is usually huge, a human intervention may bias the search toward promissing directions that the stystem by itself may be not able to find.

Aurthor	Year	Previous Work
Schmidt and Strohlein [60]	1979	Provided an annotated bibliography including more than 200 entries, listing virtually all papers on the field appeared up to 1979
Junginger [36]	1986	Described the various software products implemented, and the underlying approaches, most of which are based on direct heuristics
de Werra [16]	1985	Stated the various problem in a formal way, provided different formulations for them, and described the most important approaches to the problem stressing the graph-theoretic ones
Carter [6]	1986	Surveyed the approaches to the examination timetable problem, mainly focused on the approaches based on the reduction to the graph coloring problems
Corne, Ross and Fang [11]	1994	Provided a survey of the application of genetic algorithms to timetabling and discussed future perspectives of such approach, and compares its results obtained so far with respect to some other approaches

Table 3.2: Previous Surveys

Chapter 4

Virtual Campus, Customized Web-based Learning Environment

Virtual Campus is an Internet application in education. It links up students, instructors and personal consultants by advanced network technology and transforms the computing power into a patient learning guide that proceed in an appropriate speed as necessary for each student. Students customize their study in their own pace as well as students begin taking more responsibility for their own learning, the pace of that learning will have a more natural rhythm dictated by the individual student's needs instead of a rigid schedule. In this chapter, we discuss the motivation and design considerations of Virtual Campus.

4.1 Changing Trend in Learning Process

As mentioned before, it is clearly shown that teaching and learning is changing drastically. Instruction-based learning pattern is being challenged. New learning paradigms are forming. A summary of the paradigm shift [8] in education is as follows:

- Educational focus is approaching to student-centered from teacher-centered;
- Teaching approach is shifting to facilitating students' autonomous and independent learning from lecturing monotonously;
- Learning style is adapting to active and collaborative learning from passive learning.

Although Constructivism seems to dominate the mainstream educational research, the school of instruction theory is more acceptable in real practice as it is easier to monitor. An effective and efficient education system highly depends on the maturity and the social-cultural background of the learners, the situation of the learning environment and the content of learning materials. It becomes more relevant if the individual learning activity can be customized.

Hence, we model an effective learning system, which is an integrated, flexible learning environment to provide a platform for the learners to have their self-pace learning, to communicate effectively with others and work collaboratively.

4.2 System Design Issue

Virtual Campus is designed with the general instruction design and constructive learning environment in mind, aiming to provide customized learning guide with simple-to-use interface to support the sharing of 'own-paced' interested learning material to the right person at any time.

First, teachers and students play different roles in learning activities via the Internet education. Obviously the behaviors of each roles have significant differences , compared with the traditional paradigm. These are shown in Table 4.1 and 4.2.

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Role	Changes	Expected behavior
Students	From passive to active	• State what they need and what they want • Decide which learning mode fits themselves • Encourage participation • Grant opportunities to select the interesting topics to study

Table 4.1: Changed behavior of students

Role	Changes	Expected behavior
Instructor	Instructor	• Present the material • Answer questions from the students about the material • Relatively less of a leading role • From "chalk-and-talk" role to "guide-on-the-side" role
	Personal Scheduler	• Analyze the learning pattern of each student • Give study advice to the student • Listen to the student • Personal consultant

Table 4.2: Changed behavior of Instructor

In order to reduce the load of an instructor, the role of instructor is split into two parts. The former acts as an usual teacher delivery basic knowlege in classroom. The latter acts as a personal scheduler to support each student individually. Some argue that Web-based educational applications are expected used by groups of users without the assistance of a human teacher. However education is an interactive and dynamic process. The role of human teacher is crucial and cannot be eliminated in the advanced information system.

Technically, Virtual Campus supports development of web-based multimedia lecture resource material, question and answer facilities between teachers and students.

For non-technical teachers, they can develop web-based multimedia resources without learning to master any programming language. These instructional lecture gives an introduction and basic concepts of particular subject, then students can explore more in the rich resourced Internet. With a private storing and public sharing URL-bookmark framework, people in Virtual Campus can easily share resources and experience collaboration.

Moreover, Virtual Campus supports both group and individual learning through the Internet. Learners can access their favorite learning activities, which can be understanding the lecture notes, playing back lecture video archives, taking self-tests or querying, through the communicative infra-structure.

	Components of Learning strategy		**Expected achievement**
	Choice of individual /group learning	$\Longrightarrow$	Depend on personal style (selection of synchronized/asynchronized lecturing mode)
+	Collaboration	$\Longrightarrow$	Learn to solve problems together (social interaction)
+	Customized learning progression	$\Longrightarrow$	Instructor/scheduler advises the pace (personal pace control)
+	Efficient personal support	$\Longrightarrow$	Establish closer relationship between an instructor and students
$\Longrightarrow$	**Delivery of the right knowledge to the right people at the right time**		

Table 4.3: New learning strategy

Secondly, customized learning strategy outlines the basic components considered in the design. There are totally four main components for delivering the right knowledge to the right people at the right time. This is shown in Table 4.3. We plug the basic ingredients into practice, which described in figure 4.1. Virtual Campus is building upon the Internet making use of the WWW technology. There are five sectors in Virtual Campus:

1. Individual Studying;
2. Instruction;
3. Construction;
4. Collaboration.
5. Customized Scheduling Guideline;

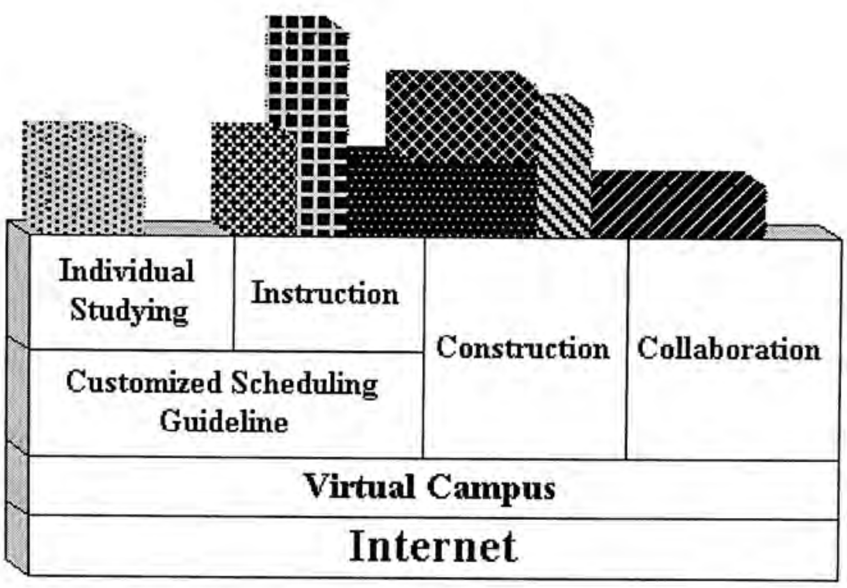

Figure 4.1: Virtual Campus System View

These sectors are categorized by the content and the presenting features of learning activities except Customized Scheduling Guideline. Different learning activities taking concurrently in Virtual Campus, blocks of different patterns placed above the sectors in figure 4.1, inherit the corresponding properties.

Sector of Instruction

- Organized learning materials with detailed navigation;
- Clear and distincitive presention of materials;

- Appropriate usage of meaningful images, sound and animation arouses interest and gain attention;
- With assessment instruments such as test or quiz to reinforce the learning outcome.

Sector of Construction

- Discussion forum, chat room or bulletin board as an example, fosters sharing atmosphere within the learning community;
- Tools and spaces for learners to construct their own learning environment;

Sector of Collaboration

- Collaborative work with common objectives for the learners so that the group learners able to share and work together;

Sector of Individual Learning

- Channels for seeking help from instructors;
- Clear and good-fit personal timetable gives a brief progress overview to learners as well as planning time to learning new and interesting things;

Sector of Customized Scheduling Guideline

This special personal guideline can be viewed as a reference showing the ongoing learning progression of each student. It is not an instruction, however it can be a tailor-fit scale for teacher and consultant following up particular student's learning enhancement. Moreover, It offers a clear orientation to students.

- Allow the learners to input their targeted subjects;
- A personal timetable shows the events clearly;
- Response to learners' feedback about the timetable as soon as possible;

Chapter 5

System Architecture Issue

In this chapter, we investigate the system architecture of Virtual Campus. Virtual Campus adopts the client-server model in functional-oriented design. Hence, we discuss the functionalities of the Campus one be one in the following sections.

5.1 Client-server Model

Client/server is a computational architecture that involves client processes requesting service from server processes [68]. The Internet is described as the client/server model as below:

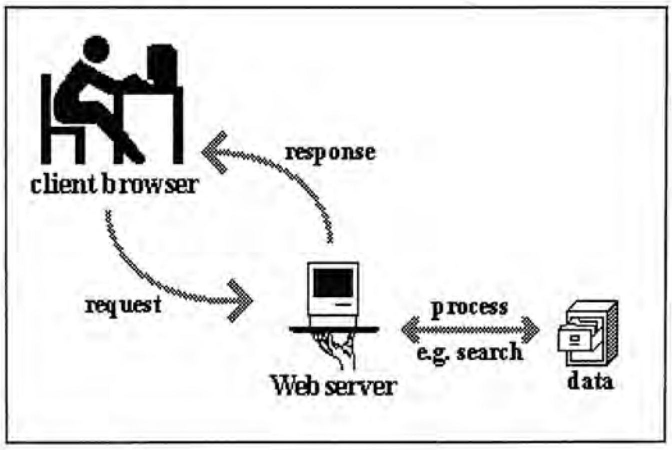

Figure 5.1: Simplified illustration of client/server model in Internet

1. The Server is a computer providing access to the data and supplies resource manifestations to the requestor, e.g. web server;
2. The Client is the software that allows users to access that data, which is capable of issuing requests and render responses containing web resource manifestations, e.g. client web browser;

The server and client are considered to be two different nodes in network. They are distributed geographically and the interaction between server and client shown in figure 5.1:

1. client sends a request for information to the server;
2. server receives the request and sends the information (data);
3. client then displays the data for the user.

In order to provide the above infomation delivery services and accessory services through Internet, the world-wide acceptance of a common transport (Transmission Control Protocol[1], TCP [54] [64]), server standard (HyperText Transfer Protocol[2], HTTP [74]), and markup language (HyperText Marking Language[3], HTML [73]) is unquestioned prerequisite.

Previously shown in figure 4.1, we mentioned that Virtual Campus shell is built upon the Internet. Clearly, Virtual Campus endeavors to deliver information to people for education purposes with a system architecture as client/server model making use of Internet technology. Figure 5.2 show the basic logical architecture of Virtual Campus. It has server / client sides: left hand side - "the schooling" / right hand side - individual student. For simplicity, all server-side components group together, but practically, they can also be distributed and communicated through the web.

[1,2,3] A brief introduction of Internet technology is discussed in Appendix A.1.

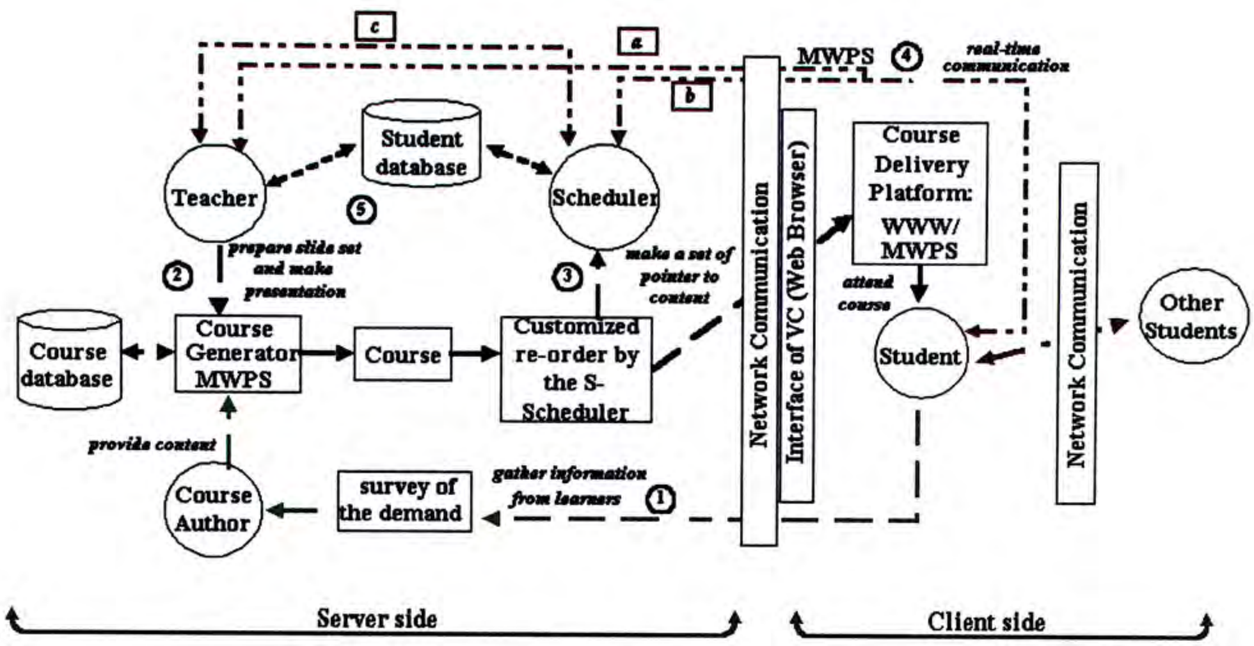

Figure 5.2: The Architecture of the Virtual Learning Environment

5.1.1 Server Side

There are several processes in the server side. They are marked in Figure 5.2 and described as follows:

1. Gathering of the course material based on the demand of students
   Learners pass learning requests to the server side, which are collected and analyzed by the course author before he/she prepares a new course material.

2. Course generation and storage
   After the contents are gathered, teachers convert them into a presentable form that is understandable and clear to students. Making use of MWPS, the teacher can deliver the lecture in a real-time mode (learners can attend the lecture just like in a traditional classroom and ask questions as usual) or in a playback mode (learners can replay the lecture at any time). A course database is used for the storage and retrieval of the course material.

3. Customized reorder of course material

A personal scheduler rearranges the order of the material in order to fit the pace of the learners depending on their learning ability and other factors. The scheduler sets the "content pointer" in each student profile and updates it periodically. The system will alert the scheduler to update the pointer before the student's next log-on.

4. Real-time communication

   (a) Interaction between learners and teachers
   Learners can use MWPS to ask questions in a real-time lecture. They can also use chatting facility to conduct a personal communication with the teacher individually.

   (b) Interaction between learners and the personal scheduler
   Learners communicate with their personal scheduler in chatting facility.

   (c) Interaction between teaches and the personal scheduler
   Teachers interact and collaborate with the scheduler, using chatting facility to for course activities.

5. Student profile storage
   A student database is used for the storage and retrieval of the student's information. Privacy and security are the two most important implementing issues to consider.

5.1.2 Client Side

In the client side, learners plan their study according to their personal time scheduling. They receive the course delivery through the Web. Whenever learners log-on the Virtual Learning Environment, they can attend the lectures, study their course notes, work on their assignment, chat with others, negotiate with the personal scheduler for their learning progress, and send queries to the teacher about the course material.

On the other hand, learners can communicate with other learners using chatting facilitate. They can work on group projects, perform collaboration, conduct brainstorming meetings, or simply chat informally. The flow in the client side highly depends on the preference of each learner.

5.2 Functional-oriented Design

Breaking down the above logical architecture, Virtual Campus is composed of four main functionalities, namely private functionality, lecture functionality, personal scheduling functionality and collaboration functionality, briefly shown in figure 5.3.

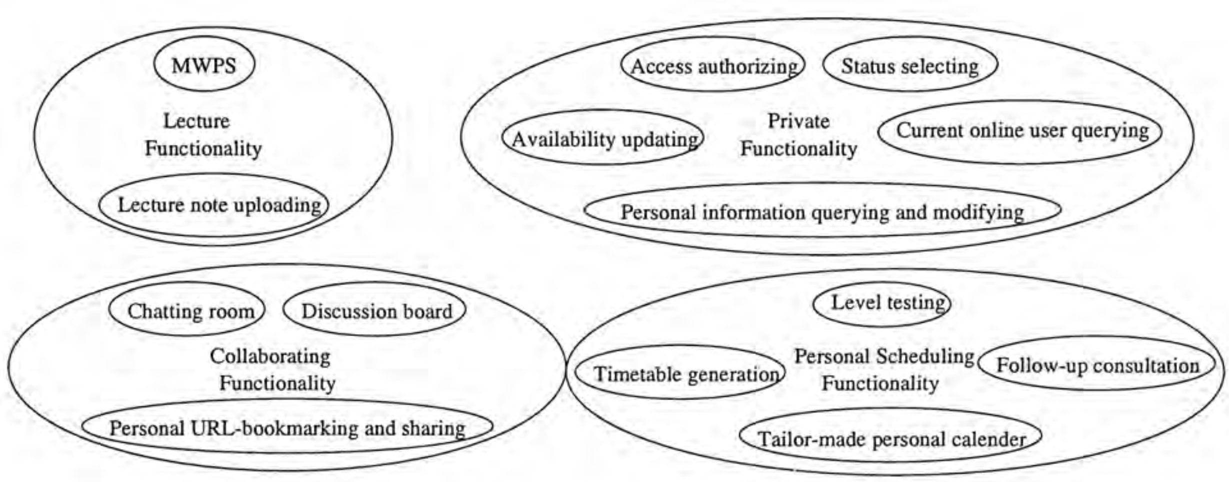

Figure 5.3: Overview of Functional Modules

1. Private functionality
    - Access authorizing - responsible for user identification;
    - Availability updating - responsible for keep checking the consistence of online learning activities for each user;

- Personal information querying and modifying - responsible for updating personal information of user and queried by other users;
- Status selecting - responsible for updating users' online status;
- Current online user querying - responsible for querying the online status of other users.

2. Lecture functionality
   - Multimedia Web Presentation System [43] (MWPS) - responsible for online/replayed lecture in order to let students attending a real time lecture and replaying the recorded lecture at anytime for customization purpose;
   - Lecture note uploading - responsible for storing the lecture material and allowing learners to access. The reading materials help the students to revise the course.
3. Personal scheduling functionality
   - Level testing - responsible for testing the learner's knowledge of particular subject;
   - Timetable Generation System (WL-Scheduler) - responsible for allocating resources appropriately, for exampe assigning teacher to class according to the availiablity of teachers;
   - Tailor-made personal calender - responsible for building personal calender for each learner;
   - Follow-up consultation - responsible for the changing learning parameter of the student by consultant.
4. Collaboration functionality
   - Chatting room - responsible for public and private chatting facilities;
   - Discussion board - responsible for sharing opinion on discussing topics;

- URL-bookmark keeping - responsible for keeping and sharing URL-address of interesting web site.

Obviously, Virtual Campus shell adoptes an approach of function-oriented design [65] in software design. The design is decomposed into a set of interacting units, and each unit has a clearly defined function. The above each function module is responsible for a set of providing services, which is detailedly discussed in the below sections.

5.3 Private Functionality Issue

5.3.1 Access Authorizing

Access Authorization is used to allow access to Virtual Campus only by those who have been given special loginID and changable passwords. Figure 5.4 shows the technical detail of the flow of loggin in/out process in Campus.

The login module restricts access to individual working area within Virtual Campus to individual user authenticated with passwords. While the users intend to login the Campus, the homepage asks them for a unique numeric login identity (loginID), changable password and belonged group information. If they enter a valid loginID, password and belonging group, they will be permitted access to their personal account. Otherwise the web server will prompt the corresponding error page back to the user. [1]

There are three data storage shown in figure 5.4, namely *Duser*, *Dlogin* and *Dout*. *Duser* stores all users' information, including english/chinese names, nick-name, password and other personal information. Virtual Campus has two main user groups: students and staff (shown in figure 5.5).

[1]An example of interaction between web server and web client is shown in Appendix A.3

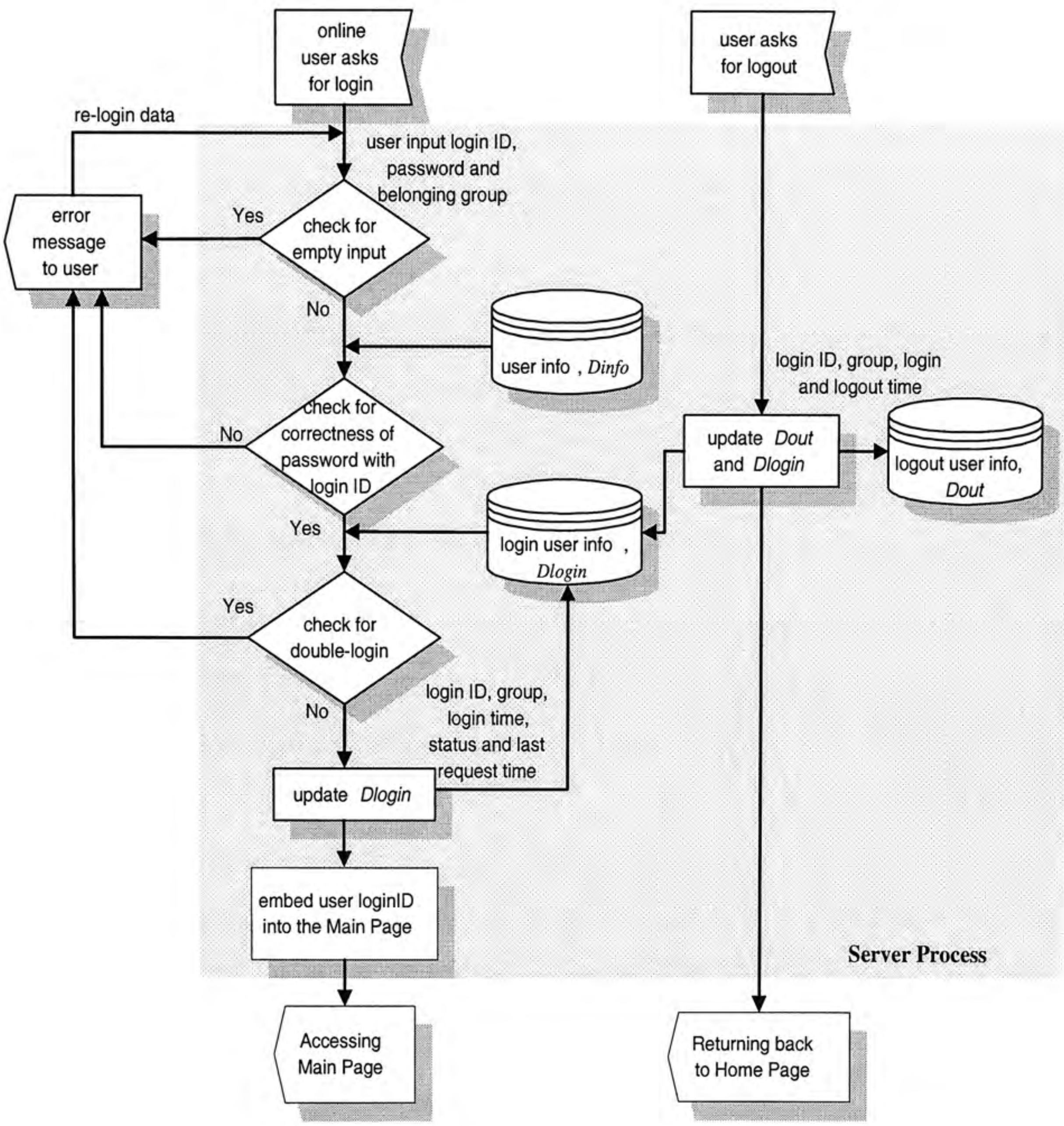

Figure 5.4: Flow of Login and Logout Process

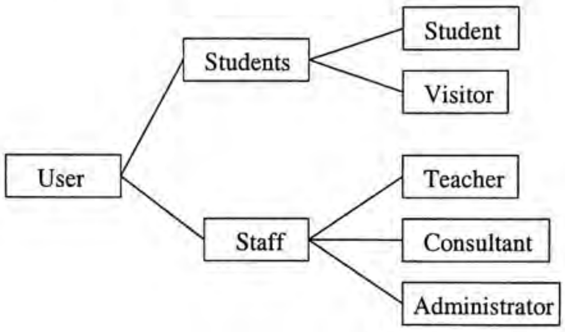

Figure 5.5: User Categories

User Categories

- A student is registered at the Virtual Campus. When he/she enrolls on a course through Virtual Campus, a tailor-fit study guideline will be prepared personally.

- A vistor does not participate in any concrete course in any way. This category is essentially for introducing purposes.

- Staff users are divided into four categories: teachers, consultants and administrators:

  1. Teachers produce the course content, then make use of the system to present it to students. There is at least one teacher assigned to each course. The teacher follows the progress of students, answer the questions posed by teh students and participates the discussion about the course. The teacher also grades the answers to assignment problems.

  2. Consultants follow up the learning progression of each student with particular subject, and switch the timetable that better suit the students.

  3. Administrator manages the system, for example, adds users and prepares disk spaces for new courses.

Dlogin stores the current login status of Virtual Campus, which is used for checking for double login and will be updated the current login details once successful login shown in figure 5.4. In the flow of logout module, the particular entry in *Dlogin* is moved to *Dout* ,which stores the logout status within the past 8 hours, while a user requests to logout.

5.3.2 Availability Updating

Because HTTP [74] protocol is stateless, the client/server connection is terminated once the required files are completely delivered. From the server's perspective, it is difficult to monitor users' availablities unless the user requests frequently. The server can not guarantee the online continuity of the user. In order to cope with this situation, the server observes the time between requests of each online user. If a user does not ask for any service within a lengthy time period (e.g. 2 hours), the server will assume this user has left the Campus, although the user has no request of exit. Figure 5.6 shows the working flow in server side.

In an attempt to distinguish and trace back each users, the client side browser will keeps a copy of the user identity (i.e. loginID), and resends it each time a page or service is requested. Those information is embedded in the request, which is shielded the details from the user. Once the user makes a request, the server will update the last request time of this user and move it in the beginning of the login list. This move tries to minimize the time to retrieve the recent data. As mentioned assumption before, the server will scan all users in the online list periodically so as to update the availiabilities of users.

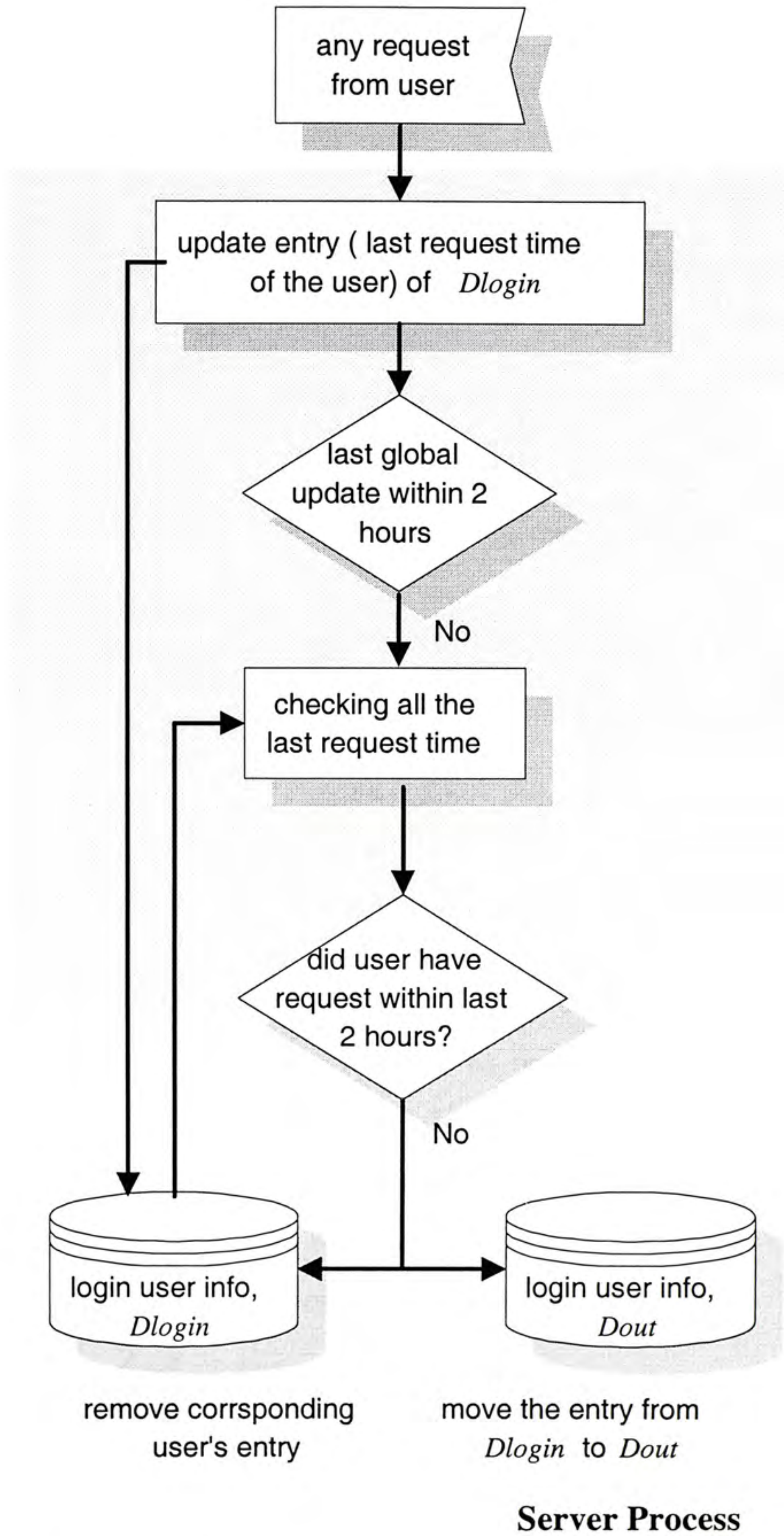

Figure 5.6: Flow of Monitoring the Users' Availabilities

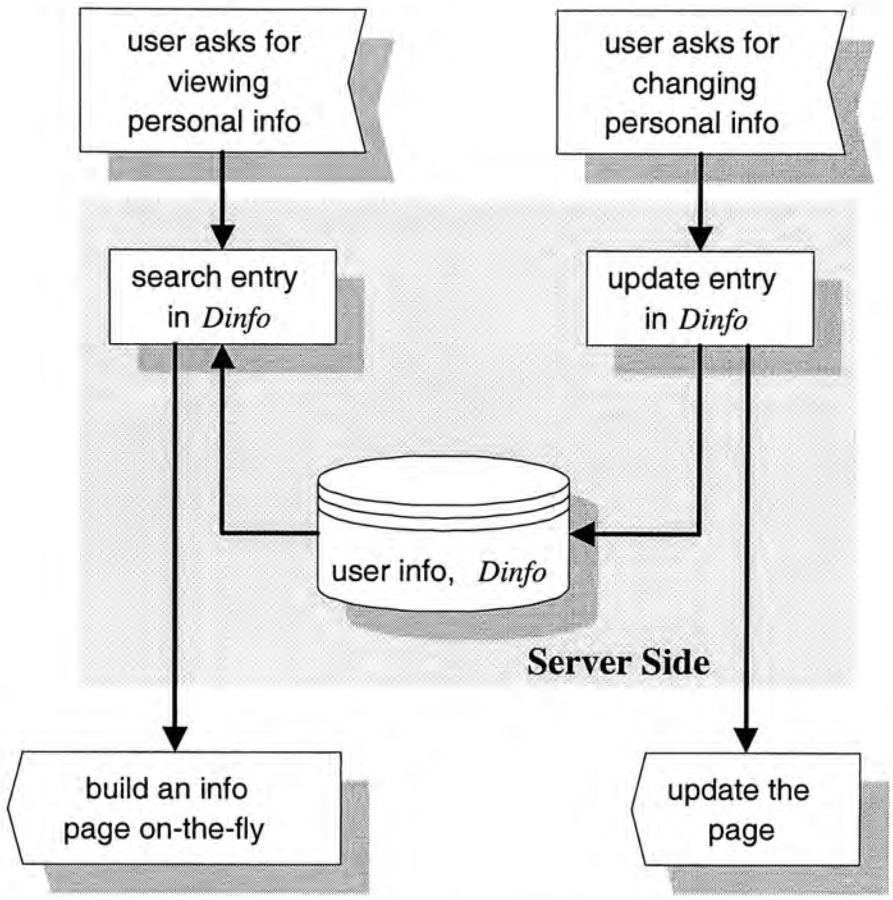

Figure 5.7: Flow of Querying and Modifying the Personal Information

5.3.3 Personal Information Querying and Modifying

Each users in Virtual Campus has a simple personal profile maintaining private information, which can be selectively shown to public. This profile contains some unchangable contents, including loginID and english/chinese name. Besides, users can have few modifications, for example nickname in chatting room and login password or leave a note to others. Figure 5.7 shows the information flow when other users pose the query of particular user.

5.3.4 Status Selecting

Every online users in the Campus has an "online" status which is indicated the user's current cyber-activating status. There are three status in selection, available to other (e.g. "I'm here"), not available to other (e.g. "Busy!") or hidden

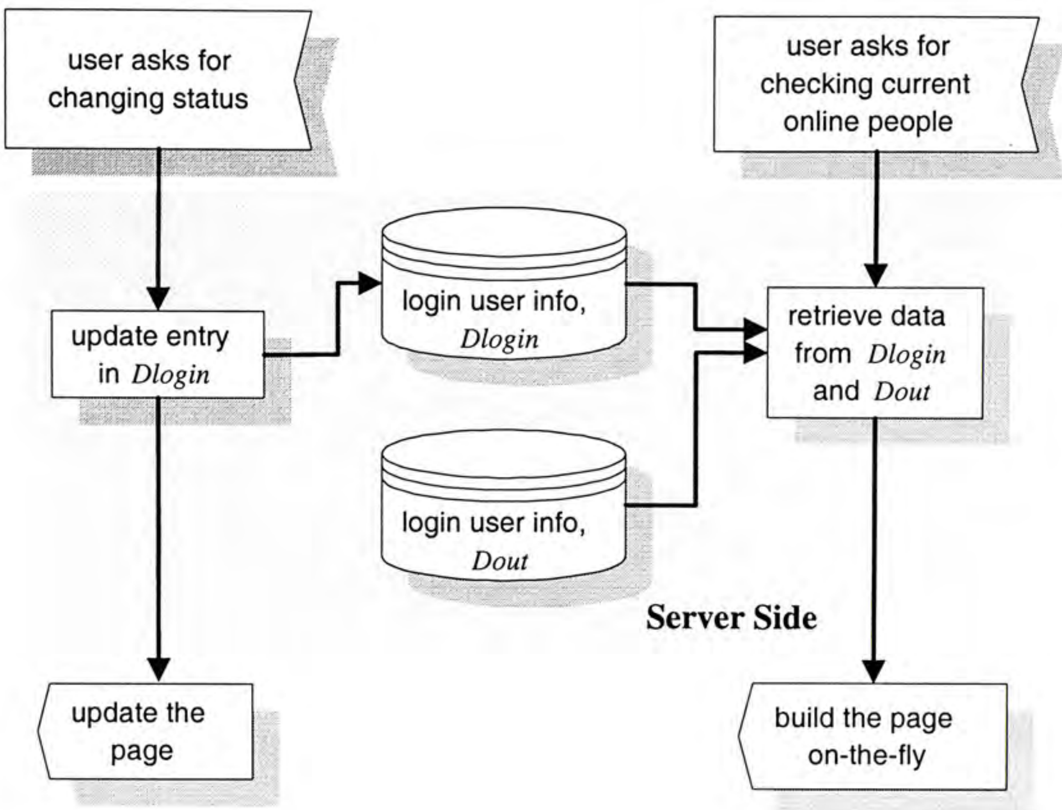

Figure 5.8: Flow of Selecting and Querying of Online Status

from other (e.g. "Invisible"). Once a user enters the Campus, an "available" status is automically granted to him/her. Later on, he/she can freely change it based on his/her perference. Left-hand side of figure 5.8 shows a simple flow of the modification.

5.3.5 Current Online User Querying

This functionality enables other users to locate a target person in Campus. The query will list out all current users in Campus execpt those status selected to be invisible. Moreover, the list will state out those left the Campus within the past 8 hours, so as to let the finder notice the absence. The right-hand side of the figure 5.8 briefly presents the working flow of this module.

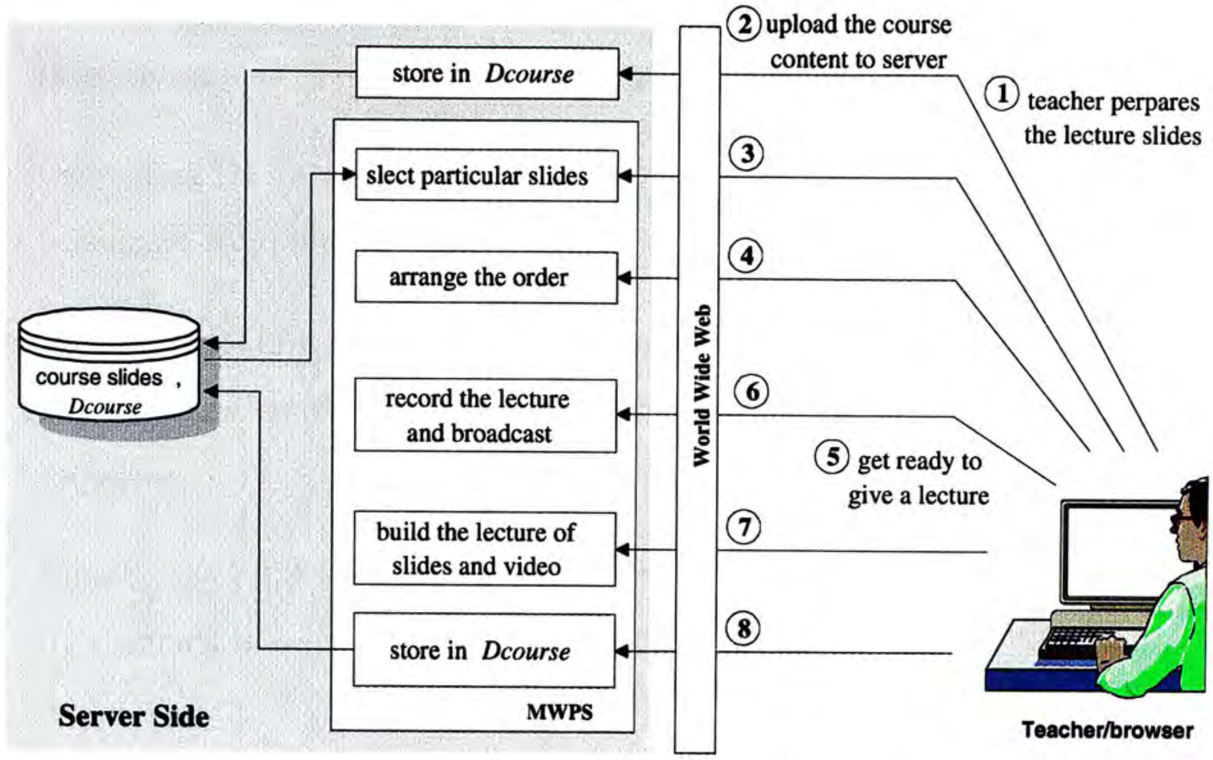

Figure 5.9: Flow of Lecture Producing

5.4 Lecture Functionality Issue

There are two main modules contructing lectures in Virtual Campus, namely lecture note uploading and MWPS [43]. Figure 5.9 shows steps of preparing lectures by teachers. The left hand side gives a brief stucture of the related processes in server to delivery a course. Assume the teacher remotely login the Campus to maintain an online course, and the flow to conduct an online lecture is as follow:

1. The teacher first checks his teaching schedule[2], then prepares course material (e.g. lecture slide) for the class beforehand;
2. After that, teacher uploads the course material to server for storage;
3. Teacher remotely selects the required slides for a particular lecture. Through the MWPS, teacher can re-use any lecture slides in advance preparation;

[2]Please refer to Section 5.5 for detailed discussion of personal timetabling

4. In order to broadcasted lecture remotely, a simple video camera is necessitated as well as MWPS client configuration with Real Encoder [57];
5. Once start the recording, the streming data will be sent to the server, then broadcast to public[3];
6. When the lecture is finished, MWPS server will build the lecture so as to integrate the content slides and captured video together in the controlled sequence;
7. Finally, the built lecture will be stored in the disk and able to be accessed by students in anytime.

5.5 Personal Scheduling Functionality Issue

This functionality provides an adjustable studying plans for each student objectively. Each student has her own set of scheduled studying material and activities. The sequences of the online course materials are designed to fit personal studying pace. In this way, the student will not waste her time learning irrelevant or already-known material. Similarly, the student will not be provided with too advanced material difficult for her to learn.

In attempt to provide customized learning schedule, estimation of student's ability on particular interest places in an important position. Module of Level Testing sticks to this direction and explores a way to achieve the aim. The components grouped with the same grey color shown in the right portion of figure 5.10 explain the information and control flow between server, teacher and student.

Student

[3] Please refer to Section 7 for detailed description of MWPS operations

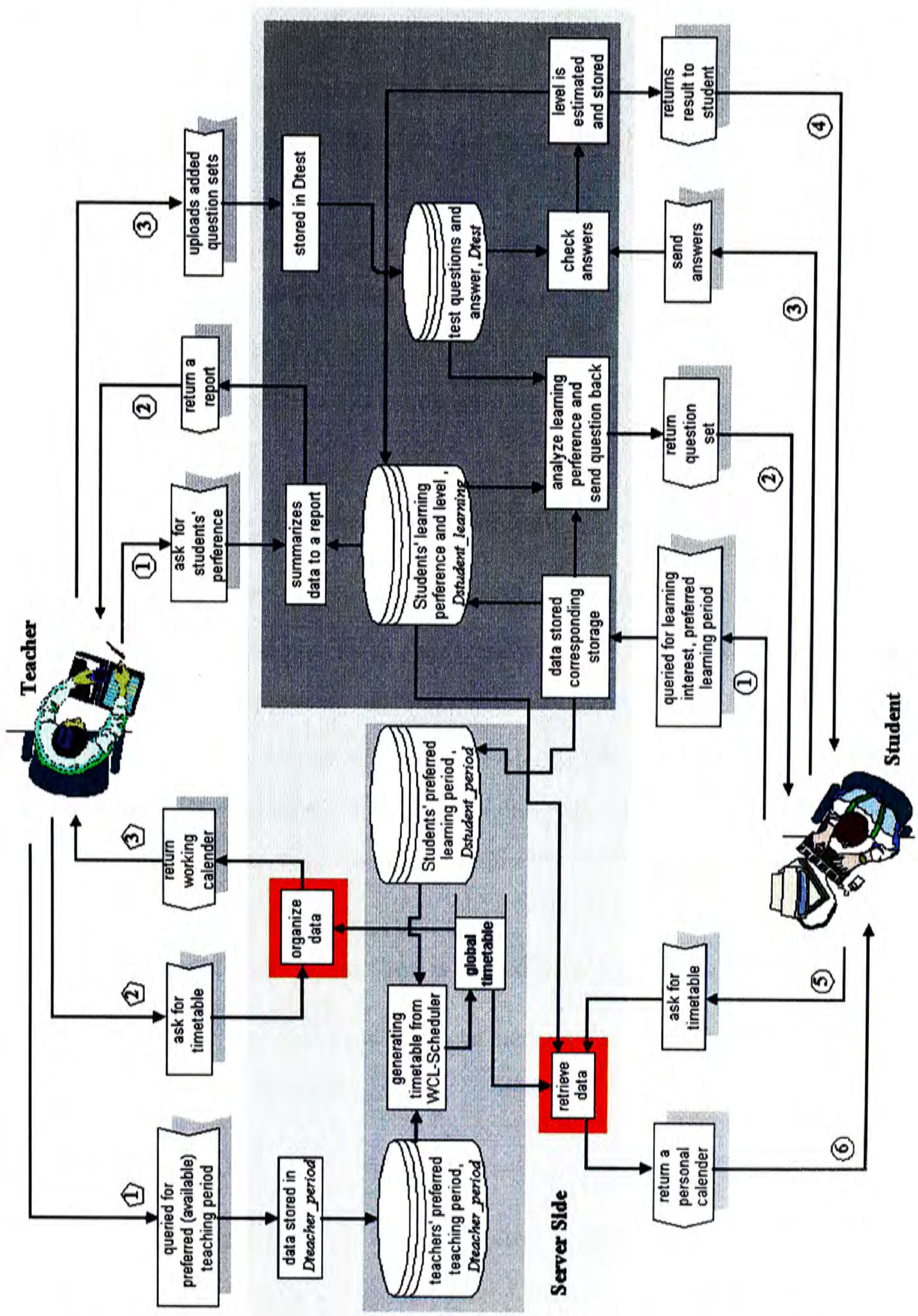

Figure 5.10: Flow of Scheduling Customized Learning Process

1. (a) Student is queried for his/her learning interest and preferred learning period;
   (b) Once the server receives the data, it will store them separately (e.g. the former stores in *Dstudent_learning*, and the latter stores in *Dstudent_period*);
   (c) Then the server invokes a module to analyze the learning preference and randomly select a set of questions in selected subjects from data storage, *Dtest*;
   (Note: assume there is some sample question sets available in the datastore.)
2. The question set is sent back to the student;
3. (a) The client browser sends back the finished question set to server;
   (b) The server then checks the answers with the suggested answer model of particular question in *Dtest*;
   (c) Based on the test result, the knowledge level in particular learning interest is estimated. This level is determined by the correctness percentage of the test, and the parameter is configured by teachers in advance;
   (d) The above information then is stored in *Dstudent_learning*;
4. Contemporarily, the test result is returned to the student so as to he/she can also verify the answers.

Teacher

1. (a) Teacher asks the server for an updated summary of students' learning preference;
   (b) Then the server retrieves the data from *Dstudent_learning* and organizes it to a periodical report;

2. The report is sent back to the teacher;

3. (a) Based on the demand of particular subject, teacher designs the question set to evaluate the understanding level of the student;

   (b) The teacher then uploads the questions to the server;

   (c) Finally, the question set is stored in *Dtest.*

On the other hand, seeking a way to generate a conflict-less global timetable and delivery the required learning schedule to the right person are also significant in providing customized learning environment. Hence, other two modules, Timetable Generation System (WL-Scheduler) and Delivery of tailor-made personal studying calender are forused on the area. They are shown in the left side of figure 5.10. The components grouped within the lighter grey area are belonged to the module of WL-Scheduler, and other two components within the darker one are belonged in delivering the timetable.

Teacher

1. (a) Teacher is queried for his/her preferred available teaching period;

   (b) This data then is stored in *Dteacher_period*;

   (c) A process of generating periodic timetable of WL-Scheduler is invoked by the server;

   (d) The scheduler retrieves the data in *Dteacher_period* and *Dstudent_period* and allocating the teaching resources in a conflict-free manner, then stored it in data storage **global timetable**; and produces a conflict-free allocation of the teaching resources

2. (a) Perpetually, teacher asks the server for the working timetable so as to follow the time slot to carry out online lecture;

   (b) The server retrieves the corresponding information for this teacher, organize it and plug them in a timetable;

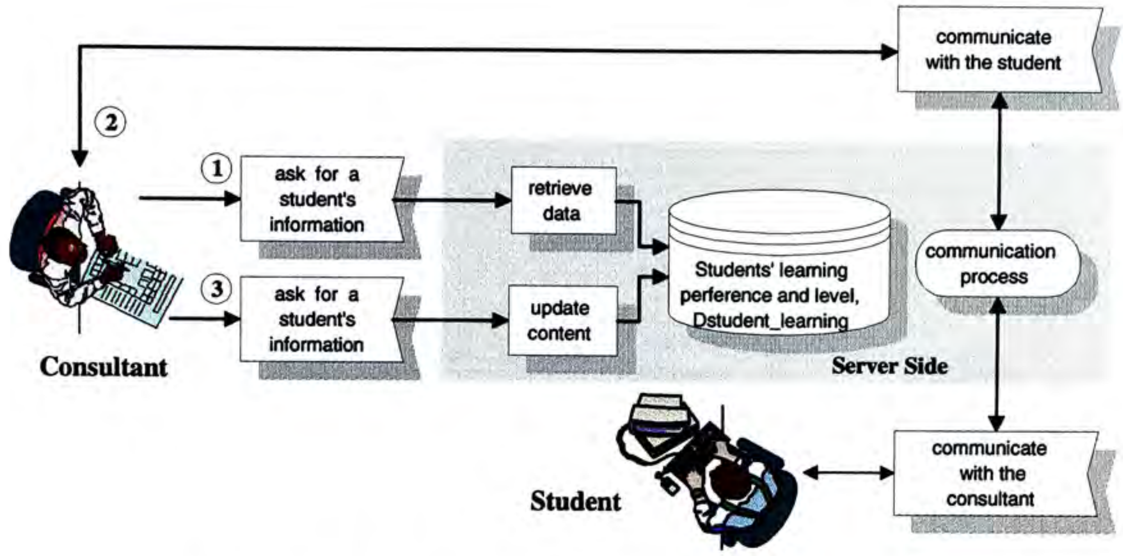

Figure 5.11: Flow of Follow-up Process

3. Teacher receives his/her timetable.

Student

(Note: the time sequence in student's operation is continued)

5. (a) Similarily, student asks the server for the updated perpetual learning timetable so as to have a target time intention on learning progres;
   (b) The server retrieves the corresponding information for this student, organize it and plug them in a timetable. The timetable is unique for each learner according to their learning pace of particular interest;
6. Student receives his/her customized learning timetable.

Finally, each student's studying progress is follow-up by a consultant so as to give sufficient personal assistance for the student. If the student find any learning difficulty, for example the learning material is too difficult for him, he can ask the consultant to adjust the learning parameter in his profile, so the coming learning schedule will be adjusted appropriately. Figure 5.11 shows the steps of following up the student's learning progress.

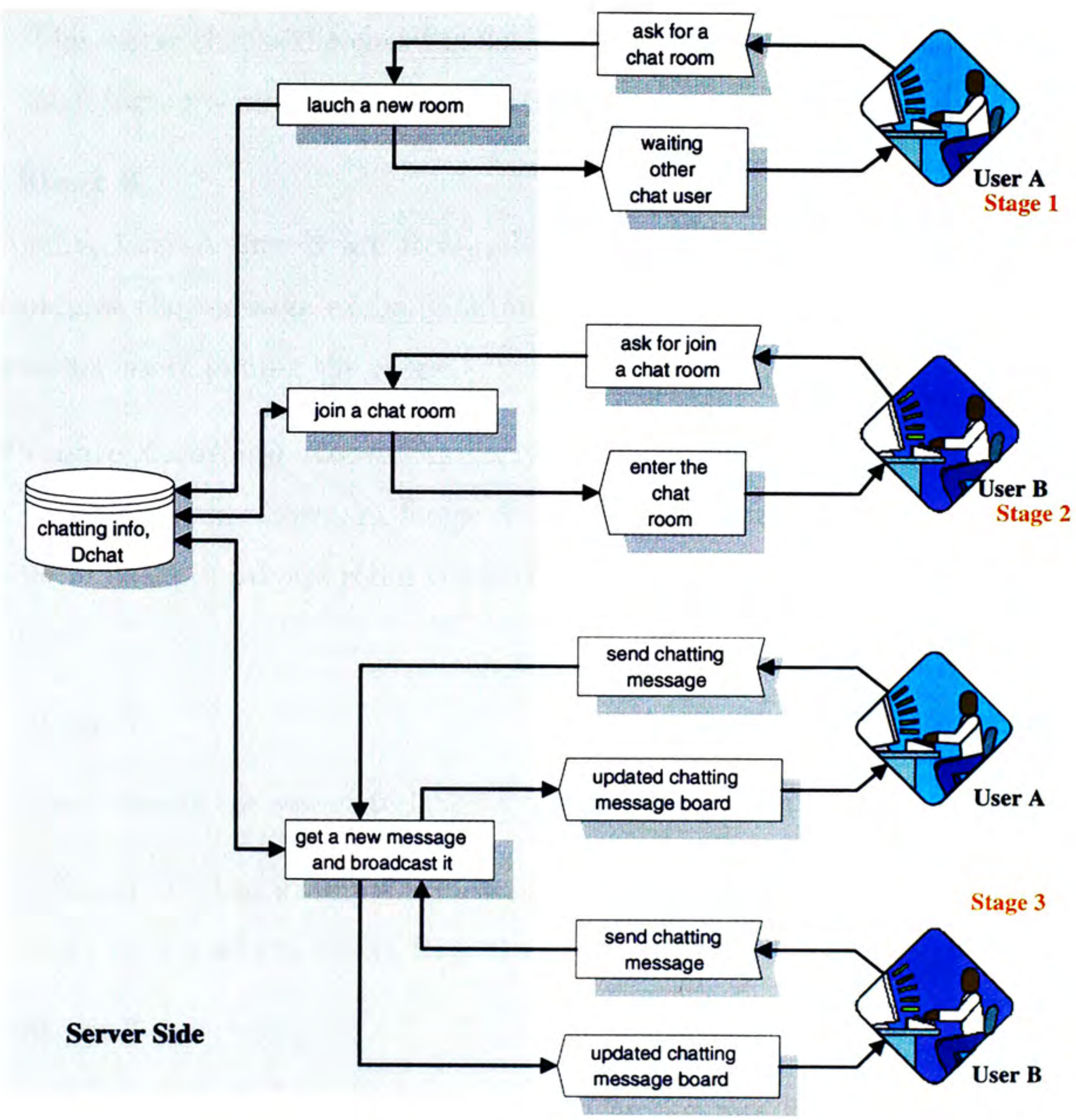

Figure 5.12: Flow in Public Chatting Room

3. User A enters the room and waits other to join.

Stage 2.

1. Meanwhile, User B wants to chat with User A, then he ask the server for joining chat room;

2. The server checks the chatting list, then lets User B to enter the room, and save the current state of this chatting room;

Stage 3.

Finally, User A and B are freely chatting through the web and the server manipulates the message exchanging and keeps the state of the room so as to allow other users joining the room.

Private Chatting Room Similarly, there are five stages in lauching a private chatting room shown in figure 5.13. Compare to the public room, the number of users in private room is restricted to two so as to achieve the private purpose.

Stage 1.

1. User A asks the server to lauch a new chatting room for private talk;

2. The server then prompts a message to User A that it will notify him/her later as it needs to locate User B's status;

Stage 2.

1. Currently, User B is available in the Campus and request the server for service;

2. The server checks whether User B is inivited to have a private chat or not;

3. Once locating User B, the server prompts an inviting request to User B stating that User A wants to have a private talk;

Stage 3.

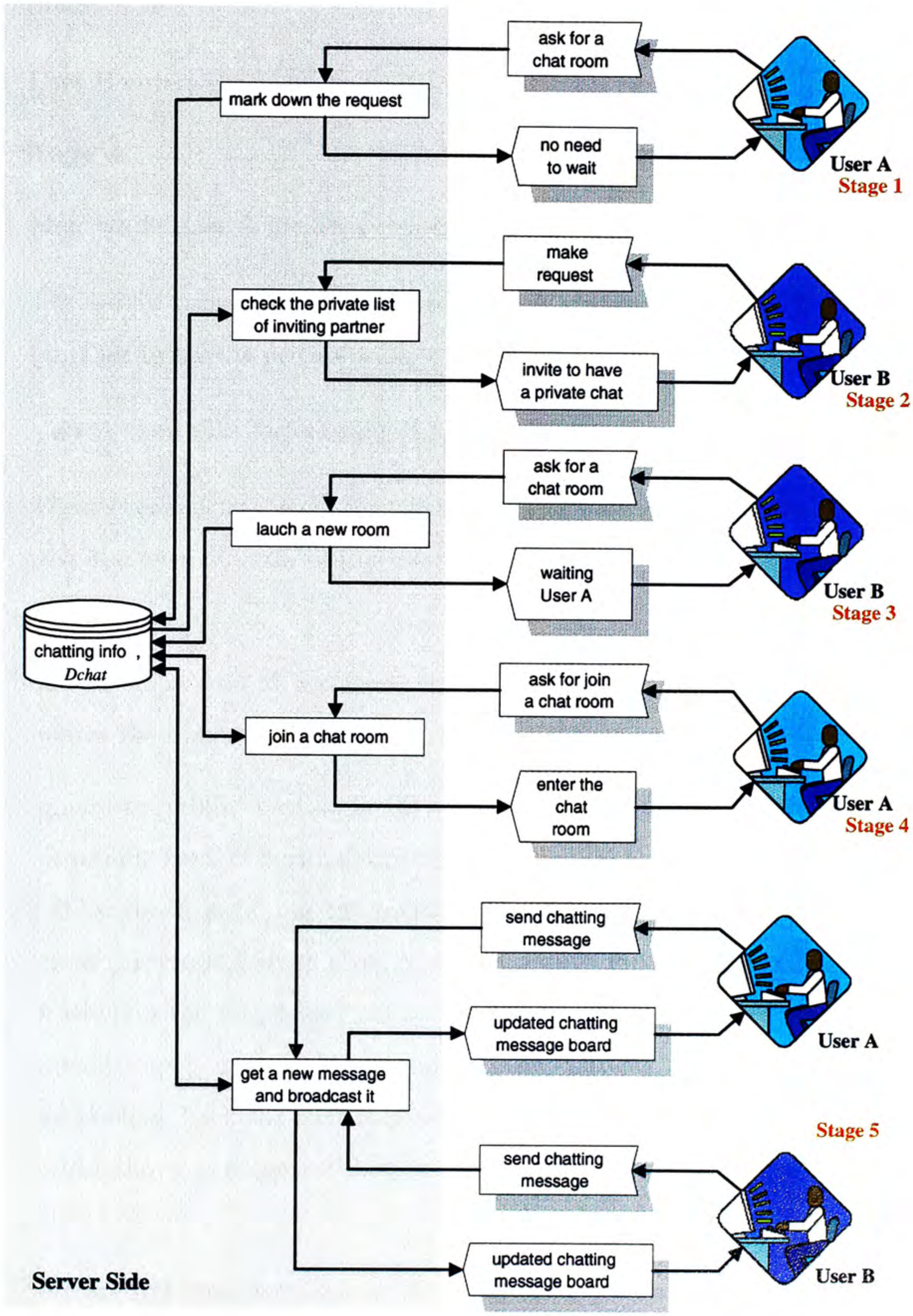

Figure 5.13: Flow in Private Chatting Room

1. If User B accepts the chatting request, he/she then lauchs a new room and marks it in *Dchat*;

2. User B enters the room to wait User A;

Stage 4.

1. Meanwhile User A makes a request, then the server locates User A;

2. The server prompts a message to User A stating that User B is waiting him/her to have a private talk;

3. User A then asks for entering the room;

4. The server checks the chatting list, then lets User A to enter the room, and save the current state of this chatting room;

Stage 5.

Finally, User A and B are freely chatting through the web and the server manipulates the message exchanging.

Compare to public chatting facility, the server has to handle a more complicated situation. Lack of permanant connection between the server and each user causes difficulty in notifying the invited chatting target to join a private talk. In order to carry out private chat, Virtual Campus initiates a monitor to keep track of whether the target user has online or not. Moreover, there is a case that the targeted user is unavailable to respond the chatting request. The monitor then has to chase back the chat-requesting user and notifying him the situation. Figure 5.14 shows the control flow in server to monitor the targeted chatting user.

There are five considerations in the monitoring process, for example User A asks for a private chat with User B:

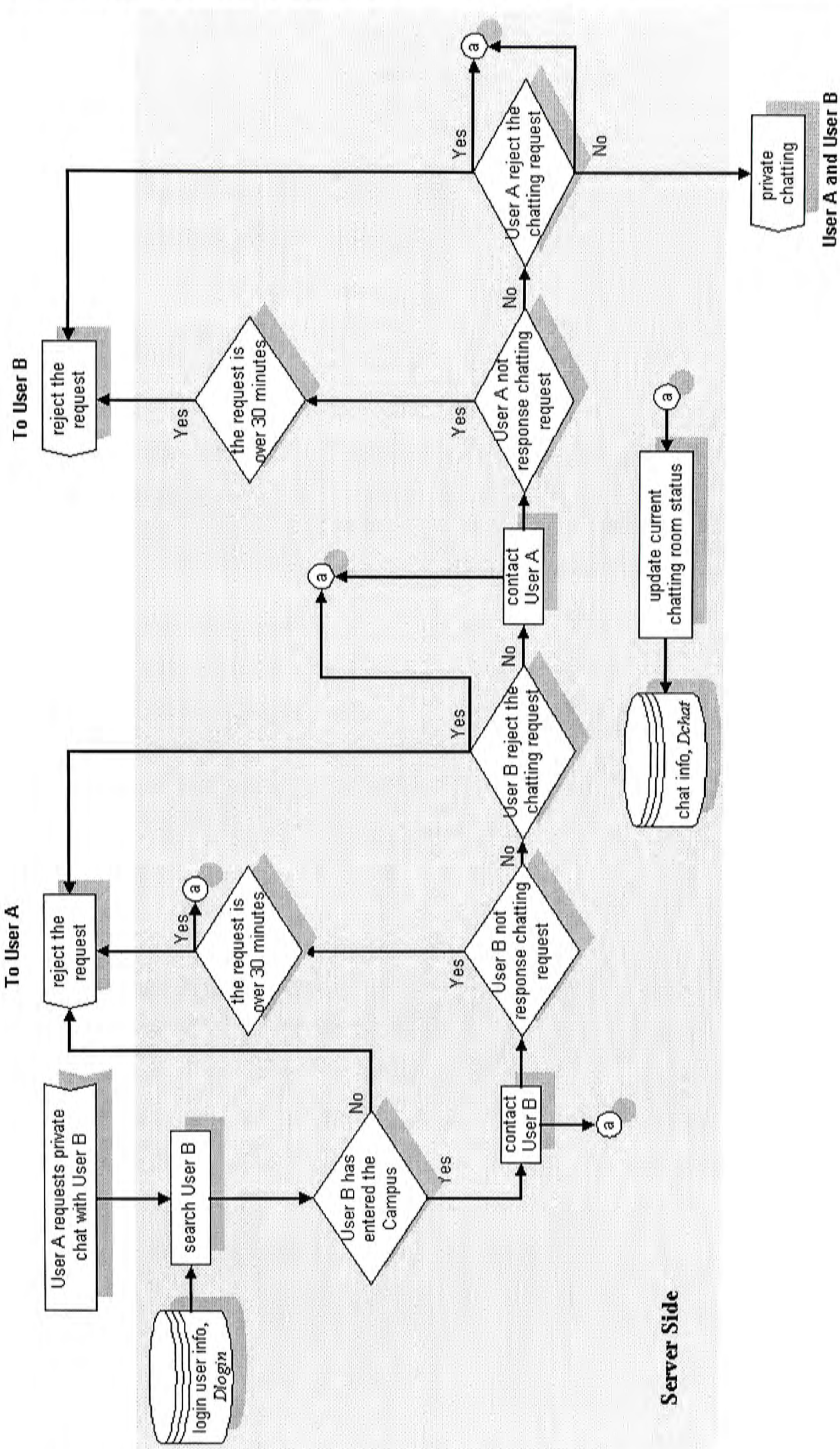

Figure 5.14: Flow in Monitoring Targeted Chatting Partner

- Checking whether User B's status is login to the Campus or not;
  Response: Sending a rejest message to User A stating that User B is not available right now as he/she is off campus.

- Checking whether the User B ignores a prompted chatting request which is passed over 30 minutes or not;
  Response: Sending a reject message to User A stating that User B has no response on the request.

- Checking whether User B rejects the request or not;
  Response: Sending a reject message to User A stating that User B has rejected the request;

- Checking whether User A ignores the waiting message which is passed over 30 minutes or not;
  Response: Sending a reject message to User B stating that User A has no response on the joining request.

- Checking whether User A rejects the request or not;
  Response: Sending a reject message to User B stating that User A is not available right now and has rejected the request;

5.6.2 Discussion Board

A discussion board is an online "bulletin board" where the user can leave and expect to see responses to messages he/she has left. This bulletin board service is invented for the purpose of exchanging opinion, although users can just read the board. The above Chatting facility can be viewed as a kind of real time discussion board. Figure 5.15 gives a brief flow in the process of discussion board. The left hand side describes the situation when users ask for checking the board and the right hand side explain how users post a new message.

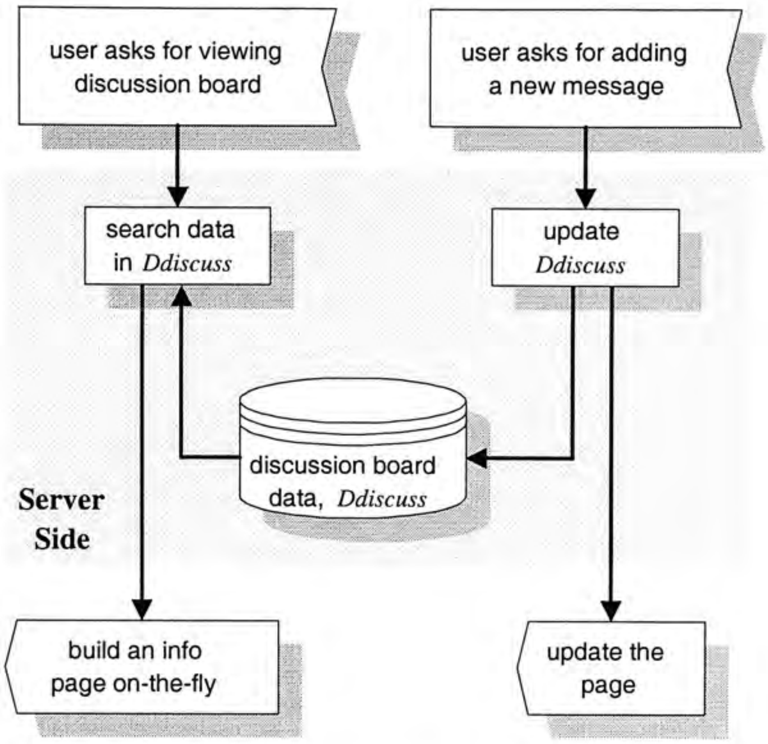

Figure 5.15: Flow of Discussion Board Manipulating

5.6.3 Personal URL-bookmark Keeping and Sharing

In attempt to encourage an effective collaboration via the Internet, Virtual Campus provides an URL-bookmarking and sharing facilities. Users can store their favorite URL-bookmarks so as to access the web resources convenience in Campus. Moreover, users can specify some bookmarks sharing to public. Figure 5.16 shows the simple flow of the process.

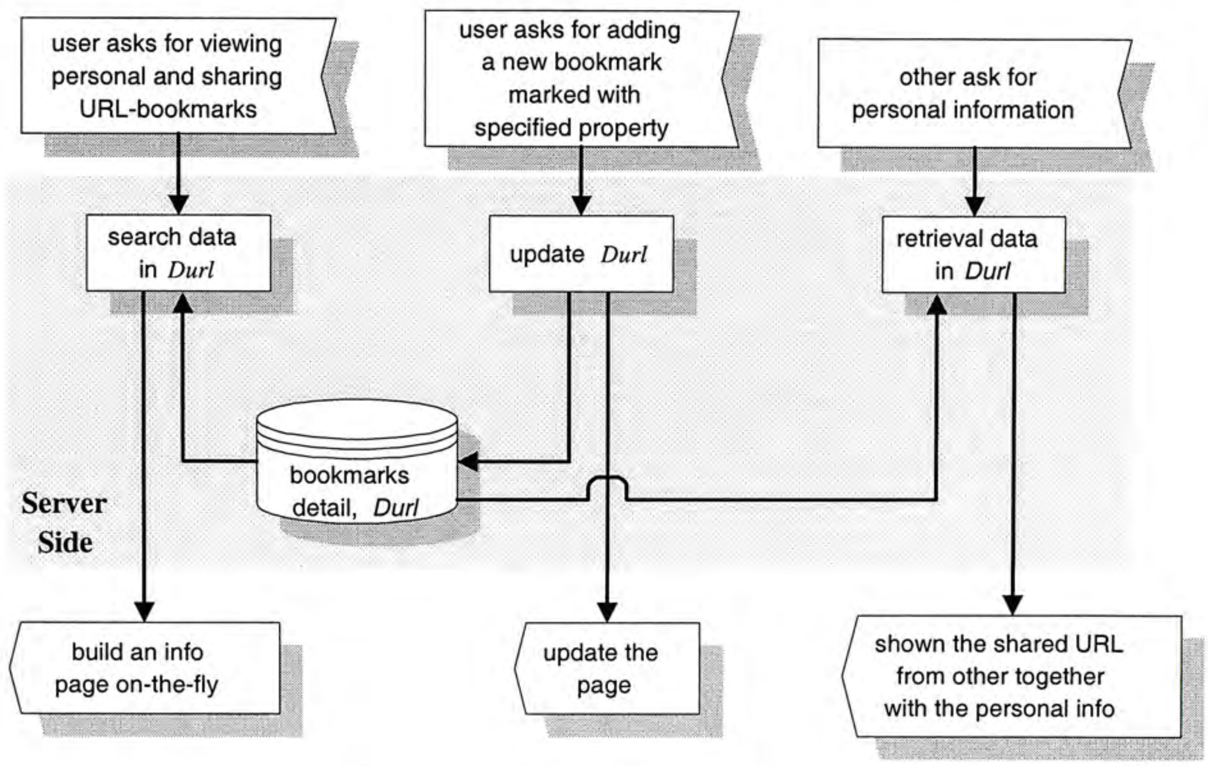

Figure 5.16: Flow of URL-bookmarking related process

Chapter 6

Web-based Learning Scheduler (WL-Scheduler)

Basically, customized learning aims to adjust the studying plans for each student personally. Each student has his/her own set of scheduled studying material and activities and the sequences of the online course materials are re-ordered to fit personal studying pace. In this way, the student will not waste her time learning irrelevant or already-known material. Similarly, the student will not be provided with too advanced material difficult for his/her to learn.

Web-based Learning Scheduler (WL-Scheduler) is a tool to produce a weekly scheduling for all the on-line lectures to period in such a way that no teacher is involved in more than one lecture at a time, and other constraints are satisified. In this chapter, we discuss the problem formulation, solution approach, algorithm used and evaluating methodology.

6.1 Web-based Customized Timetabling Problem, WCTP

Suppose Virtual Campus has S students $\{s_1, s_2, \ldots, s_m\}$ and E classes $\{e_1, e_2, \ldots, e_n\}$ (ie. E subjects) which have to be timetabled over D days with P periods $\{p_1, p_2, \ldots, p_q\}$ per day with T teachers $\{t_1, t_2, \ldots, t_p\}$.

A nonnegative integer matrix R with $\|R\| = n \times p$[1] where n is the number of classes and p is the number of teachers. R is called requirements matrix, with each entry r_{ij} is the number of lectures that teacher t_j must give to class e_i, for i is the index of class and j is the index of teacher.

Because the learning material is delivered throught the web, we assume each subject has only one class, and there is no limit in class size. Moreover, each subject is teached by one pre-assigned teacher. However, there can be a special case that one teacher simultaneously teaches two online classes on an overlapped topics because no restriction in room size in Internet in stead of reality.

The status of each teacher is taken into account by introducing a binary matrices BT with $\|BT\| = p \times q$[2], where p is the number of teachers and q is the number of periods, such that each entry:

$bt_{jk} = 1$ if teacher t_j is available at period k;

$bt_{jk} = 0$ if teacher t_j is unavailable at period k.

f each class is taken into account by introducing a binary matrices C with $\|C\| = n \times q$[3], where n is the number of classes and q is the number of periods, such that each entry:

$c_{ik} = 1$ if class e_i is available at period k;

$c_{ik} = 0$ if class e_i is unavailable at period k.

[1,2,3] Assume ||name_of_matrix|| = Size of matrix

The mathematical formulation of the problem is the following [36] [21] [16]:

WCTP find x_{ijk} $(i = 1 \dots n;\ j = 1 \dots p;\ k = 1 \dots q)$

s.t.

$$\sum_{k=1}^{q} x_{ijk} = r_{ij}\ (i = 1 \dots n;\ j = 1 \dots p) \tag{6.1}$$

$$\sum_{i=1}^{n} x_{ijk} \leq bt_{jk}\ (j = 1 \dots p;\ k = 1 \dots q) \tag{6.2}$$

$$\sum_{j=1}^{p} x_{ijk} \leq c_{ik}\ (i = 1 \dots n;\ k = 1 \dots q) \tag{6.3}$$

$$x_{ijk} = 0 \text{ or } 1\ (i = 1 \dots n;\ j = 1 \dots p;\ k = 1 \dots q) \tag{6.4}$$

Constraint (6.1) ensure that each teacher gives the right number of lectures to each class. In attempt to take into account the possibility that a teacher (or a class) is unavailable at a given time in real instances, Constraint(6.2) (resp. Constraint(6.3)) ensure that each teacher (resp. class) is involved in at most one lecture for each available period.

The WCTP has been shown NP-complete by Even et al. [21] through a reduction from 3-SAT [25]. The problem WCTP is a search problem, whose solution is any feasible timetable. Obviously, we would like to find the optimal one in all feasible timetable solutions. We propose a way to find a set of feasible timetables (local optimal), then we have a systemic way to pick up the best one.

6.2 Solution Approach - Local Search

Local search techniques are a family of general-purpose techniques for the solution of optimization problem [1]. Consider an optimization problem, and let S be a possible search space for it. A function N, which depends on the structure of the specific problem, assigns to each feasible solution $s \in S$ its *neighborhood* $N(s) \subseteq S$. Each solution $s' \in N(s)$ is called a neighbor of s.

A local search technique, starting from an initial solution s_0 (which can be obtained with some other technique or generated at random), enters in a loop that navigates part of the search space, stepping iteratively from one solution to one of its neighors. The modification that transforms a solution into one of its neighbors is called a *move*.

The selection of the move to be performed at each step of the search is based on the *objective function f*, which assesses the quality of the solution.

Among the local search techniques, we have the steepest descent method (SD): It analyzes all possible moves and chooses the one that gives the best improvement. It accepts the candidate move only if it improves the value of the objective function, and it stops as soon as it reaches a local minimum.

The above method requires the exploration of the whold neighborhood. The randomized descent method (RD) instead analyzes a random neighbor and accepts it if it is better than the current one, otherwise the current solution is left unchanged and another neighbor is generated. It stops after a fixed number of iterations without improving the value of the objective function.

The randomized descent method is also trapped in the very first local minimum it gets. The randomized nonascendent method (RNA) instead accepts the random neighbor only if it is better or equall to the current. Its stop criterion is also based on a fixed number of iterations without improving the value of the objective function.

Allowing also for sideways moves, RNA has the feature of being able to follow descending paths thatpass through *plateaux* [62]. That is, if the search lands in a plateau, it is able to move inside the plateau itself, and might get down from it through a solution different from the one from which it reached the plateau.

The steepest nonascendent method (SNA) combines the search for the steepest move with the use of sideways moves. This method, and some variants of it, have been used, for example, for the SAT problem with the name GSAT [62] [61].

Local search techniques, giving the possibility to start the search from any timetable, easily allow for construction and maintenance of timetables. In fact, once a timetable has been generated, it can be used as the starting point for a new search after some constraints have been manually modified. This ability to work interactively is widely recognized as crucial for timetabling systems in the research community. To this respect, local search has a great advantage over other methods, such as constructive ones and genetic algorithms.

6.3 Algorithm for Approaching Feasible Timetables

Our objective function to maximize is the number of satisfacting constraints stated in section 6. Thus a feasible solution is a timetable that fulfills all the constraints. Figure 6.1 shows the methodology used to locate the best timetable and table 6.1 shows the meaning of symbols used.

Symbol	Description
$\|y\|$	number stored in y
$[1, \ldots, y]$	number range from 1 to y
y = {0,1}	y has either value 0 or 1

Table 6.1: Notation used in the algorithm 6.1

The algorithm has totally three stages:

1. Initializing Stage

   In this stage, a randomized starting timetable is generated based on the Constraint 6.1. It restricts the generation of timetable satisfying this constraint too.

Input: Three matrices R, BT, C (Refer to section 6.1)
Output: $x_{ijk} = \{0,1\}$
where i represents number of classes
j represents number of teachers
k represents number of periods

Algorithm 6.1 Generating timetable (x_{ijk})

Initializing stage - GetInitialSolution
initialize all entries of x_{ijk} to be 0
for each candidate $r_{ij} \in R$ do
    generate $|r_{ij}|$ different numbers $\{k_1, k_2, \ldots, k_{|r_{ij}|}\}$ in the range $[1, k]$
    for each $k_s \in \{k_1, k_2, \ldots, k_{|r_{ij}|}\}$
        $x_{ijk_s} := 1$
    end
end
Seaching stage - FindFeasibleSolution
count := 1
while (count $\leq$ 100) or (count $>$ 100 and feasible_list is empty)
    if ($\sum_{i=1}^{n} x_{ijk} > bt_{ik}$) or ($\sum_{j=1}^{p} x_{ijk} > c_{ik}$)
        add x_{ijk} in infeasible_list
    else
        add x_{ijk} in feasible_list
    end
    do
        randomly pick an entry $x_{i_s j_s k_s}$ in x_{ijk}
        randomly find a k_t such that $x_{i_s j_s k_t} \neq x_{i_s j_s k_s}$
        swap($x_{i_s j_s k_s}$,$x_{i_s j_s k_t}$)
    while $x_{ijk} \in feasible\_list$ or $x_{ijk} \in infeasible\_list$
    count := count + 1
end
Evaluating stage - PickTheBestTimeTable
pick x_{ijk} from feasible_list such that g(x_{ijk}) is the minimum

Figure 6.1: Generating Timetable Algorithm

   (a) Initialize all entries in timetable x_{ijk} to be 0;

   (b) Add 1 in the timetable x_{ijk} based on the requirement matrix, R, so as to a particular teacher must give pre-assigned number of lectures to a particular class;

2. Searching Stage

   In this stage, the search process explores the neighbours of current timetable seeking a better feasible solution.

   (a) Check whether the current timetable is satisfying the Constraint 6.2 and Constraint 6.3 stated in previous section in order to identify this current table is feasible or not;

   (b) Copy the current timetable to the appropriate storages (feasible and infeasible lists) for preventing future looping;

   (c) Randomly pick up an entry in x_{ijk}, and then swap this entry with another one with opposite value (i.e. if the picked entry is 1 then the other one must be 0, vice versa) in the same k-indexed row;

   (d) The above operations run repeatly and stop when

   case 1: At least one feasible solution obtained in 100 times of processes;

   case 2: If the operations repeat 100 times with no feasible solution, the processes will continue operate until find one feasible solution.

3. Evaluating Stage

   This stage responses to choose the best timetable from list of feasible solution. The main criteria of the candidates is giving the minimum value of evaluation function, g, which is described in the coming section 6.4.

6.4 Evaluating The Best Timetable

In attempt to choose the best timetable from a list of satisfying candidates generated from the above search problem. We define a function $g(x_{ijk})$ which gives a measure to a timetable for selecting the best one. The principle of our approach considered to look for the best timetable x^*_{ijk} is picking up the minimum value of g over all feasible timetables.

The criteria function g is composed of the student's learning interest and preferred learning period so as to minimize the case that student can not attend the live course which he/she interests to that topic.

Let us define:

The interested subjects of each students is taken into account by introducing a binary matrices SS with $\|SS\| = n \times m$ where n is the number of classes and m is the number of students, such that each entry:
$ss_{iy} = 0$ if student s_y have no interest in class (subject) i;
$ss_{iy} = 1$ if student s_y have an interest in class (subject) i.

The unavailability of each student is taken into account by introducing a binary matrices BS with $\|BS\| = m \times q$ where m is the number of students and q is the number of periods such that each entry:
$bs_{yk} = 0$ if student s_y is available at period k;
$bs_{yk} = 1$ if student s_y is unavailable at period k.

$EvaluationFunctionming(x_{ijk})$

$$g(x_{ijk}) = \sum_{y=1}^{m}(\sum_{i=1}^{n}(\sum_{k=1}^{q} ss_{iy}y_{ik}bs_{yk}))$$

where

$x_{ijk} \in feasible\_list$

$y_{ik} = \sum_{j=1}^{p} x_{ijk}(\text{for } i = 1 \ldots n; k = 1 \ldots q)$

Chapter 7

Multimedia Web Presentation System (MWPS)

Multimedia Web Presentation System (MWPS) [43] is a subsystem of Virtual Campus aiming in providing a virtual classroom environment in the Internet. During the on-line lecture, multimedia content and view graphs navigation sequence are recorded and delivered to students, which is similar as lauching a practical classroom in the Internet. This chapter will give a full image of this powerful web-based presentation system.

7.1 Overview

Multimedia Web Presentation System (MWPS) [43] is a Chinese version of NCSU Web Lecture System (WLS) [37], that supports construction, editing, and management of Web-based presentations, as well as synchronous and asynchronous capture and delivery of classes and lessons shown in figure 7.1.

The presentations consist of HTML documents with streaming synchronized audio and video. The video can be of the low-bandwidth variety or it can be based on MPEG-2. Low-bandwidth MWPS lesson can be received over ordinary

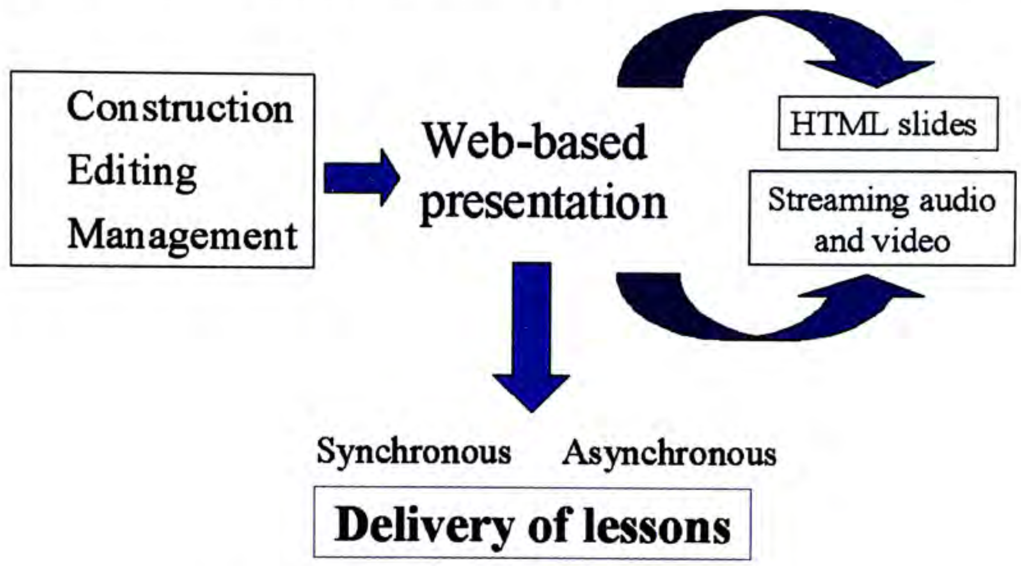

Figure 7.1: Overview of MWPS

modems and telephone lines. MWPS contains an on-line editor that allows instructors to prepare slides for delivery. The system captures audio and timing data during live presentations and automatically creates a Web-deliverable version of the presentation. All of the details of the underlying system are hidden from the users, including both instructors and students.

7.2 System Components

MWPS allows users to attend a on-line presentation using a standard Web browser, such as Netscape, and watch as well as listen to the accompanying streams via a RealSystem player. The attendants can raise question and give feedback to the presenter in the live presentation through this system. Practically, MWPS consists of three components, namely server machines, client machines and student machines.

Server machines: responsible for content stroage and request execution;

Client machines: responsible for generating new presentation for a lecture, so sometimes is called lecturer machines;

Student machines: simply an ordinary computer for accessing MWPS.

7.2.1 The MWPS Server Machine

The Server Machine is referred to a HTTP Server running the MWPS Server Program [74]. It contains a RealServer [56] for supporting the ReadMedia streaming and storage, which consists of component RealEncoder [57] for supporting RealServer [56].

7.2.2 The MWPS Client Machine

A Client Machine consists of a web browser and a MWPS Client program. The former one provides an application interface through the web, and the latter one in the form of browser plug-in together with RealEncoder [57] produces the multimedia audio/video content during presentation by capturing the multimedia content and presenting view graphs sequence.

7.2.3 The Student Machine

Student Machine is an ordinary computer with web browser and RealPlayer [58] for students to access the resources in MWPS.

7.3 Presentation Flow

As mentioned before, MWPS is an Internet Application built on top of the web environment. It allows instructors/lecturers conducting presentation/lectures to those students through the Internet using web browser.

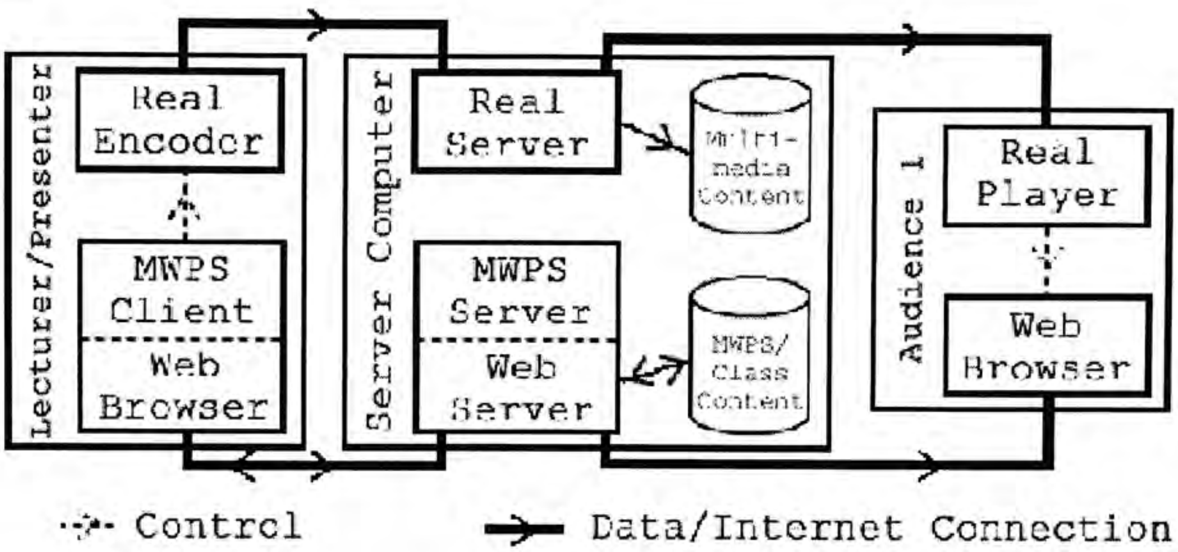

Figure 7.2: MWPS live presentation in synchronous mode

Basically, MWPS supports two presentation mode, namely Asynchronous and Synchronous mode. Synchronous mode presentation is referred to live presentation throught the web in real time, Asynchronous mode means playbacking the recorded presentation material at any time. In the other words, the processes of presenting and attending are taken in Synchronous mode at the same time. In Asynchronous mode presentation, the two processes are separated.

Hence, we focus on the synchronous mode of MWPS, which the "classmates" attend the class in real-time. The students can interact with the presenter directly giving instantaneous feedback.

Figure 7.2 illustrates the connection flow of MWPS System during synchronous mode public presentation. On the left-hand side is the presenter's MWPS client machine and MWPS server is in the middle. Students are placed in the right-hand side as audiences.

The server is comprised of three parts: RealServer [56], MWPS Server and Web Server. The RealServer [56] handles all aspects of multimedia contents, says audio and video. The Web Server provides access of slide of course materials, which containing mainly images and text, to Internet. It also uses to prove the

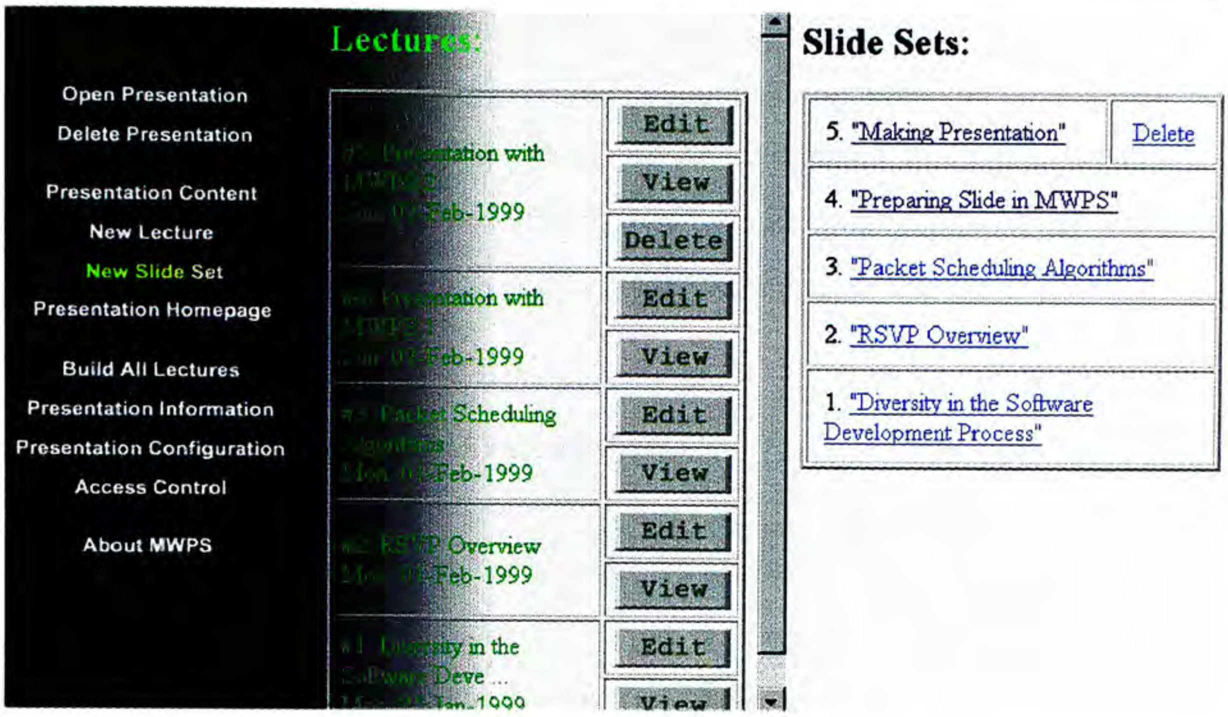

Figure 7.3: Lecture Editing Main Menu

authentication to access and sets the environment of web browser for running CGI [69] and JAVA [66] programs. The MWPS Server coordinates the other two servers and functions the whiteboard application.

Once the lecturer starts the presentation, signals will be sent to the MWPS Server through the Internet connection, MWPS Server will then retrieve corresponding lecturing material (HTML [73] view graphs) back to the client machine and coordinates it to control the RealEncoder [57] in order to start recording. This multimedia content is directly transferred to the student/audience machine through the RealServer [56] and the view graph sequence is also transferred from the MWPS Server. Afterward, RealServer [56] will store the multimedia content captured from the RealEncoder [57], while MWPS Server will capture the sequence of view graphs and generate the presentation. Figure 7.3 shows the main menu for the teacher to prepare the online lecture.

7.4 Highlighed Features

MWPS has numbers of highlighted features for delivering lecture through the web. They are slides sequence capturing, audio/video capturing, script-text on playback, student feedbacking and white board facility.

7.4.1 Slides Sequence Capturing

In lecturing, teacher presents the materials in an order. MWPS supports this slides sequence capturing which can provide a classroom-like environment in Internet. By doing this, MWPS records the order of slides showing and play it back in order. Moreover, MWPS provides two methods of playback, namely automiatic and manual page turning. In the former case, the lecturing content will be played back automatically in order without any control. The users have more control in the latter case, so they can jump to the slides which they want.

7.4.2 Audio/Video Capturing

Obviously, MWPS is capable to support both audio and video capture in order to deliver the lecture through the web clearly.

7.4.3 Script-Text On Playback

Attending an online course, students are difficult to catch the meaning if the presenting language is the learner's second language. In cope with this situation, MWPS shows the teaching speech in text form simultaneously during the lesson so as to let the student gain more understanding in the particular topic.

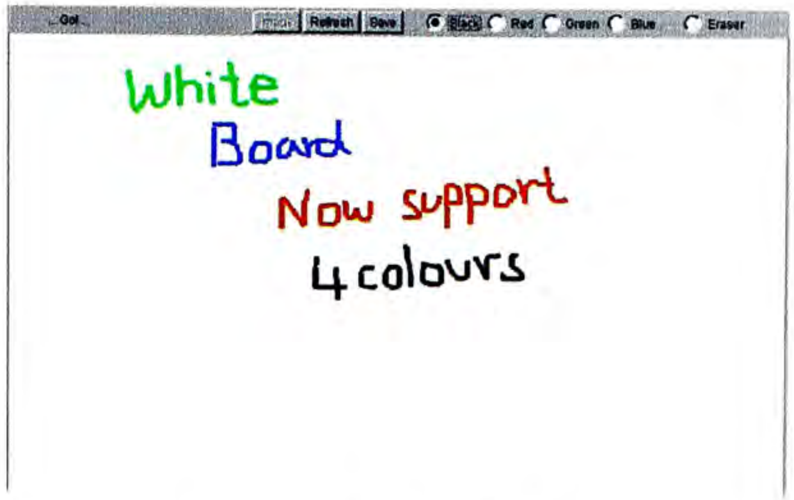

Figure 7.4: Whiteboard

7.4.4 Student Feedbacking

This feature supports feedback in on-live lecture so as to increase the communication between student and teacher. Hence, MWPS enhances the opinion exchanging in Virtual Campus.

7.4.5 White Board Facility

This white board facility provides a place for teacher to further express or explain his/her ideas by writing and drawing. Figure 7.4 shows an example of using whiteboard.

Chapter 8

Illustration via Screen-shots

8.1 Login Screen

In this chapter, a simplified demonstration of Virtual Campus is illustsrated via samples of screen-shots.

Figure 8.1: The login screen of Virtual Campus

When a user logins Virtual Campus in Figure 8.1, she provides username, password and belonging group (namely student, instructor, consultant and administrator) for identification. Unauthorized users are prohibited from accessing. Once a student logs in the Campus, the server will keep the student's information in a login list.

8.2 Functionality provided for Students

Figure 8.2: A description of the practical usage menu bar

Figure 8.2 describes the basic functions in Virtual Campus. An announcement broad will then be shown where an example is illustrated. The upper part displays the latest announcement from teachers and consultants.

The lower part is a functional menu which can be divided into three parts. The most left-hand side list allows the students to

1. go back to the announcement broad,
2. view the discussion broad and,
3. go to chatting room.

The middle rolling bar shows other activities in Virtual Campus, including

1. check with the scheduled timetable,
2. attend a lecture,
3. check who is in the Campus,
4. revise the reference note,
5. modify the personal login information (e.g. nickname and password) and,
6. log off.

The most right-hand side list shows the current date. Moreover, students can change her status which can be checked by others who is active in Campus. Several states are provided here, e.g. "I'm here" or "Busy!", etc.

8.2.1 Personalized Learning Timetable

Figure 8.3 shows an example of the timetable for a student. Her timetable indicates the times of lectures and the deadlines of assignments, which are not the same as other students. Note the sequence of the course has been provided according to the student's learning ability. On the other hand, she can attend lecture. Moreover, user can add their personal schedule in the same calender as an organizer, which is shown in figure 8.4.

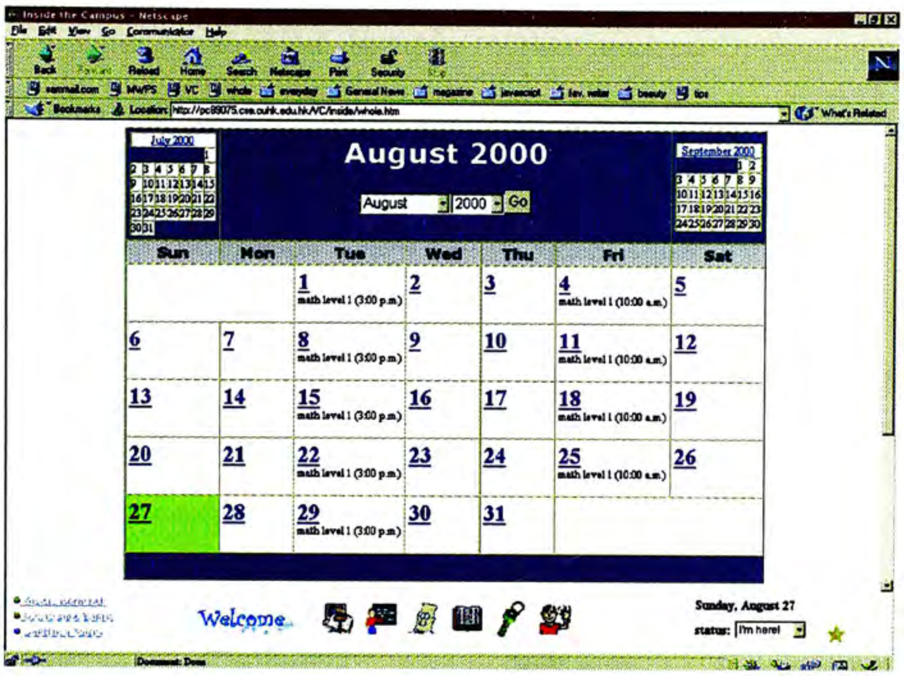

Figure 8.3: Learning Timetable for a Student

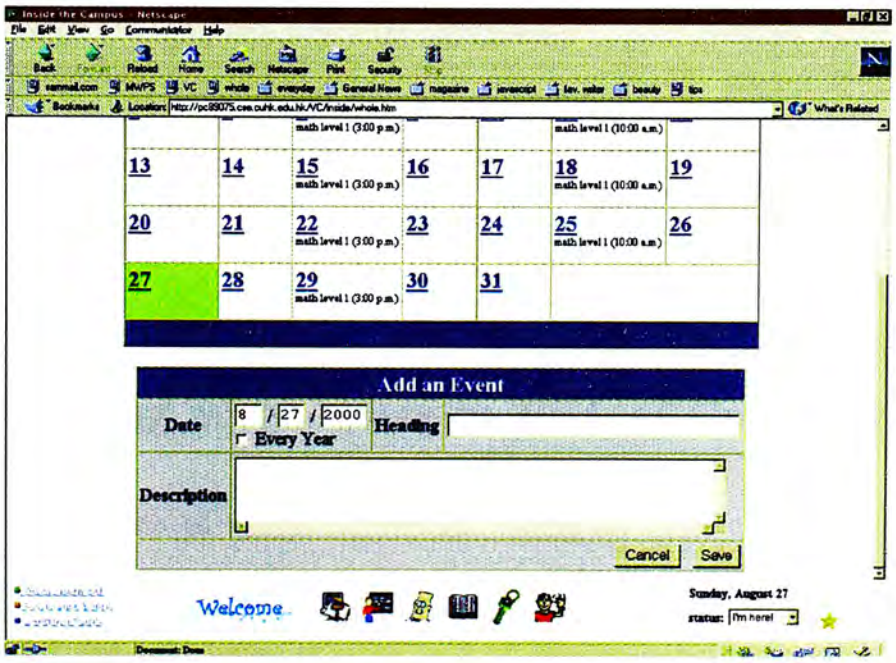

Figure 8.4: Adding Event as Personal Organizer

8.2.2 Lecture Delivery

In the figure 8.5 below shows a sample lecture viewed by learner. A video is recorded and playing in the right-hand side of screen, so the learner can see the face of lecturer as well as listen his voice. There is a rolling caption, which automatically follows the speech below the image of the lecturer. The slides in the left-hand are sequenced in order and self-moving according the pace of lecture. On the other hand, learner can switch to other activities, says chatting with other by clicking the system menu bar, which is below the lecture presentation.

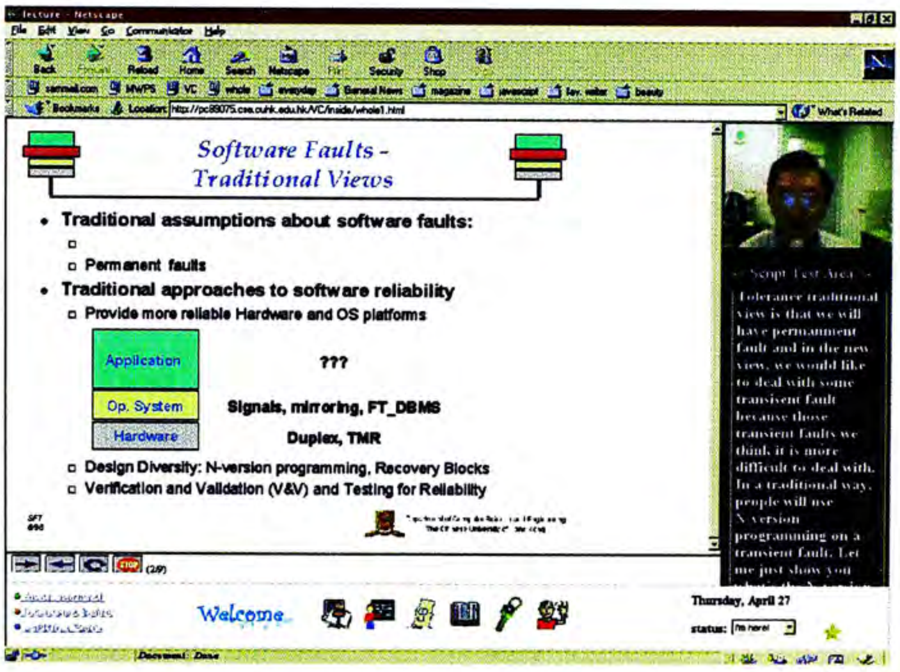

Figure 8.5: An Online Lecture Delivery

8.2.3 Checking active users in Virtual Campus

Figure 8.6 shows lists of users in Virtual Campus. The upper table indicates the current users in Campus: Login identity, English and Chinese name, current state, login and recently request time. All of above shows the activeness of login users. The lower table records the users who logout within the past 8 hours. This facility those who are finding someone for help. For instance, a student wants

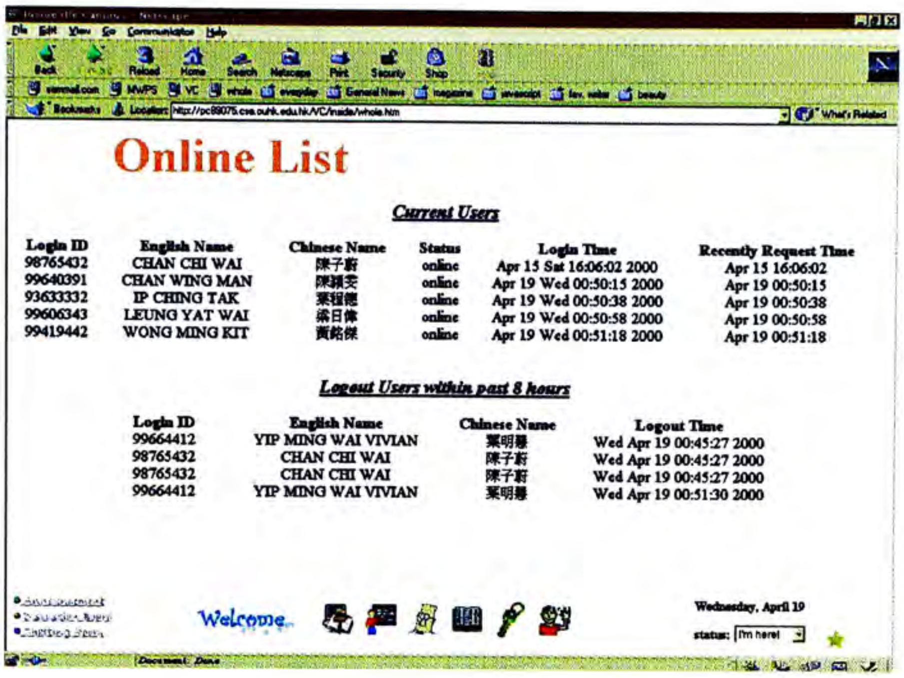

Figure 8.6: Lists of users' state currently in Campus

to seek an instructor asking questions. If he checks the logout list and finds the targeted instructor just left for a moment, he may need to find him next time.

8.2.4 View and Update Personal Information

In Figure 8.27, user can view her personal information: Login identity, English and Chinese name, Major subject and nickname (if added before). User only allows changing or adding the nickname used in chatting room and login password. Other items are not allowed to change.

Continually scolling down the screen, users can check their current learning profile, which shown in figure 8.28. They can join the available course, but need to take an entry test first to determine what level should him start to learn, which will discuss briefly in the coming subsection. Moreover, users can request their interesting topic that is absent now. This makes a link between teacher and student. It leads teachers understanding the demanding topics. Lastly shown in figure 8.9, users can change their learning preference period used as generating

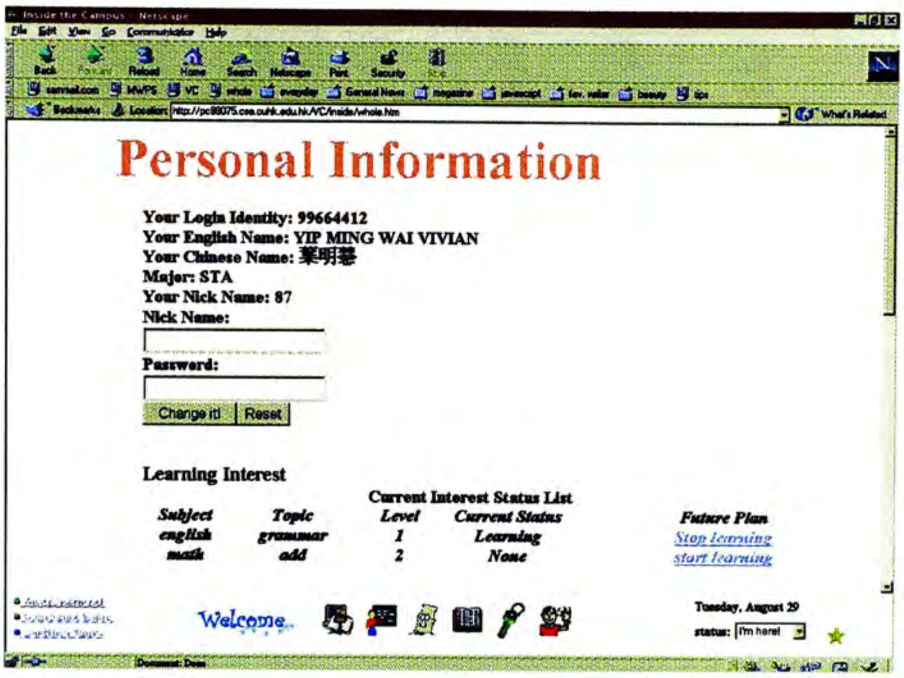

Figure 8.7: View and Changing in Personal Profile

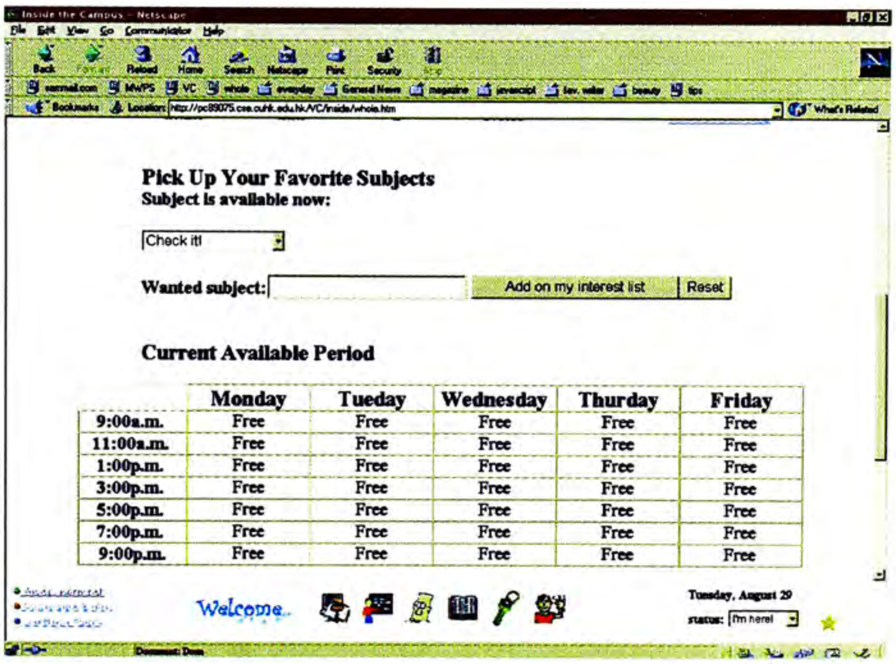

Figure 8.8: View and Changing in Personal Learning Profile

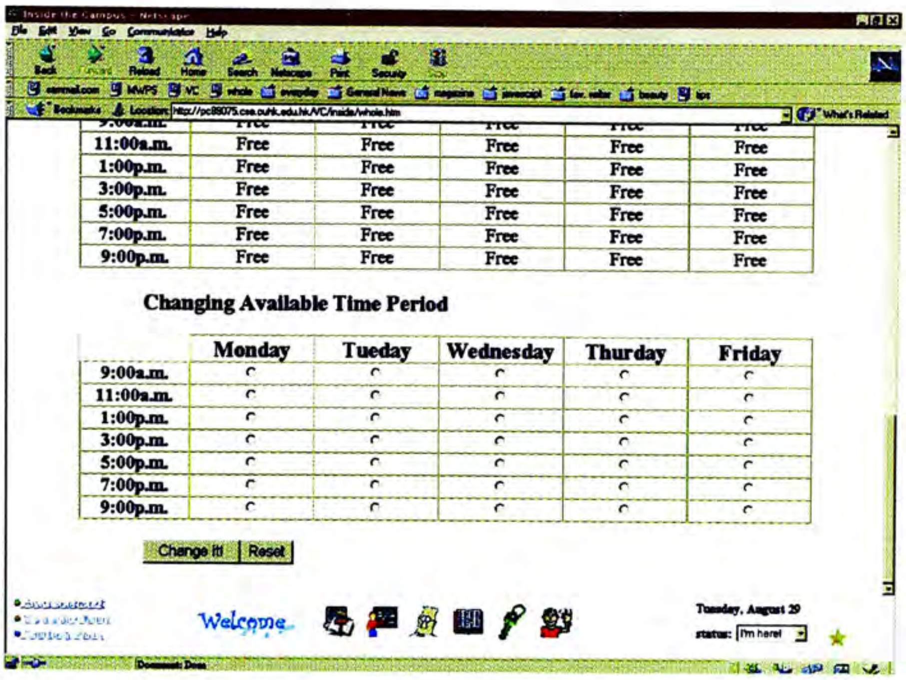

Figure 8.9: View and Changing in Available Period

the coming new timetable.

8.2.5 Taking An Entry Test for Interesting Subject

When student chooses an interesting topic in the learning list, then a prompt window will ask him to take an entry test shown in figure 8.10. If he accept the test, then questions will be generated on-the-fly shown in figure 8.11. This questions are picked up from a question pool which is built by teacher in advance. Teacher provides questions of different level, the test will pick up a fixed number of question for different level which is also set by teacher.

Once the student finishes the test, Virtual Campus will check the answer for him. Since teacher has set the number of question in each level need to be correct in advance, so the system then check and locate the entry learning point. This entry learning point of this subject will be added on his learning profile for reference. Virtual Campus then return it to student shown in figure 8.12. Finally the student can check back the answer of each question shown in figure 8.13.

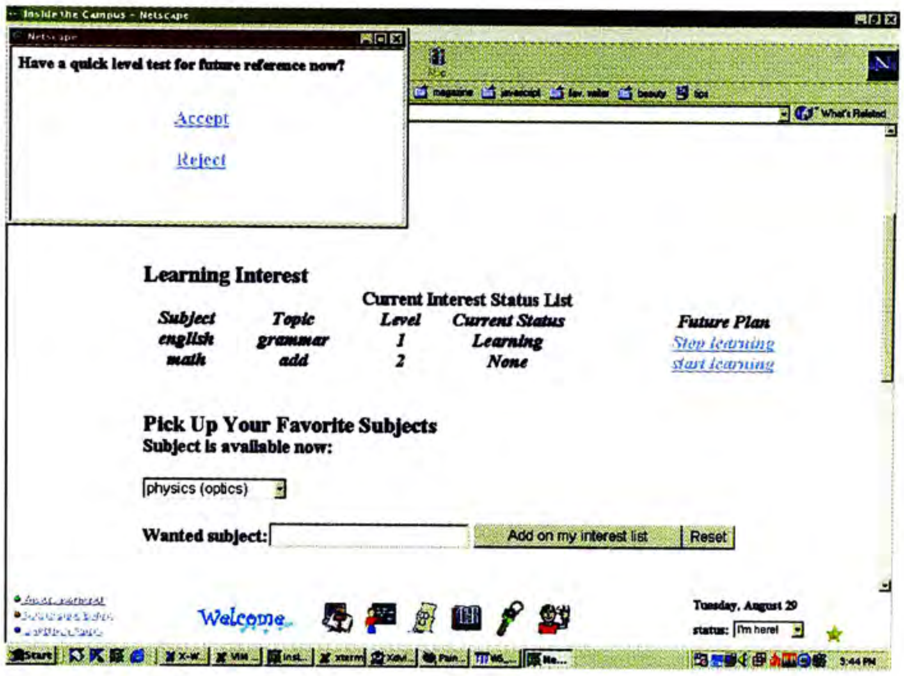

Figure 8.10: A Prompt-up Screen for Taking Entry Test

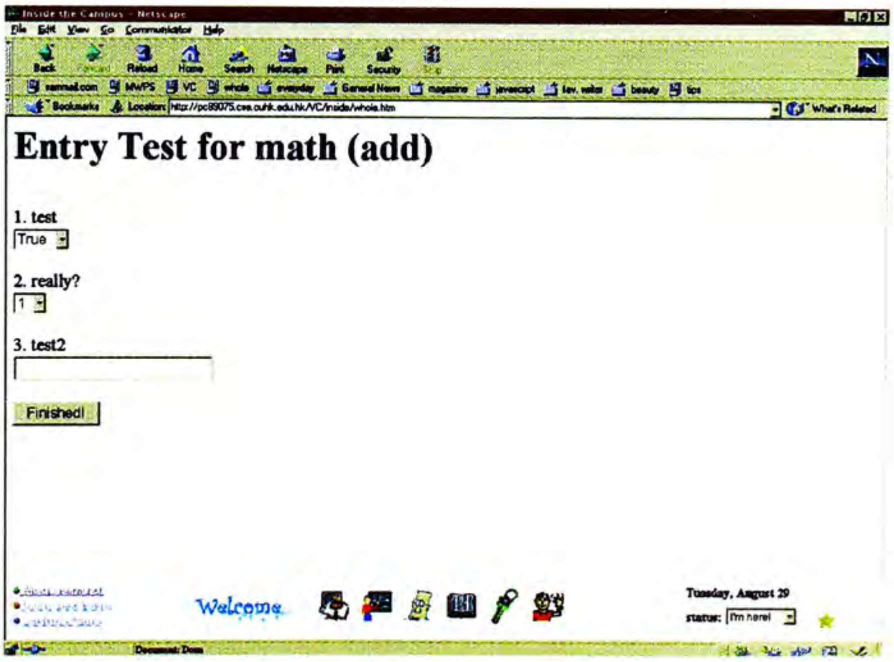

Figure 8.11: Questions Generated by Randomizing Pick Up in Question Pool

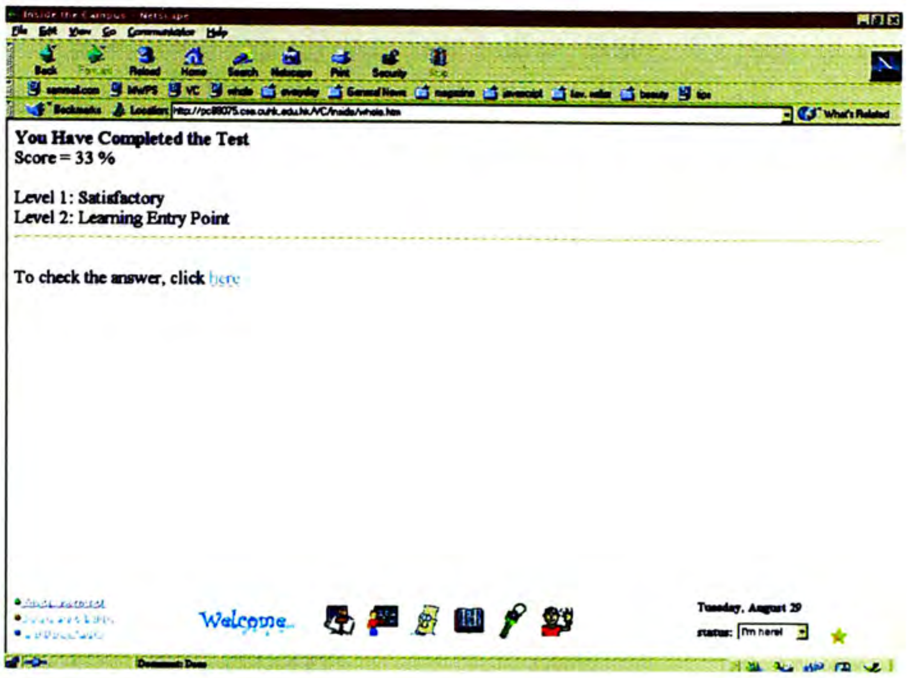

Figure 8.12: Check the Answer and Return the result

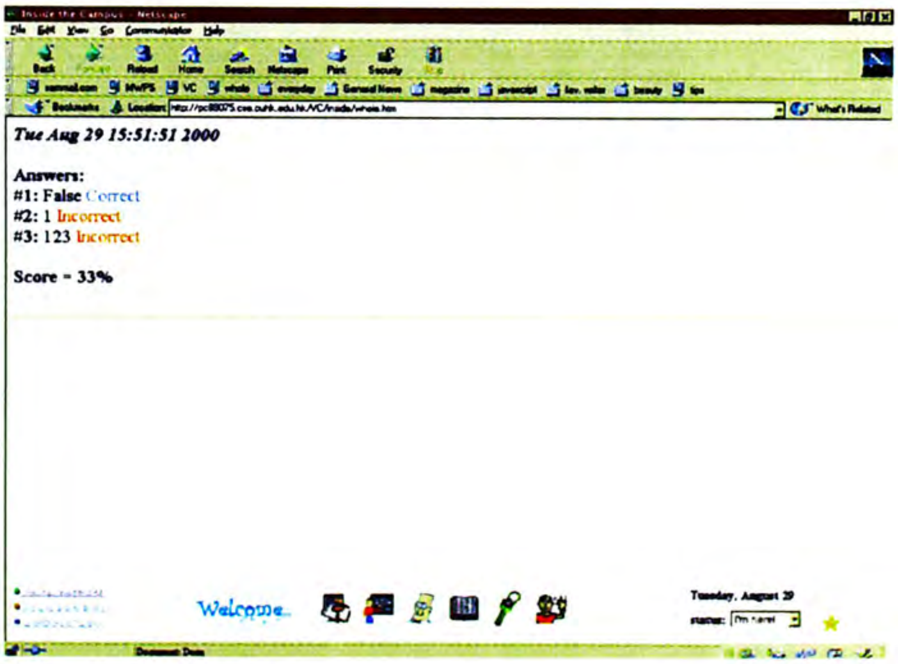

Figure 8.13: Show the Correct and Incorrect Answer

8.2.6 Changing Current State

In Virtual Campus, user can change her online state. Currently there are three states provided to users:

1. "I'm here!" - let other know the user is logged in the Virtual Campus;
2. "Busy!!!" - let other know the user is busy and ask other not to disturb her;
3. "Invisible ..." - don't let other know you is logged in the Virtual Campus.

8.2.7 Discussion Board

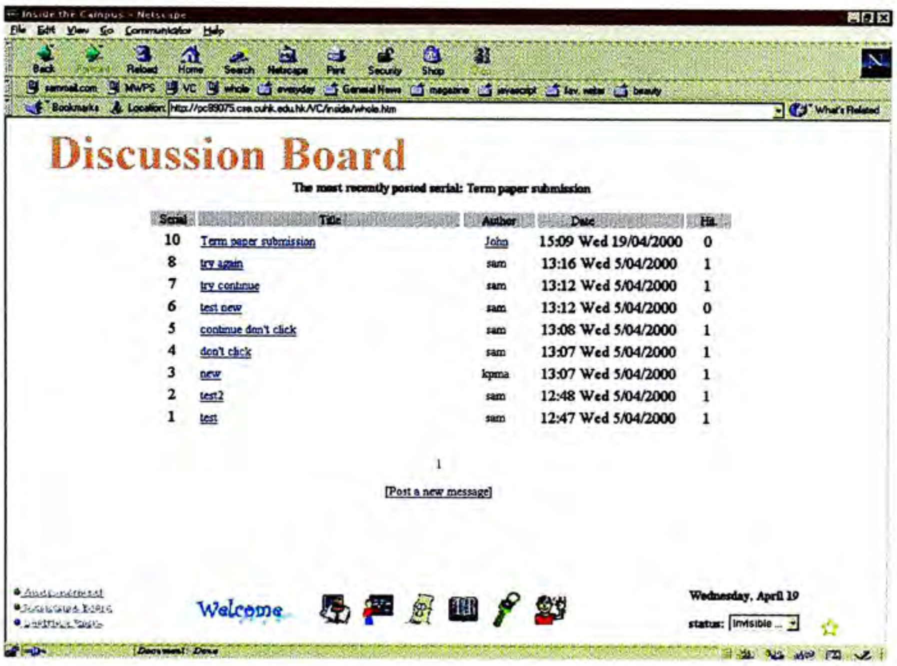

Figure 8.14: A discussion area

In Figure 8.14, disscussion board facility is provided for user to share some experiences and opinions. Users can post a new message thread shown in Figure 8.15.

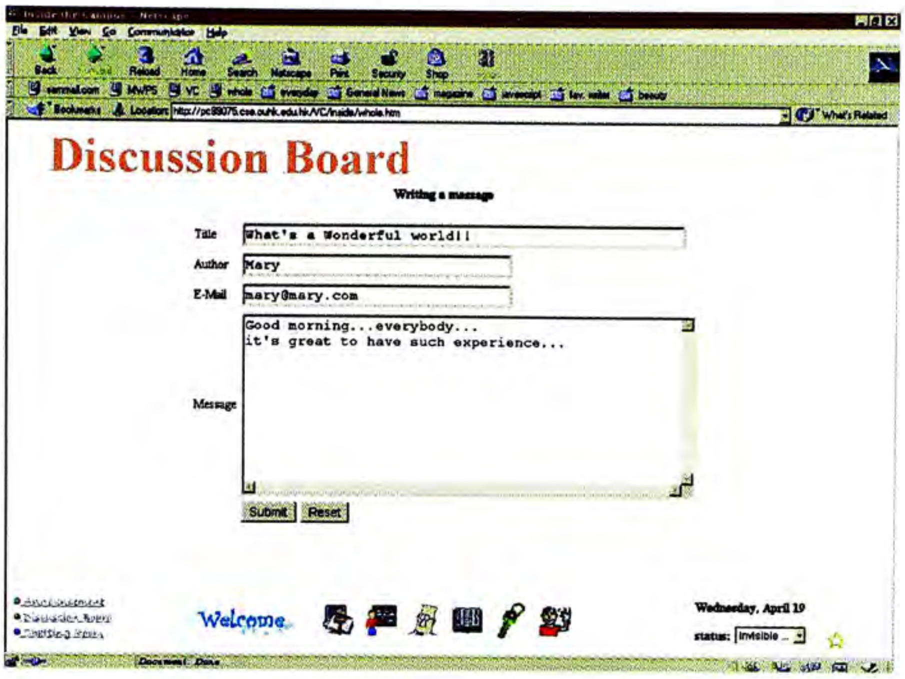

Figure 8.15: Allow the user to post new message

8.2.8 Chatting Room

Figure 8.16 shows the chatting room page in Virtual Campus. Users are allows to make a new room or freely join the public chat room. Specially, there is a facility called private room, which is only allowed the user and invitied chatting partner carrying private chatting. There is a public general chatting shown in Figure 8.17. It is ease to use and simple to user.

8.3 Functionality provided for Teachers

For teacher, the basic functionalities are same as students'. Specially, one extra functionality is added, Question Editing. As mentioned before, teacher has to build a question pool first in order to let student to have an entry test for particular subject. This functionality allows teacher to build such question pool.

In figure 8.18, it shows some questions of different subject with different level are made before. Teacher can add a new topic by filling the scrolling down

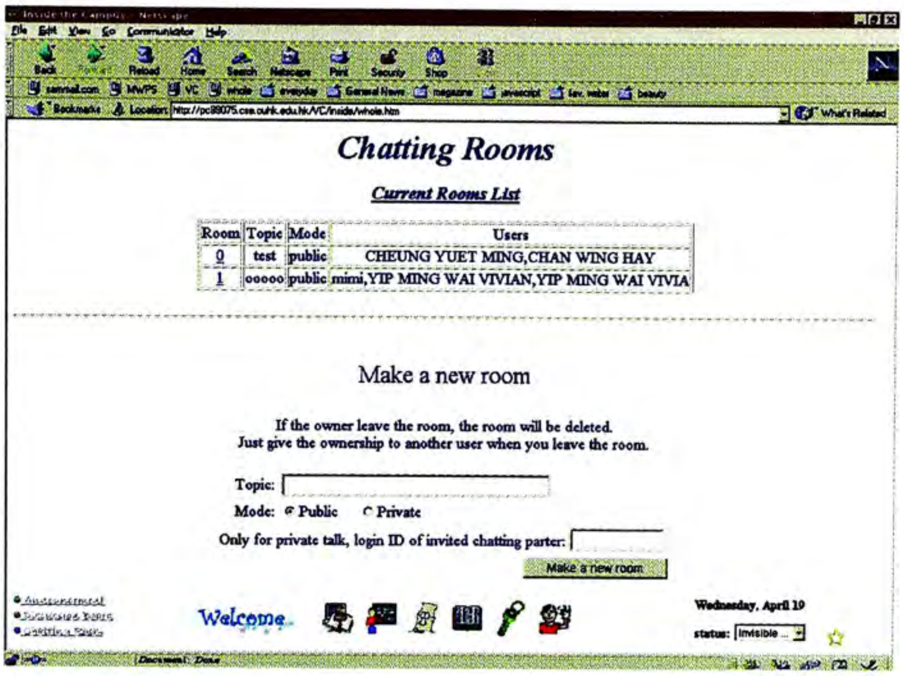

Figure 8.16: Chatting room facility interface

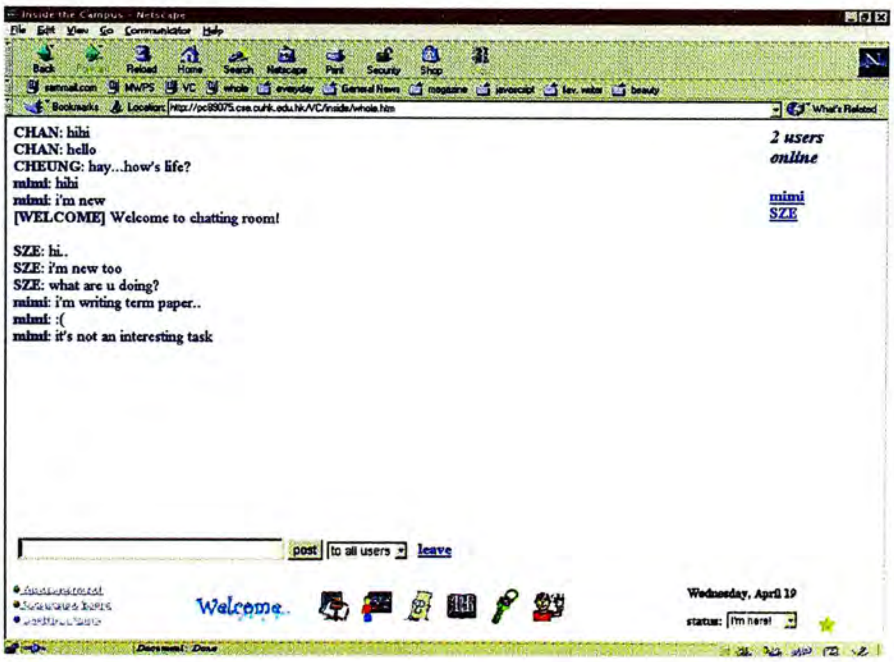

Figure 8.17: Users are chatting with each other

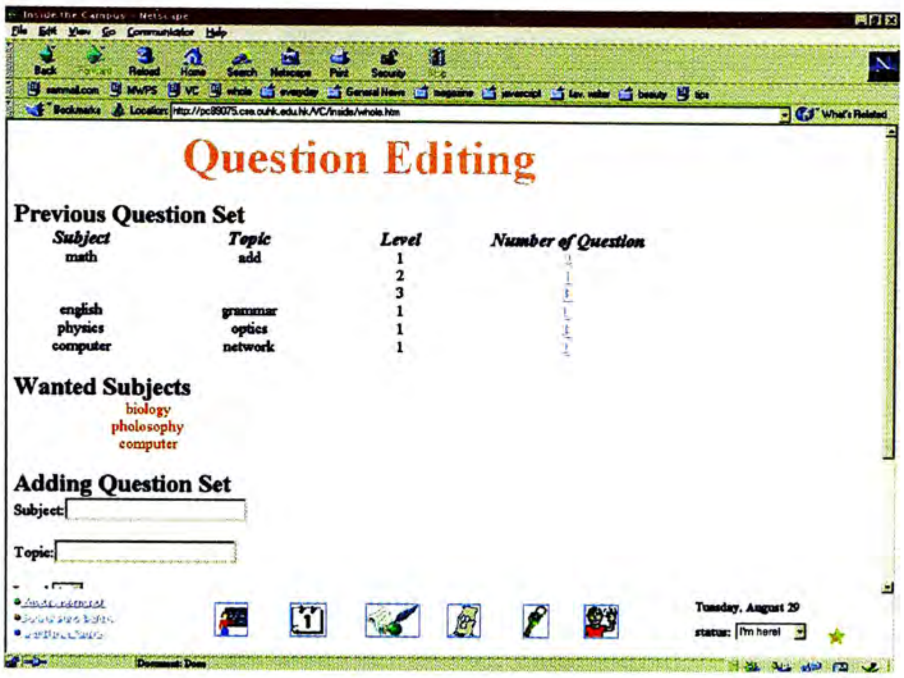

Figure 8.18: Question Editing Page

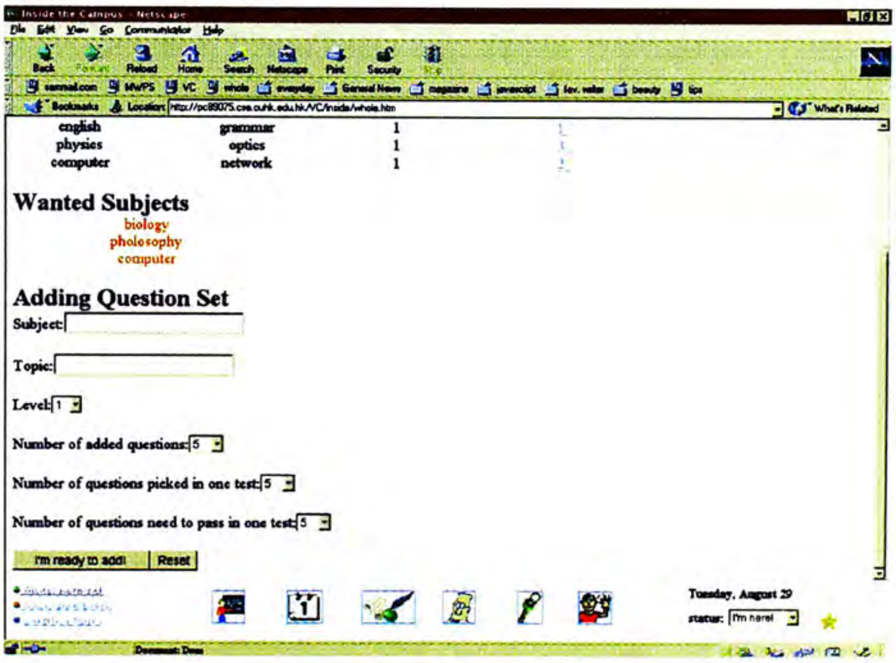

Figure 8.19: Adding Question

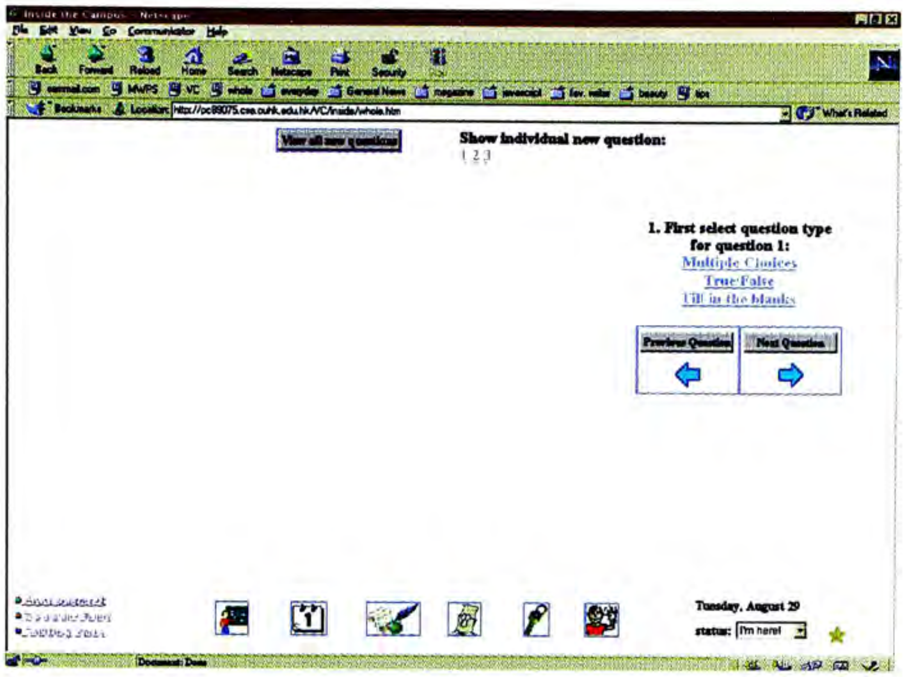

Figure 8.20: Editing Question

parameters shown in figure 8.19.

For example, a teacher want to add 3 new questions on a new topic (Subject: Chinese, Topic: Grammar) of level 2. Then a page of question adding will be shown in figure 8.20. There are three types of questions can be used by teacher, namely Multiple Choices, True/False and Fill in the blanks. There are few steps to add question:

1. Choose the question type shown in the right hand side of figure 8.20;
2. Enter the question and answer of chosen type respectively:
   (a) Figure 8.21 shows the expected input fields of Multiple Choices question type;
   (b) Figure 8.22 shows the expected input fields of True/False question type;
   (c) Figure 8.23 shows the expected input fields of Fill in the blanks question type;

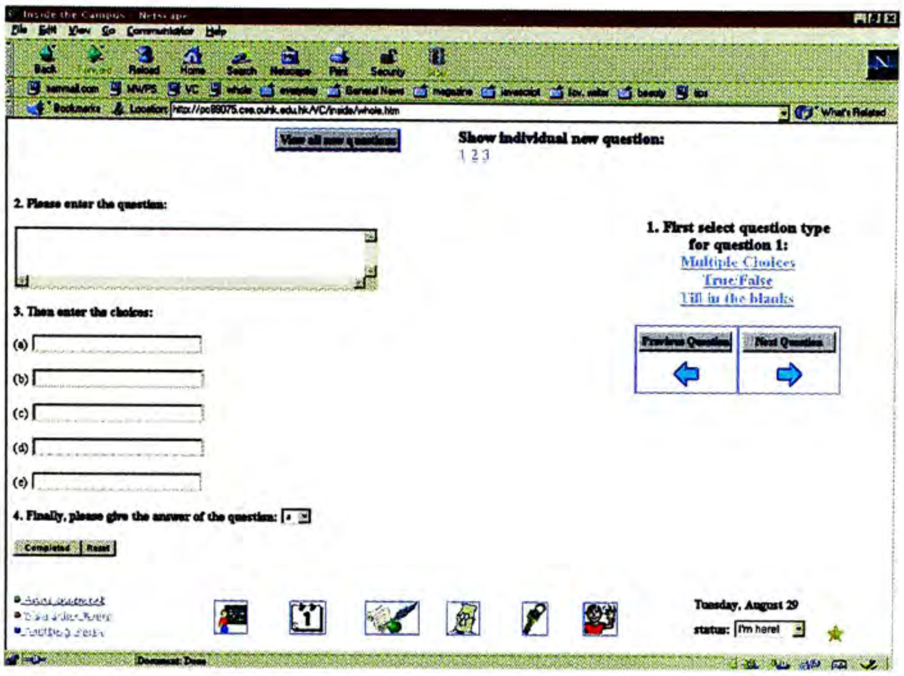

Figure 8.21: Multiple Choice Question Editing

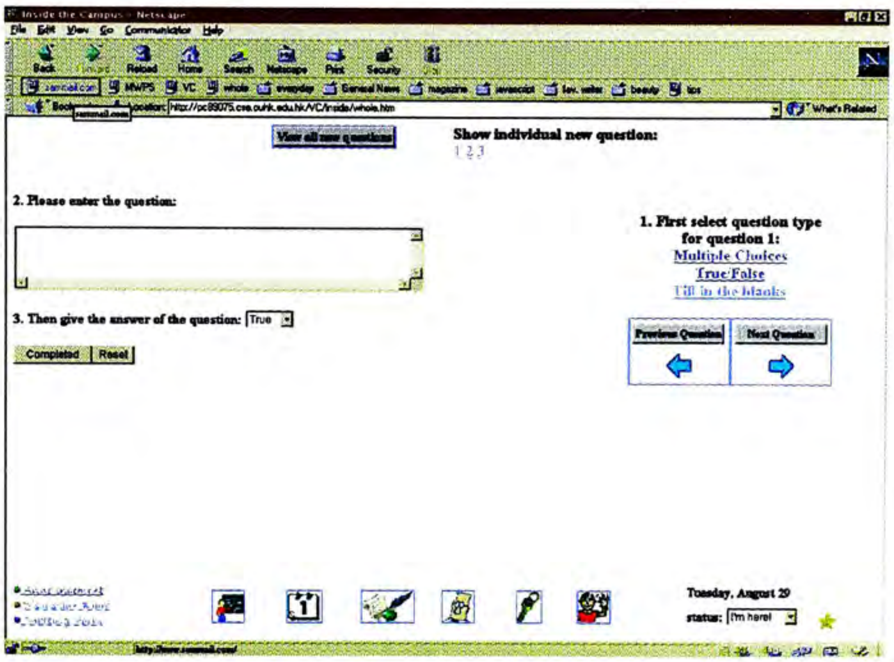

Figure 8.22: True/False Question Editing

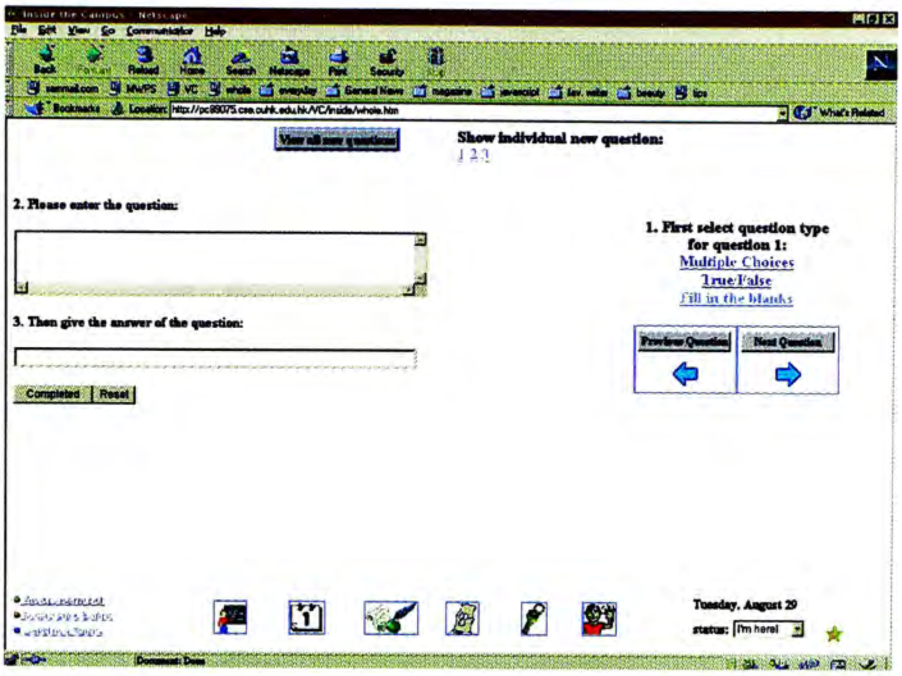

Figure 8.23: Fill in the blanks Question Editing

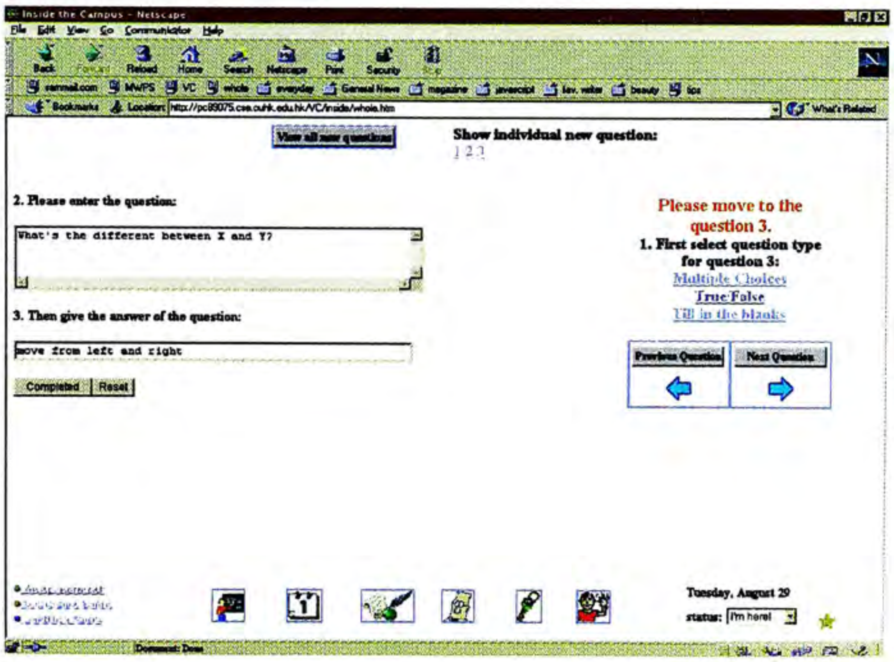

Figure 8.24: Ask for Entering the Next Question

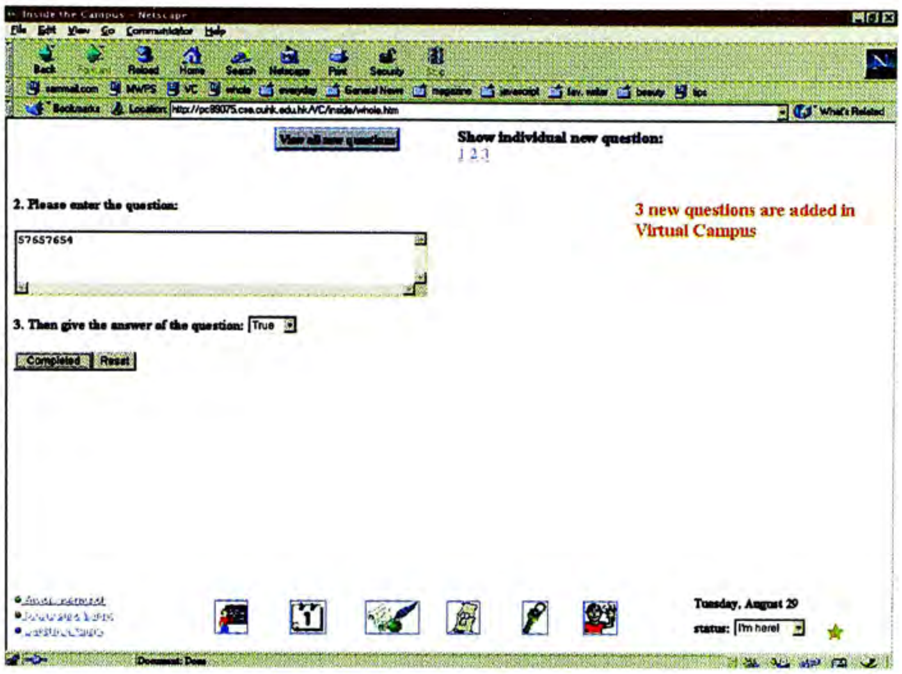

Figure 8.25: Finish Editing

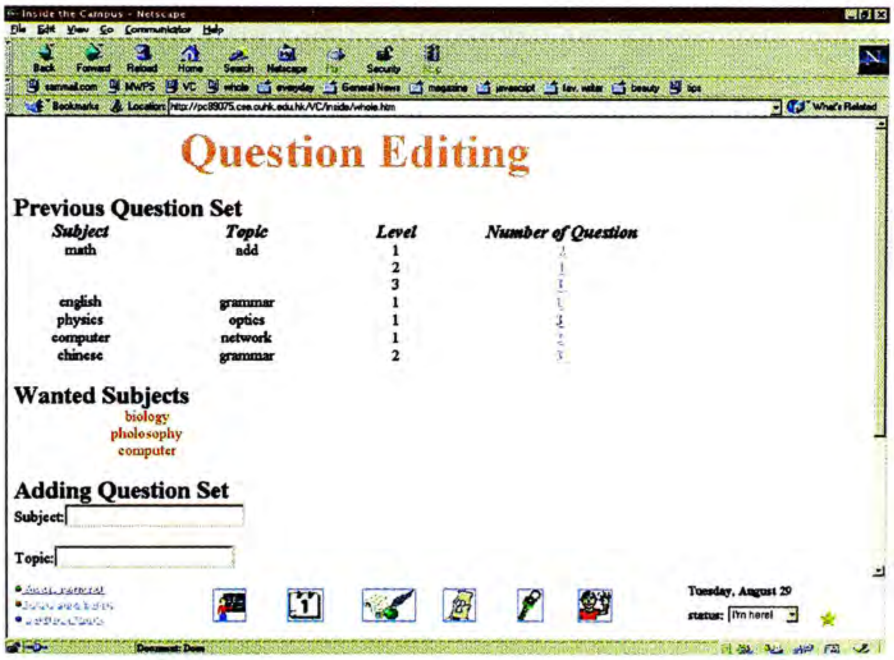

Figure 8.26: Add the New Questions in the Question Pool

3. Once teacher finishs one question, the system will ask him to move on until finish, shown in figure 8.24 and 8.25.

When teacher surfs back the main of editing quesion, the newly added questions will be available, shown in figure 8.26.

8.4 Functionality provided for Administrators

For administrator, one special functionality is added besides those in other accounts. Since a global timetable is generated periodically, it needs inputting parameters in such generation (briefly discussed in Chapter 6). This parameters are controlled by administrator.

Required Matrix is the main parameters in generating timetable. It shows which teacher is responsible for which subject and the number of lectures given within a pre-assigned number of days (for example, 7 days). Figure 8.27 shows the current settings. This setting can be changed by administator by choosing the entry in the list.

There are other parameters can be changed in generating timetable. Adding New Teacher is one of functionality and changing the time distribution of the timetable, which is shown in figure 8.28.

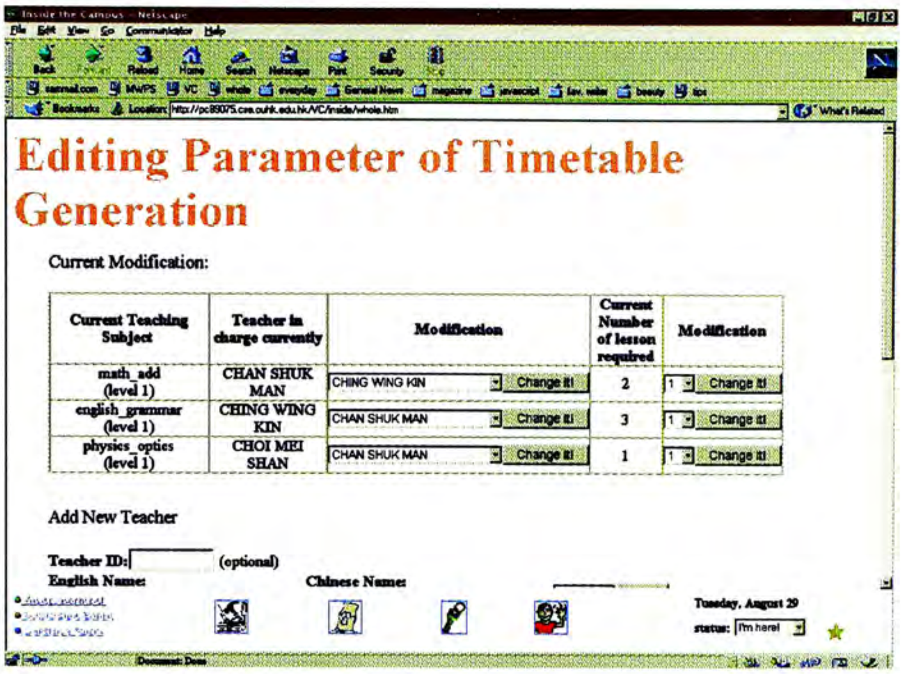

Figure 8.27: Editing Parameter of Timetable Generation

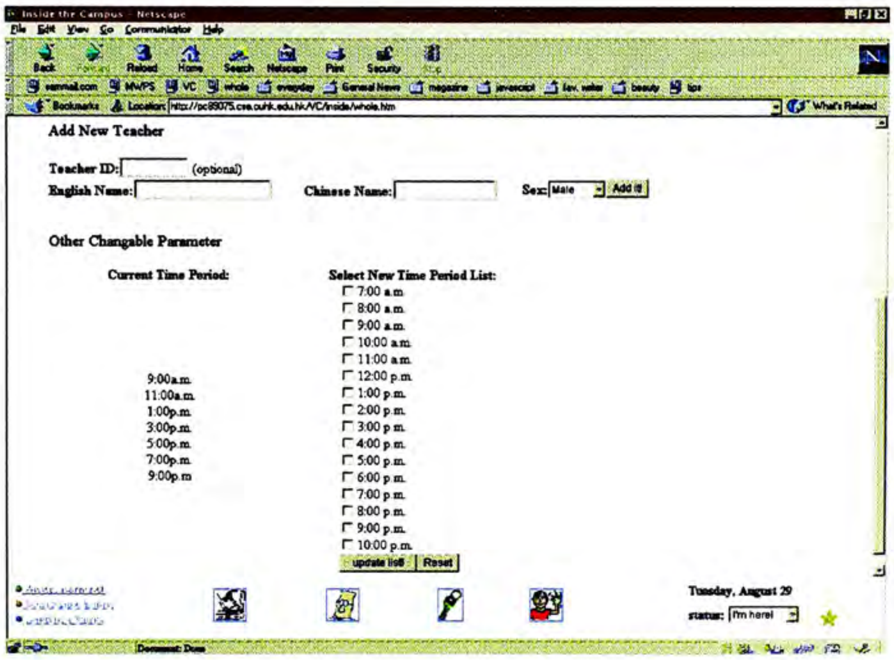

Figure 8.28: Editing Parameter of Timetable Generation

Chapter 9

Conclusion

The Internet becomes an emerging media using in education delivery. In sprite of applying such awesome technology to education, we would like to ask again a question, "How can fully utilize the Internet in order to delivery the right information to the right student at a right time". In this thesis, we have proposed an alternative way, Virtual Campus, for distributing the customized learning material.

In summary, Virtual Campus has three main design features in order to enrich the studying life of a student: customized learning cycle, interactive learning environment and ease of use.

1. Customized Learning Cycle
   In Virtual Campus, given the information provided from each student and her academic record, an intelligence scheduler systematically produces a periodic preliminary study plan for each student. After being reviewed by an experienced consultant and interchanging opinions with a particular student, a tailor-made timetable is generated for that student. It offers a clear learning orientation so that the student always knows what she should be doing, what needs to be done next, etc. Together with the flexible individual/group-paced learning Internet environment, delivering right

material to the right person at a right time can be realized by Virtual Campus. It is very important that a learning environment allows the receivers (students/learners) to adjust their learning rate based on their abilities and interests, rather than being totally controlled by the senders (instructors/teachers). In this information explosive era, a person can hardly survive as if she stops learning new things. That means the society pushes people to be a life-long learner. As it is not an easy task to require self-discipline and continuity, a customized study planning service in Virtual Campus promotes the learners' motivation and learning progress. In addition, the consultant acts as a personal supporter giving extra advises to students.

2. Interactive Learning Environment
   Virtual Campus provides a place for parties, instructors/consultants and students. It supports both individual and group learning through the Internet. While attending the real-time on-line lecture, students can ask questions and receive replies directly from the lecturer. On the other hand, students can seek help via Virtual Campus once the corresponding lecturer or tutor is online. Moreover, Virtual Campus can carry out group projects or discussions for the students in a highly interactive fashion [26].

3. Ease of Use Virtual Campus acts as a web-based education gateway allowing teachers/instructors to fully utilize the Internet conveniently without worry too much about technical details. To subscribe an on-line lecture delivered in Internet [37], a general web-browser (e.g. Netscape or IE) and a simple media player (e.g. Real Player) are good enough. In general, a browser is essential to view, respond to, and interact with Virtual Campus.

In short, Virtual Campus is a tool for teaching and customized learning through the web.

Technology is viewed as a catalyst and tool for reengaging teachers and students in the excitement of learning and for making that learning more relevant to the 21st century. Rather than being taught separately, technology should be integrated into the larger instructional and curricular framework.

On the other hand, learning is an active and social process athat occurs best in environments that are student centered, where teachers take facilitative roles to guide students in meaningful inuiries, where discovering relationships among facts is valued more than memorizing the facts themselves, and where knowledge building activities and balanced with the sensible use of guided practice and direct instruction.

However, technology is not a magic bullet - it is only one necessary ingredient in reform efforts. Despite its potential, technology can never replace teachers. Virtual Campus invites teachers to enjoy lecturing through the web. Moreover, customization hardly brings to reality in the existing educational system. Virtual Campus aims in providing a tailor-fit learning schedule for each person can have his/her own desired goal. In conclude, technology is not a panacea for educational reform, but it can be a significant catalyst for change. Customized learning will be the trend for the future education as urgently need a solution in manipulating the explosive information for personal interest nowadays.

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Appendix A

Appendix

A.1 Internet Technology

The Internet is a collection of interconnected networks that use a specific set of protocols. It connects millions of heterogeneous computers with best-effort services, which endeavors to deliver packets to the correct destination with no guarantee on the delays or the loss rate of the transmissions.

The main protocols of the Internet are the Internet protocol (IP) and the transmission control protocol (TCP). IP supervises the addressing of nodes and the routing of packets. TCP is a control mechanism that runs in the source and destination computers. It ensures the packets are retransmitted until they are correctly delivered and regulates the rate at which computers send packets to prevent some links from becoming excessively congested.

A hyperlinking of documents located in computers around the world is called World Wide Web (WWW). The hypertext transfter protocol (HTTP) uses TCP to get documents from a server. The documents, described in an easy-to-write language called HyperText Markup Language (HTML), can include text, graphics, video clips, audio and links to other documents. Users navigate in this worldwide collection of documents by simple mouse clicks on links or locate them by using a search engine. The World

Wide Web, with its popular interfaces Netscape navigator and Microsoft Explorer, breaks down distances, integrates multimedia, enables users to find information, and, equally importantly, makes every user a potential publisher. The Web merges computers and communication and transforms every personal computer into a personal communication device. The value of connectivity is much larger than its cost, and it increases with the number and quality of information available on the Web and with the number of people you can reach with it.

A.2 Web Server

A Web server acts as a bridge between the network and the resources for example shared video/audio and documents. The job of the Web server software is very simple: it receives requests from Web browsers for documents over the network, deciphers each request to determine which file is needed, finds that file if it is available, and sends that file back to the Web browser over the network connection.

In addition to delivering documents, the Web server can execute programs to dynamically generate information. Once the client browser requests a program (script, general term for programs executed in web server), the web server executes the requested program and relays the result to the client. Things done by script are summarized as translates the input from the client, calls other programs, and translates the processed output to specific format before return it to the client.

This makes it possible to create interactive applications. It also permits the Web server to act as a gateway to access resources that are not Web servers, such as databases. The ability to run scripts makes the Web extremely flexible and lets the Web incorporate a vast array of services.

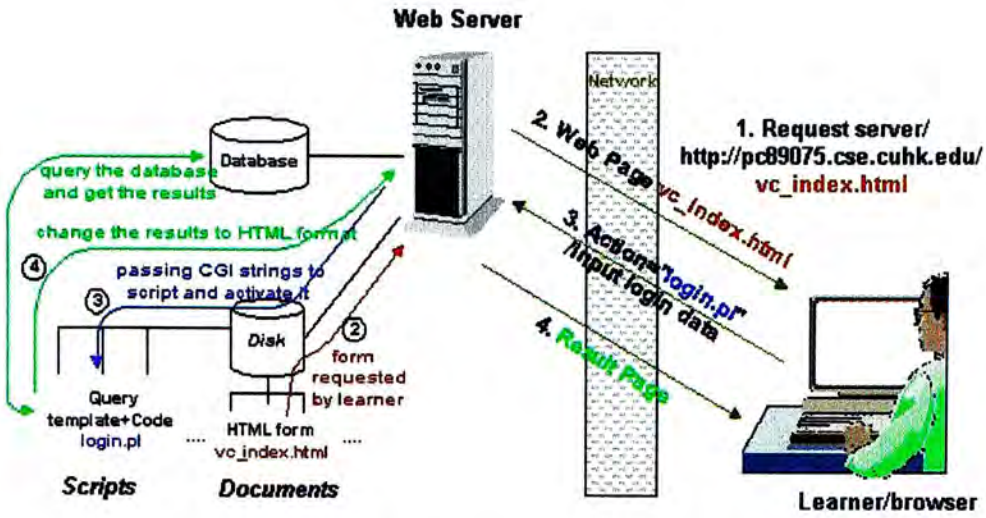

Figure A.1: Illustration of Interaction between web server and client

A.3 Web Client/Server Example

The numbers indicate the four basic steps that take place. There are two perspectives of these actions: the client (right-hand) and server (left-hand) sides In here, we describe the simplest example, says the log-in process of a learner entering Virtual Campus:

1. Server side: A form (shown in figure 8.1) is created first and stored in web server.
   Client side: The form is requested by typing its address (http://pc89075.cse.cuhk.edu.hk/vc_index.html) in the web browser.

2. Server side: The web server looks up the file (/vc_index.html) in its document tree. This is done using the file system of the server, which is normally part of the operating system. If a file of the right name is located and can be read by the web server and then the web server sends it to the learner.
   Client side: Then the learner receives the form (the above login page).

3. Server side: The web server locate the script firstly (/script/login.pl) and confirm that it is an executable program of some kind. If so, the server executes it correctly.
   Client side: The learner then enters his personal login information: login-name, password and belonging group. This data is returned to the Web server and

activate the script written in Perl language.

4. Server side: The script talks to the interface of the database and makes a query. Then it changes the output result from query into HTML format that can be displayed in the learner's web browser.

   Client side: An on-the-fly result page then is sent to the learner side.