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Establishment of an Asynchronous Web-based Instruction System for Labour Safety and Hygiene*

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This paper looks at the use of the asynchronous capability of the World Wide Web (WWW) in order to establish a system for Web-Based Instruction (WBI) on labour safety and hygiene. Planning related to online courses for implementing a WWW asynchronous instruction is also discussed. Specifically, the main purposes of this article are to investigate the basic specifications of requirement for asynchronous WBI system, and to actually establish an asynchronous WBI system on labour safety and hygiene. The WBI system for labour safety and hygiene used the WWW as its development platform. Microsoft Access 2000 and Internet Information Server (IIS) 5.0 were used as the developmental tools for the system. The system's framework is made up of registration area, personal area, bulletin area, instruction area, evaluation area, interaction area and resource area, with each section carrying out different tasks.

INTRODUCTION

Annually, there are numerous industrial accidents worldwide. These disasters not only affect the health and well being of the families of labourers who have been injured or killed, but also bring about equipment losses and project delays. Damage to society and the nation is also a result [1].

The Council of Labour Affairs (Executive Yuan, Taiwan) and statistics on industrial accidents indicate that joint efforts by the government and the labour force have resulted in a gradual decrease in the number of industrial accidents in Taiwan. Table 1 illustrates this downturn.

The number of casualties shows similar characteristics, as shown in Table 2. Around 105 people daily have met with mishaps; this has caused, apart from human misfortunes, losses totalling NT$35 billion [2].

According to Heinrich's domino theory, five factors cause industrial accidents and injuries and can generate a chain reaction. These factors are namely:

- Ancestral background;
- Social environment;

Table 1: The ratio of occupational accidents per 1,000 labours (excluding traffic accidents).

Year	1992	1993	1994	1995	1996	1997	1998
Ratio	3.55	3.27	3.02	2.87	3.06	3.42	3.86

Table 2: Occupational injury statistics: 1992-1998 [2].

Year	Injury rate			
	Total	Injury	Disability	Death
1992	(26,543) 34,056	(21,146) 27,810	(4,617) 4,824	(780) 1,422
1993	(25,851) 32,585	(20,581) 26,596	(4,530) 4,676	(740) 1,313
1994	(25,115) 31,520	(19,962) 25,700	(4,358) 4,505	(795) 1,315
1995	(22,878) 28,849	(17,622) 22,932	(4,585) 4,792	(671) 1,125
1996	(22,891) 29,716	(18,016) 24,009	(4,155) 4,492	(720) 1,215
1997	(25,421) 33,179	(20,415) 27,218	(4,310) 4,706	(696) 1,255
1998	(29,095) 38,217	(23,820) 31,866	(4,569) 5,034	(706) 1,317

(x): Excludes traffic accidents.

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- Personal mistakes;
- Unsafe behaviours;
- Unsafe conditions.

Analysis of 7,494 events of serious occupational accidents for the period from 1982 to 1999 in Taiwan [4] has shown unsafe behaviours to be the major cause of most of the occupational accidents over the last decade (see Table 3), thus showing that most have been man-made disasters. As such, there is a definite need to change unsafe behaviours and conditions [3]. Therefore, the training and education of industrial safety and hygiene for labourers has become very important.

Table 3: Cause analysis for serious industrial accidents: 1988-1999 (7,494 events).

	Causes for accidents			
	Unsafe behaviours	Unsafe conditions	Unsafe behaviours & conditions	Unknown
Individual accidents	2,981	2,114	2,179	220
Percentage	39.72%	28.17%	29.04%	4.37%

Educational Instruction

In traditional classroom instruction, a teacher relying upon lecturing only will not only limit his/her effectiveness at teaching but will also likely bore the student. In recent years, with the popularisation of computers and networks, virtual classrooms could assist traditional classrooms. Although there are still a few problems that need to be solved, namely dealing with humanities and the classroom situation, the future possibilities of the virtual classroom are endless [3].

In order for distance teaching and learning environments to be established, it is necessary to use the fast and progressive features of IT (information technology). These include the advancements in computer, telecommunications and audiovisual technologies. These elements, along with artificial intelligence, simplification, diversification and integration, allow IT to improve and evolve quickly. The multi-platform environment of the Internet has helped to materialise the vigorous growth of the World Wide Web (WWW), multimedia and hypermedia. The important benefits of Web-Based Instruction (WBI) and a Web-based learning environment include:

- The abundant amount of online instructional material.
- The diversity of instructional resources.
- The personalisation of learning requirements.
- Its publicly accessible environment.
- Its lack of time and space limitations.
- The ability to concurrently implement synchronous and asynchronous instructional methods [4].

Due to these reasons, this paper has been prepared for universities and colleges to consult and use in the implementation of Web-based courses on labour safety and hygiene by investigating the characteristics of virtual classroom asynchronous assisted instruction. This paper also seeks to establish a set of virtual classrooms for this assisted instruction system.

SPECIFICATIONS FOR AN ASYNCHRONOUS WBI SYSTEM

A virtual classroom is a system that provides the same opportunities for the teaching and learning process. However, the virtual classroom goes beyond the physical limits of the traditional classroom's walls, thanks to the use of computer communication networks. Due to the ubiquity and popularity of the Internet - particularity the World Wide Web (WWW) - most virtual classroom implementations are Web-based [7].

Some of the benefits of a Web-based classroom are its:

- Geographic, temporal and platform independence.
- Simple, familiar and consistent interface.

Some of the drawbacks are:

- Limited access to the Internet worldwide.
- Resistance to new and alternative forms of teaching, learning paradigms or methodologies.
- Privacy, security, copyright and related issues.
- A lack of uniform quality [8].

Virtual classrooms are instructional environments established on the WWW. Due to the nature of the Web's multimedia and convenient online applications, it allows instruction to be even more diverse and convenient. Therefore, by using online capabilities in establishing course materials, discussion rooms and various types of instructional activities and management, the requirements for distance education can be met. Online virtual classrooms should provide even better learning environments than traditional classrooms, especially when considering teacher-student interaction [5].

According to the rules established in the Main Points for Universities and Colleges Setting Up Pilot Distance Instructional Programmes, which was issued by Taiwan's Ministry of Education in 1999, setting up asynchronous online instruction system should meet the requirements listed in the following eight areas listed below [6].

Bulletins

Because students and teachers cannot achieve face-to-face contact in asynchronous instruction, communication is required more often. Only teachers and assistant instructors can post public announcements, which should be arranged by date with the more recent announcements listed first. They also should have time limits to prevent the bulletin board from becoming too crammed.

Course Materials

Teachers need to place course materials in a place where all students have access to it. They must also be posted online or sent to the student's e-mail address according to the lesson schedule.

Discussions

Discussions are the most important part of an asynchronous instruction system because of the numerous categories, namely: the course materials, the instruction system's function, student assignments, examinations, etc. Therefore, no matter what method of discussion is used, it needs to be organised in an orderly fashion to give the students easy access to the desired discussion material.

If the discussion is in question form, then the teacher must be able to give an adequate response to the student within the deadline set. All students should be able to access the discussion material. Teachers need to participate in the discussion so that the students will feel that teachers are concerned with their educational welfare.

Assignments

Teachers must announce all assignments online and ensure that all students are notified of them. The instruction system needs to ensure that all students can read the assignment themes and also be able to notify students who have not read them yet. Assignment discussions can be carried out online.

Students should also be able to send their answers online and be able to know immediately if the assignments were received. Teachers need to be able to notify students who have not sent their assignments in on time and to also notify students of the results of their assignments.

Online Self-evaluation

In order to ensure the quality of the student's learning, the instruction system needs to provide mechanisms for online self-evaluation and ensure that the students have a fixed online schedule so as to prevent students from falling behind in learning due to asynchronous class characteristics.

Evaluation of Students

Because it cannot be determined if students have cheated in online courses and online examinations, or whether they personally took the test, the old method of taking examinations at a particular location is primarily used. Teachers need to announce the method of grading. Evaluation can include: assignment grades, discussion grades, individual and group grades, examination grades, comportment grades and classmates' mutual evaluations.

Due to asynchronous learning characteristics, teachers need to make sure that online discussions are graded according to the quality of their content. This is because these discussions are important vehicles for students to obtain solutions to questions within a limited time.

The results should reflect the student's interaction derived from reading Web pages and participation in instructional activities. It should further help to determine both the student's evaluation and the need for the teachers to alter the Web page regarding course materials.

Course Evaluation

The instruction system needs to provide course evaluation for both the course materials and the instruction activity. This evaluation should be able to be carried out online as well as be able to be analysed.

Registration

The system needs a registration mechanism in order to record students' data and the teaching situations. This will make it easier for the teacher to manage the students and understand their learning capabilities. The students should use these means to both register and prove that they are qualified for the online course.

ESTABLISHING AN ASYNCHRONOUS WBI SYSTEM FOR LABOUR SAFETY AND HYGIENE

In order for online courses to be able to use the virtual classroom asynchronous assisted instruction system adequately for maintaining users' interest, they must be simple and easy to use and must provide a graphical user interface. They must also be convenient for both the teacher and the student to participate in discussions.

The virtual classroom utilising asynchronous Web-based instruction system for labour safety and hygiene is dubbed the Instructional Web for Industrial Safety and Hygiene (IWISH) system [11].

IWISH System Environments

Because of the multi-platform WWW, users can utilise various platforms by using a browser to connect to the system and obtain the desired resources or user interaction. Additionally, the WWW can use various conventions (like e-mail, FTP, BBS, etc) to provide Internet services and to allow convenient user interaction and file downloads. Furthermore, the WWW can integrate text, sounds, pictures, images, etc, to provide diversification in presentation methods and bring human and machine interaction closer together [7]. Therefore, Microsoft Access 2000 and Internet Information Server (IIS) 5.0 were chosen as the WWW system developmental platform and utilities (see Figure 1).

End users can use browsers to access the instruction system. All of the user's needs are received and handled by the WWW server. Because related instructional resources utilised HTML as their language and instructional documents used Microsoft Access as their database, the WWW server has two handling methods for providing services. If one inquires about resources, then the HTML document is sent directly to the user. If one accesses instructional documents, then he/she must go through ASP and Microsoft Access databases to access the related resource and convert it to HTML.

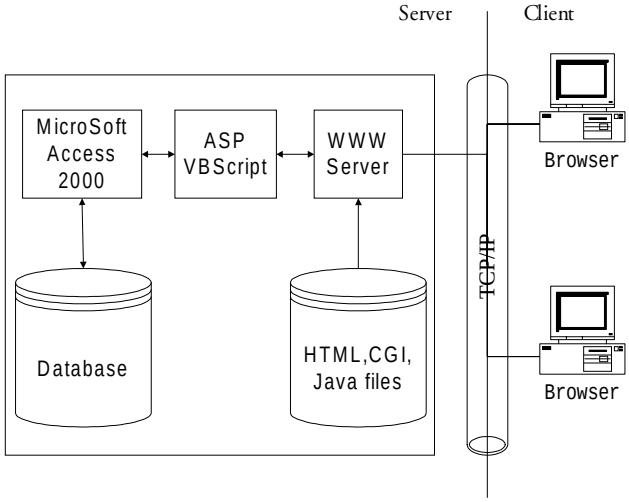

Figure 1: Environments for the development of the asynchronous assisted instruction system.

Framework of the IWISH System

The structure of the virtual classroom for labour safety and health consists of one main system and three subsystems, as shown as Figure 2. The virtual classroom's main system provides various functions required for teaching and emphasises the interaction between teachers and students.

The subsystems of online materials and online tests provide various functions required for the student's self-learning. This will allow the students learn more independently. The learning process recording subsystem can provide the learning records of users, as well as website visiting records, so as to allow teachers and students to view the records of the learning process and the analyses of website visits conducted by system managers.

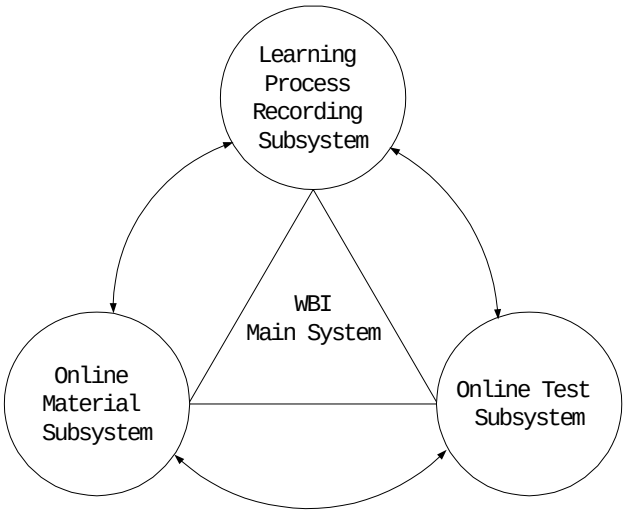

Figure 2: Framework of the virtual classrooms for asynchronous Web-based assisted instruction system.

INTENTION OF THE IWISH SYSTEM

The IWISH system is divided up into seven different areas: registration, personal, bulletins, instruction, interaction, evaluation and resources (see Figure 3). Each area is responsible for different types of service and capabilities and are discussed in broader detail further below.

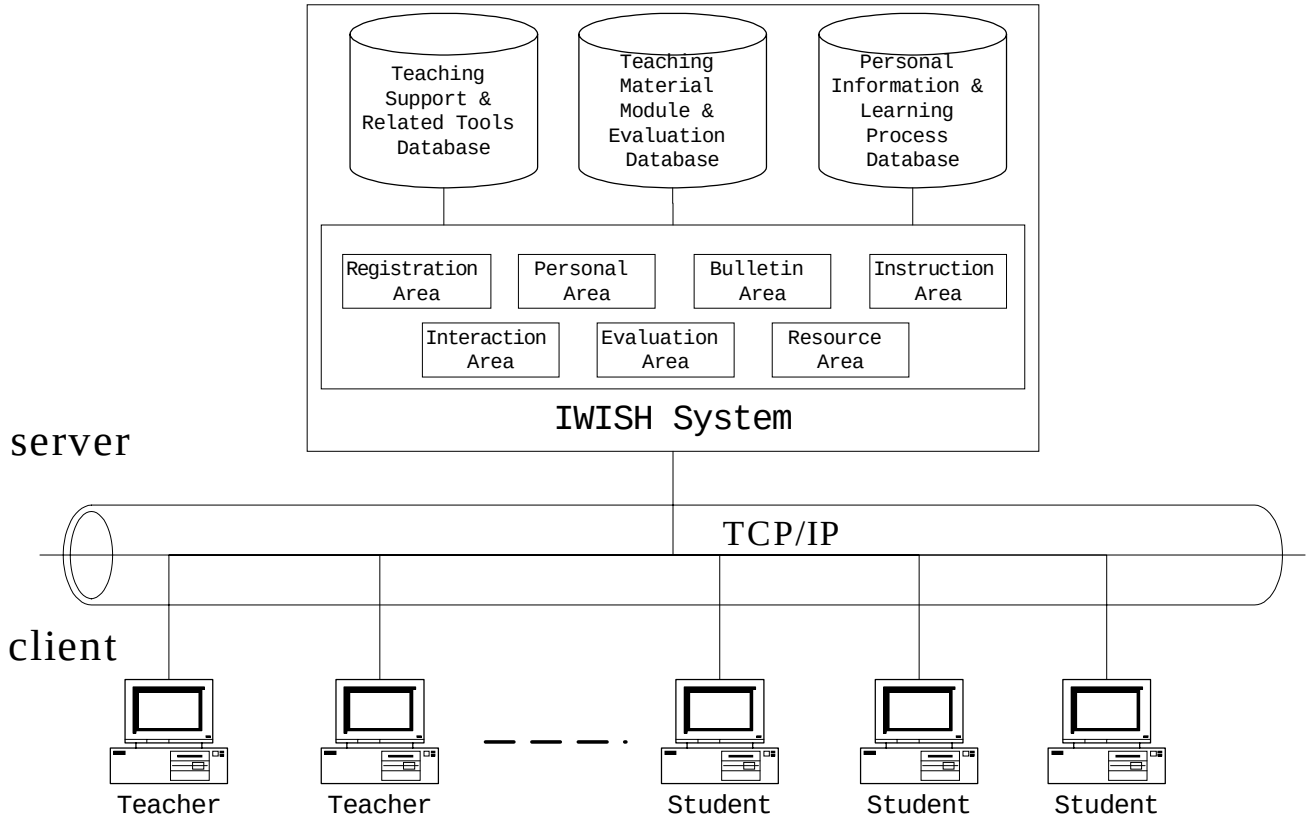

Figure 3: The intention of the asynchronous Web-based assisted instruction system's framework.

Registration Area

The registration area helps the students begin to understand this learning assistance network system. This will help the students become regular users of this teaching system. The area covers:

- The introduction to program system will help the students and visitors understand the teaching assistance network program.
- The registration of the student will require login account numbers and passwords for students to use this system while registering when the program begins to operate.
- The querying of account numbers and passwords to check these registered details.

Personal Area

The personal area helps to manage personal information files and incorporates:

- Students can change and inquire their personal information at any time.
- The data of all classmates can be found, including names, genders, birthdays, professional specialties, personal homepages, e-mail boxes, etc.
- The learning progress records include the number of visits, previous duration, total duration, number of messages, number of discussions, etc. Learning progress records of individuals and all classmates are provided for inquiry.

Bulletins Area

The bulletins area is a public contact channel for the system administrator, teachers, discussion supervisors and students. Dated and undated announcements, educational resources, recent discussion subjects and activity announcements can be used in this area. Furthermore, the bulletin board or e-mail can be utilised to notify students of date changes and discussion topics.

Instruction Area

The instruction area manages the assisted instructional files and also provides each teacher with a file storage location. In addition, it also helps the teacher to manage his/her files of course materials by modifying, deleting or inquiring about assisted instructional files. Because the assisted instructional file selection can have an impact upon the student's learning ability, the contents of this area several elements, featuring:

- Instructional progress checklist.
- Teacher's basic data.
- Instructional activity designs.
- Instructional activity evaluation.
- Student assignments and report.
- Course records for the student.

Interaction Area

The interaction area provides an opinion exchange environment for both teachers and students. It designs both discussion environments and electronic bulletin boards. Users can either post a topic or opinion, or they can respond to posted topics or opinions. This can be used to discuss difficult questions in the course materials or to review what has been learned. In using discussion, this facilitates an exchange regarding everybody's experiences or what they have learned.

Evaluation Area

Evaluations after the students finish learning are provided and cover:

- The online test exercise system is based on a question database and divides the questions in each module into two categories of Yes/No and multiple choice. Students can have continual test exercises that provide feedback immediately, thereby facilitating the user's mastery of each module.
- The uploading of students' assignment files and inquiry of personal and classmates' handing in status is facilitated.
- The formal examination consists of randomised questions in Yes/No and multiple choice formats. When the test time is up, the system will give an alarm and force students to hand in their test papers. Upon completion of the test, results can be shown at once and inquiries of test grades and rankings can be presented simultaneously.

Resource Area

The resource area is responsible for the management and presentation of each resource as well as other online resource connections. It accomplishes the consultation of prepared instructional materials and selects the online resource channel. It also maintains up-to-date materials. This aspect provides the following related resources:

- Instructional resources.
- Designing and consulting of instructional activities.
- Related instructional Web sites.
- New information.
- Further education channel.

WEBSITE DESIGN FOR THE IWISH SYSTEM

The design of the labour safety and health virtual classroom can be explained from four aspects covering:

- The Website function design of the virtual classroom major system.
- Design of online teaching material subsystem.
- Design of online test subsystem.
- Design of learning progress records subsystem.

Website Function Design of Virtual Classroom Major System

Based on the structural content of the system, the Website function design is conducted immediately in this research as shown in Figure 4. In addition to the seven major functions of the virtual classroom system, other value-added functions include the system bulletin, Website flow, online messaging, maxims and choice of songs, etc, so as to encourage usage.

Design of the Online Teaching Material Subsystem

The online teaching material system divides teaching material into many modules and provides the functions of inventory of directories, content guide map and turning page by page, etc, to facilitate the reading of online material. There are eight parts in each module set; these include: teaching objective, case study, basic terminology, course unit, test exercise, homework, question discussion and e-mail to the teacher, etc. Figure 5 shows the online teaching material design of labour safety and health. Currently, there are four developed modules, namely:

- Investigation and analysis of accidents;
- Mechanical safety and protection;
- Fire safety;
- Electrical safety.

Design of Online Test Subsystem

The online test subsystem allows the user to do online test exercises. At present, there are four modular sets of test paper databases for online test exercises with 228 questions in total, divided as follows:

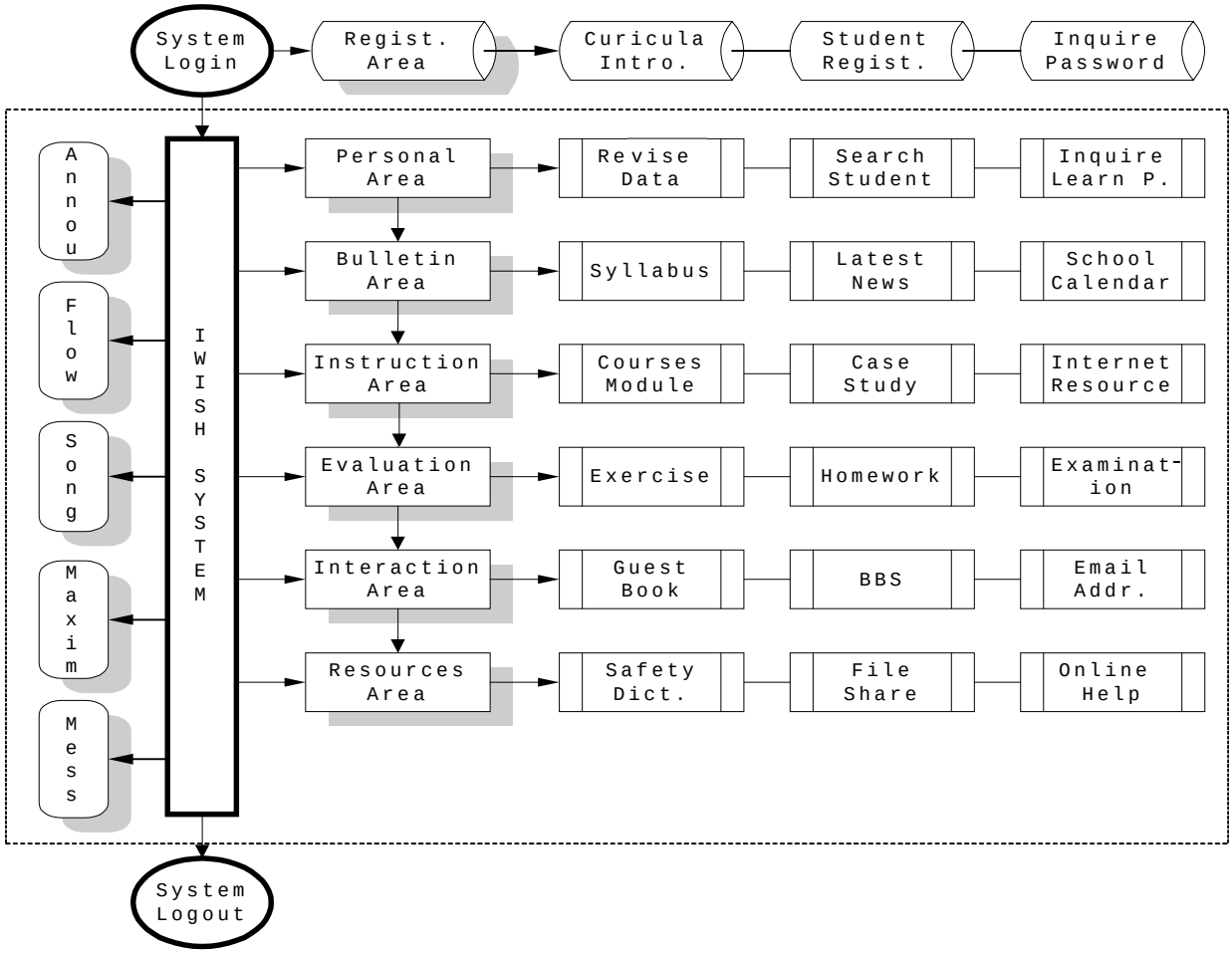

Figure 4: The Website's design for the IWISH system.

- The module on investigation and analysis of accidents has 71 questions in total, with 40 Yes/No questions and 31 multiple choice questions.
- The mechanical safety and protection module totals 41 questions, with 24 Yes/No questions and 17 multiple choice questions.
- The fire safety module has 70 questions, with 40 Yes/No questions and 30 multiple choice questions.
- The electrical safety module is comprised of 46 questions, with 25 Yes/No questions and 21 multiple choice questions.

Each module has two types of questions in Yes/No and multiple choice format. The system randomly gives 10 test questions each time for the user to complete and serves to reinforce the concept of each course.

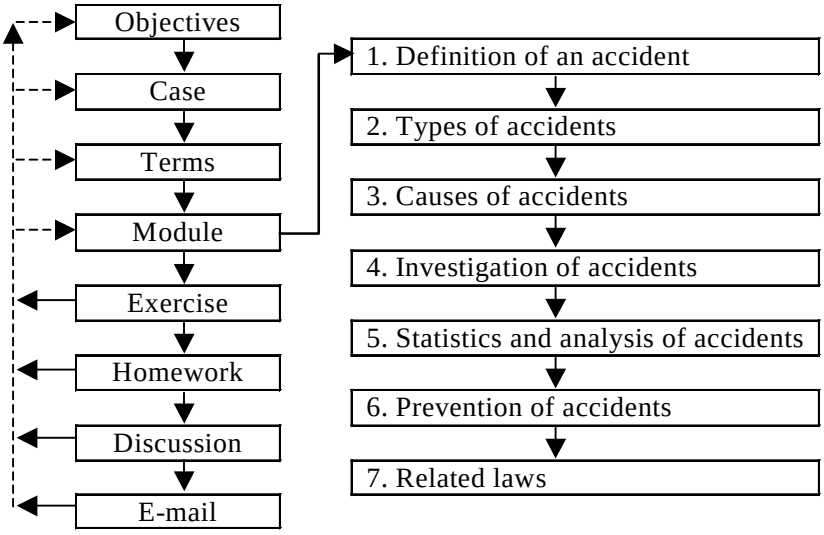

Figure 5: Online teaching material design of labour safety and health.

Design of the Learning Progress Records Subsystem

The learning progress records subsystem provides summarised information for Website users to conduct analyses. Thus, two functions are designed for different users as follows:

- User learning records consist of the number of visits, previous duration, number of discussions, number of messages left, number of teaching material accessed, duration of reading teaching material, number of online practices, duration of online practice, duration of various Website functions used, number of online messaging, etc.
- Website use records cover the number of daily visitors, number of weekly visitors, number of monthly visitors, number of accumulated visitors, daily flow statistics (per hour), annual flow statistics (per month) and statistics of various Website functions used, etc.

USER ROLES FOR THE IWISH SYSTEM

There are four kinds of roles that users can play as they sign in for the labour safety and health virtual classroom. These roles are: system manager, teacher, student and visitor with specified individual functions as listed below:

- **System Administrator**: The system administrator has limits of authority that are different from those owned by other roles played by users. He/she cannot participate in class activities; on the contrary, all he/she can do is manage groups, the bulletin board, messages, the curriculum and users. The person that installs the system is identical to the system administrator because he/she has to get the system prepared for use by setting up a portion of system groups and information while finishing installing the system.
- **Teacher**: After signing in the system, the teacher can leave messages, change personal information, add or delete information on students taking the course, start classes, commence teaching activities and manage the curriculum. To become an authorised user to start a class, he/she has to be identified as a teacher by the system manager.
- **Student**: Upon signing in the system, the student can leave messages and change personal information. However, he/she is not entitled to manage anything that relates to teaching in class. Anyone can become a student merely by registering an account number under open registration or by joining as a system administrator or a teacher.
- **Visitor**: The user who enters into the system without normal registration procedures through account numbers and passwords is a visitor. He/she is only allowed to take a look at the information and leave messages. However, the visitor is not permitted to go into sections such as course materials, assignment handing in, discussions, etc. This way, the rights of students taking the course can be protected.

SUGGESTIONS

The paper's discussion of establishing labour safety and hygiene virtual classrooms for asynchronous Web-based assisted instruction system is summarised below. Suggestions for further research regarding online asynchronous courses are also listed.

- Survey the present situation of universities' and colleges' usage of suite software for labour safety and hygiene. What types of software is being used and how often? What problems have been experienced? What opinions are to be found on the subject?
- Experiment with labour safety and hygiene virtual classrooms for asynchronous assisted instruction system.
- Research the students' learning efficiency results and carry out quantitative evaluation and qualitative research.
- Design a survey to identify what the students think about labour safety and hygiene virtual classrooms for asynchronous network assisted instruction.

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BIOGRAPHIES

David Wen-Shung Tai was born in July 1951 and is a Professor in the Department of Industrial Education at the National Changhua University of Education (NCUE) in Changhua, Taiwan. He completed his undergraduate degree in the Department of Industrial Education at the National Taiwan Normal University in Taipei, Taiwan, and earned his MS degree from the Department of Industrial Technology at the University of Wisconsin-Platteville in the USA. He earned simultaneously his MS degree from the Department of Computer Science at Iowa State University in the USA and his PhD from the Department of Industrial Education and Technology at the same University in 1987.

From 1987 to 1993, he was an Associate Professor at the NCUE and was awarded a professorship in 1993. From 1999 to 2001, he has been Chairman of the Department of Industrial Education. He was appointed the Dean of the College of Technology at National Taiwan Normal University as of 2001.

Prof. Tai's research experience includes engineering drawing, computer-assisted learning, spatial ability and problem solving. His latest projects include the study of promoting student spatial abilities and the problem solving abilities of orthographic engineering drawing in vocational high schools.

Jin-Chuan Lee was born in February 1964 and is an Associate Professor in the Department of Industrial Safety and Hygiene at the Chia-Nan University of Pharmacy and Science in Tainan, Taiwan. He completed his undergraduate degree in the Department of Industrial Education at the National Taiwan Normal University in Taipei, Taiwan, and earned his MA degree from same university. Dr Lee gained his PhD from the Department of Industrial Education at the National Changhua University of Education in Changhua, Taiwan.

Assoc. Prof. Lee's research experience includes Computer Aided Drawing (CAD) teaching, asynchronous Web-based Instruction (WBI), safety management and training in industrial safety. His latest projects include the study of asynchronous Web-based assisted instruction in virtual classrooms for industrial safety and hygiene.