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TELD: Courseware Engine as a Virtual Classroom for Active and Collaborative Teaching*

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TELD is an on-line courseware engine over the World-Wide-Web. Firstly, TELD represents a method of 'teaching by examples and learning by doing' that unifies a number of contemporary methods such as problem-based learning (PBL), project-based learning (PBL) and case method (CM) in medical, engineering and business education respectively. Secondly, TELD serves as a web server for hosting teaching and learning materials especially based on the TELD method. Thirdly, TELD is a courseware search engine where educators are able to register their course materials and search for materials suitable for a particular course. Finally, TELD is an on-line virtual classroom for electronic delivery of electronic curriculum materials and for on-line conduct of many class activities. This last TELD feature is the subject matter of this paper. Like most commercial on-line course tools, TELD provides typical facilities such as syllabus tool, calendar of events, e-mail and live chat boxes, threaded forums, etc. However, what is unique with TELD is that it combines the above three features into one courseware engine. This paper focuses on explaining how TELD is used as a virtual classroom for active and collaborative teaching and learning. The TELD web site is currently at http://www.teld.net/

INTRODUCTION

DURING THE LAST few years, there have been significant developments in the on-line course tools over the World-Wide-Web. WebCT [2], eTeaching Solutions [3], e-education [4], and Course Info [5] are some of the examples widely used at colleges. These tools host teaching and learning materials for both the teachers and students while providing facilities to enhance and improve the interactivity between the teachers and students. Typical on-line facilities provided in these tools include syllabus tool, calendar of events, e-mail and live chat boxes, threaded discussion forums, tests and exams, announcement bulletin boards, study journals, feedback questionnaires, etc.

These course tools can be used within and/or outside the classrooms. If they are used outside the classrooms at distance, they provide a virtual classroom environment for delivering curriculum materials at any time from anywhere by anyone who is enrolled on the course [6, 7]. If they are used as an enhancement in classroom teaching, they not only improve the accessibility but also interactivity within the classes. Wade, et al. [8] discusses their experience of not only the use but also the development of Web-based educational environments for software engineers.

TELD is yet another on-line courseware engine over the World-Wide-Web. However, TELD has its unique features. Firstly, the TELD engine is also a courseware search engine with which both teachers and students are able to search for relevant curriculum materials. This is similar to the function of the NEEDS search engine where teachers register their teaching materials while others including students get hyperlinks to down these materials. Secondly, the TELD engine is a web host with which teachers and students archive and obtain curriculum materials. This function is common in most software course tools. However, TELD specifically support the 'teaching by examples and learning by doing' method that unifies case method (CM), problem-base learning (PBL), and project-based learning (PBL) widely practiced in business, medical, and engineering education respectively. The third unique feature of the TELD engine is its on-line facilities supporting group activities in collaborative and participatory learning. Groups are able to plan their exercises and projects within TELD. Groups are able to prepare agendas for holding workshops or meetings on specific issues of the project and then report on the progress in the form of minutes of meetings.

OVERVIEW OF THE TELD.NET COURSEWARE ENGINE

TELD not only unifies the case method and problem/project-based learning methods but also represents a Web-based on-line courseware engine as a computer system on the Internet. After our

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The TELD web site is accessed at http://www.teld.net

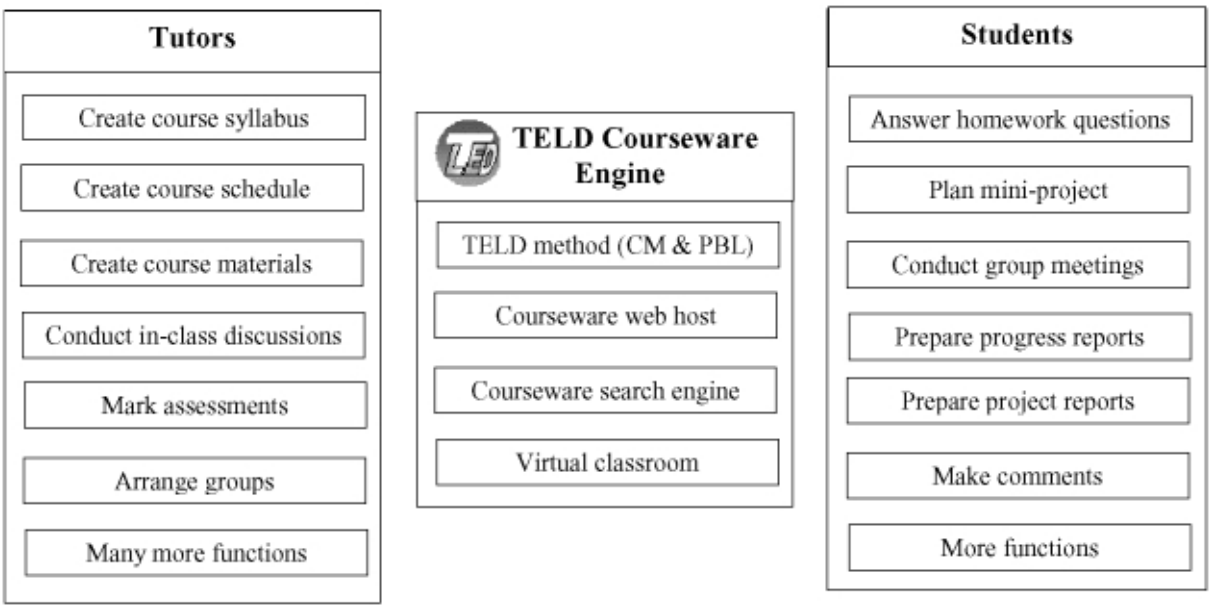


Fig. 1. TELD overview.

initial efforts, the prototype TELD system has been developed. Figure 1 shows a general scenario where TELD is used to support faculty and student users.

The TELD courseware engine combines the following four key functions into one framework:

- Firstly, TELD represents a teaching and learning method that unifies a number of contemporary methods such as problem-based learning (PBL) in medical education, project-based learning (PBL) in engineering education, and case method (CM) in business education.
- Secondly, TELD serves as a web server for hosting teaching and learning materials especially based on the TELD method. A variety of on-line facilities are provided for editing and uploading course materials such as syllabus, schedule, curriculum, examples of case study, exercises of mini-project, assessments.
- Thirdly, TELD is a courseware search engine where educators are able to register their course materials and search for materials suitable for a particular course. In contrast with general-purpose search engines, TELD is set up for the special purpose of education. Therefore, the time and efforts spent on surfing are expected to be reduced dramatically.
- Finally, TELD is an on-line virtual study room and classroom for electronic delivery of electronic curriculum materials.

TELD AS A TEACHING AND LEARNING METHOD

TELD stands for Teaching by Examples and Learning by Doing. It reflects an ancient Confucius education philosophy, 'I hear and I forget. I see and I remember. I do and I understand'. 'TELD' exactly reflects this ancient philosophy in modern education within a technology-intensive environment. 'Teaching by Examples' allows the students to 'see and then remember'. 'Learning by Doing' allows students to 'do and then understand'.

TELD is a method that has widely been used by a number of leading universities in delivering a variety of subjects and courses, with a number of variations. Examples, case studies and projects play an important role in TELD. The case method (CM) has been adopted by a vast number of business programs all over the world since its formal introduction at the Harvard Business School in the 1900s [9, 10]. Likewise, the problem-based learning (PBL) method has been widely practised by leading medical schools in the world since it was formally introduced at the McMaster University Faculty of Health Sciences in the 1920s [11, 12]. Engineers have always been trained through various projects. Project-based learning (PBL) has been commonly used for teaching senior undergraduate and graduate courses, even for teaching subjects such as design technology in primary and secondary schools [13].

It is only in recent years when case method (CM), and problem/project-based learning (PBL) are no longer the preserves of where they were originally introduced. They have now been widely promoted across a wide range of disciplines. Whatever the term is used to describe these methods, the essence is to extensively use real and/or hypothetical problems, examples, and case studies in the course of teaching and learning. TELD captures this essence and therefore unifies these different terms. For this reason, CM, PBL, and TELD are used interchangeably throughout this paper.

Like PBL and CM, TELD strongly emphasizes

self-centred learning by students themselves. This generally works well for senior students at year two and three or above, but proves a big challenge for first-year students. TELD balances this by providing clear guidance from the tutors/teachers so that the students know what they are doing and where they are getting and how to some extent. Such a balance between the knowledge acquisition and skill development is a major strength of TELD. That is, knowledge is most effectively acquired in the context in which it is discovered. 'Teaching by examples' provides such a context of problem-based learning. In addition, skills are most efficiently developed during the process by which a practical problem is solved. 'Learning by doing' creates such a problem-solving process.

Courseware web host

The World-Wide-Web (or Web/WWW) has become increasingly popular for tutors to provide their teaching and learning materials on the Internet. One of the most significant advantages of doing this is that students are able to access the materials anywhere and anytime on the Internet. It is now a straightforward practice to set up a personal computer as a web server to host the course web pages. Besides, most universities and organisations provide web hosts for individual course web pages/sites. For example, the Teaching Development Grants (TDG) from the Hong Kong University Grant Committee have supported a number of large projects for developing web sites and pages for various subjects such as civil and construction engineering, biodiversity, industrial engineering, etc.

In addition, there are commercial courseware hosts such as WebCT. These systems have been specially developed to host course materials from lecture notes to assessment quizzes. Many useful tools such as syllabus tool, on-line chat tool, course forum, etc. are provided.

Although the results from these HKUGC DTG projects have been impressive and commercial systems such as WebCT provide great convenience, they all suffer from a common weakness. That is, they do not explicitly support any contemporary teaching and learning methods such as PBL or CM or TELD method.

On the other hand, cases are at present published and available from various sources depending on the subjects. ECCH (European Case Clearing House) [14] and HBS (Harvard Business School) [15] are the two centres for distributing hundreds and hundreds of business cases around the world. These cases are not readily available from the Internet even with subscription.

The above analyses highlight a gap between the current use of the web technology in education and the contemporary teaching and learning method. The TELD courseware engine aims to fill this gap by providing a web host for TELD-based materials.

Courseware search engine

There is no doubt that a rich set of teaching and learning materials exists on the Internet all over the world. The remaining question is how to find the most appropriate materials on the web. One solution is to use search engines. Most of the search engines are for general purposes at present. They are not specifically developed for teaching and learning materials. Therefore, it is extremely time-consuming to surf for the most relevant materials by using keyword searches. The resulting list is usually very long and includes many irrelevant items. This often puts off tutors and students.

There seems to be the need for a special-purpose search engine for teaching and learning materials. In fact, the United States National Science Foundation has established a coalition of educational and industrial partners. This coalition has developed a national database, called NEEDS—the National Engineering Education Delivery System [16], to make product development and design cases available to educators, students, and practitioner engineers. The NEEDS engine has expanded into other subjects and disciplines such as chemistry. This kind of search engine is expected to play an effective role in teaching and learning.

TELD is yet another search engine with similar purpose. However, TELD is a search engine mainly devised for the teaching and learning materials hosted by itself although outside materials may also be included.

Virtual classroom and study room

TELD can be considered as a virtual on-line class or study room where tutors and students can look at the teaching and learning materials provided by the TELD courseware engine and more importantly, discuss relevant questions. TELD provides a rich set of facilities to facilitate studies within and outside the classes. For this reason, TELD can be considered as a virtual study/class room where tutors and students archive and fetch materials, ask and answer questions, and exchange comments on relevant points. Some of these functionalities are summarized as follows:

- *Course syllabus.* TELD is an on-line courseware web server that hosts multiple courses. Facilities are provided for registered teachers and organisations to create new courses and define their syllabus in TELD. This leads to a community of teachers and learners who share the resources in the Course Library.
- *Case management.* Cases are the basic constructs of TELD. They form what is called the Case Library. As a search engine, TELD supports teachers to find teaching and learning materials most relevant to his/her course(s) and topics. Cases can be adopted/adapted as teaching examples or learning (assessment) exercises.
- *Assessments.* Teachers use TELD to prepare both formative (discussion questions as homework) and summative assessments (comprehensive

exercises often in groups). Students submit their answers on-line onto the TELD database. On-line marking and commenting by tutors are supported.
- *Feedback and student-teacher interactions.* Course forum and questionnaires are some of the common methods to obtain student feedback on the course delivery. E-mails and on-line chatting are often useful interaction and communication tools.
- *Teaching and learning planning.* Facilities are provided for teachers to schedule their lectures, discussions, homework, and exercises. Similar facilities are also provided for students. Most significant is the facilities for students to organize their group work or meetings.

TELD constructs

The TELD courseware engine uses a number of specific terms or constructs in building up the backend database and the front-end user interfaces. A course is defined by its syllabus and is scheduled by a number of lessons/sessions in a semester or equivalent. A lesson is related to a case or certain part (called 'Sections' in TELD) of a case. Therefore, the concept of cases is the most fundamental building blocks of the TELD data constructs.

A case is usually dedicated to one key theme/topic in a course syllabus. In order to cover the entire syllabus of a course, several cases may be needed. These cases may be closely coupled with each other logically or may be simply loosely put together. In TELD, these cases used for the same course constitute what is called a 'curriculum'.

Three basic constructs have now been mentioned, i.e. course syllabus, curriculum and schedule. The syllabus specifies what themes of topics of a subject should be taught/covered in a course. The curriculum specifies the content materials, i.e. cases in TELD, with which topics/themes are discussed. The schedule specifies when and how long the topic/theme should be discussed with the assigned content materials. Readers may have different interpretations for these terms. However, they are used with the above specific meanings in the TELD data model.

Cases and curricula have different names when they are used for teaching and learning. When a case is used by the tutor to teach a course, it is called an example. When a case is used by the students to learn a theme/topic of the course (as part of the summative assessment), it is called an exercise.

Likewise, when a curriculum is used for teaching, it is called a case study (which consists of multiple examples). When a curriculum is used for summative assessment, it is called a project or mini-project (which consists of multiple exercises).

ACTIVE TEACHING WITH TELD

TELD provides a number of on-line facilities for delivering lectures and conducting a variety of activities associated with the course delivery. Some of them are listed below and will be examined in more detail in this section:

- checking participation and attendance in classes and workshops;
- delivering lectures using the course materials according to the schedule;
- conducting in-class discussions;
- marking discussion questions (homework);
- marking mini-project exercises;
- conducting peer-assessment among student groups;
- obtaining student feedback through the course forum and questionnaires.

TELD virtual classroom

A virtual classroom is an environment where lectures are given electronically with the help of software and computer-mediated communications [7]. Such an environment may be geographically distributed while linked to the Internet through the Web. TELD provides a number of facilities for both the tutors and students in this typical situation of distance learning. In the meanwhile, these

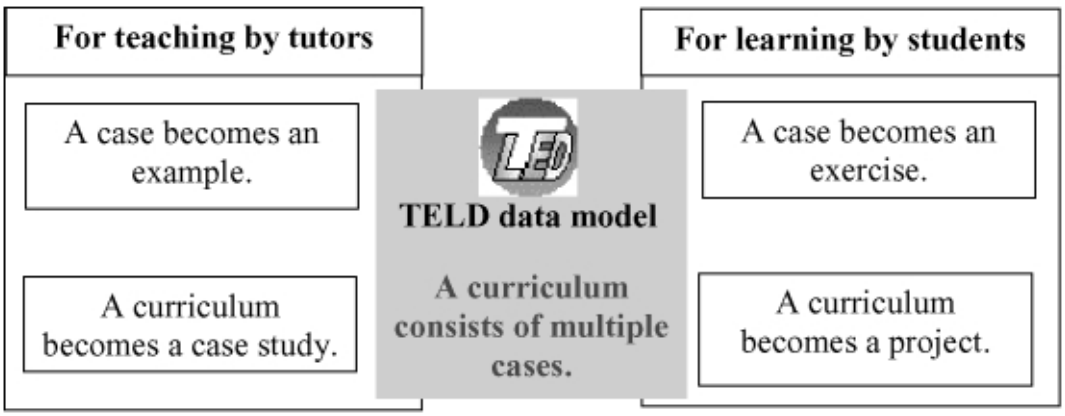


Fig. 2. Many faces of TELD constructs.

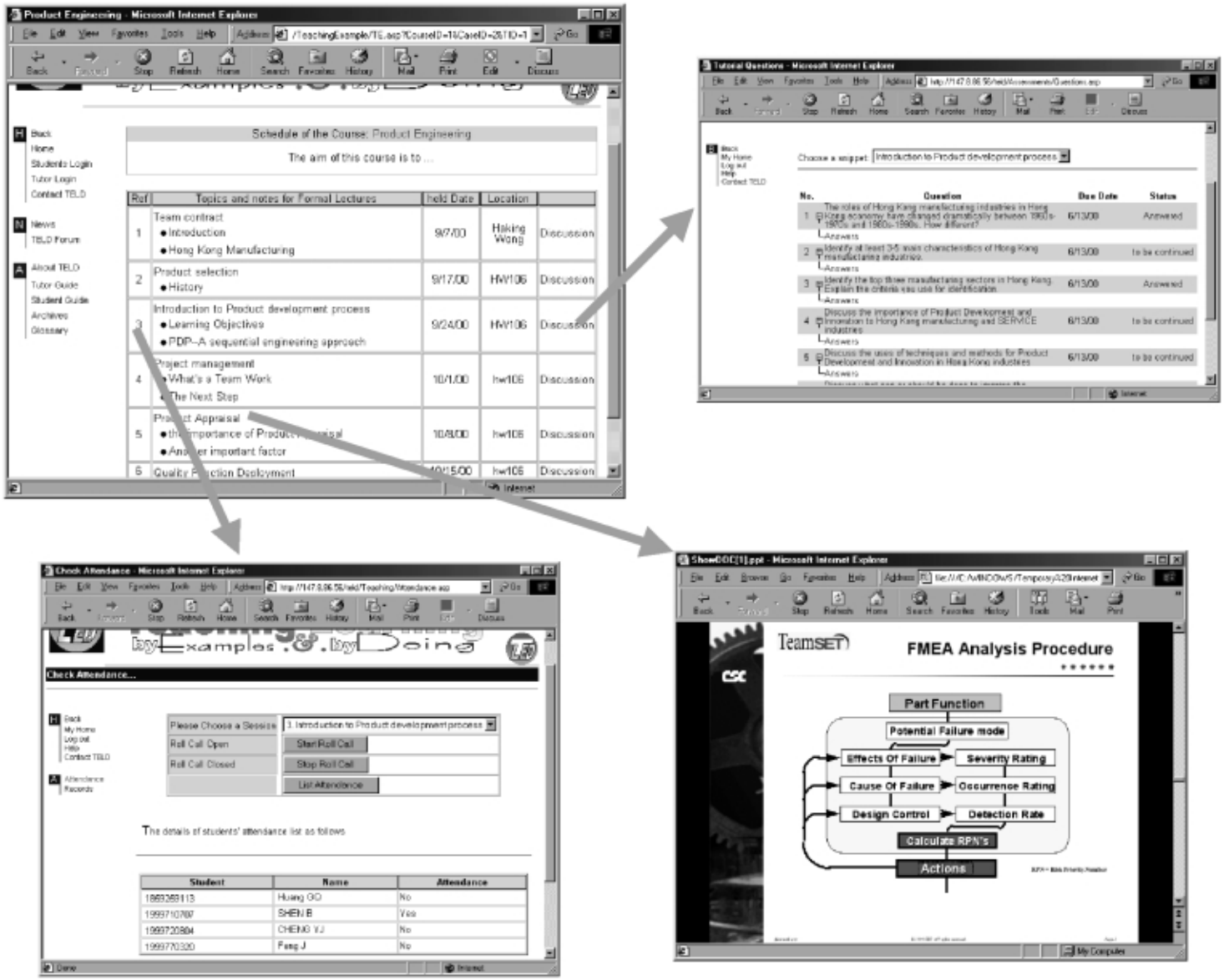


Fig. 3. Attendance and participation record.

facilities are actually enhancements to a classroom where traditional lectures are given by a tutor and each student (each group of students) is provided with a networked computer. This latter situation of virtual classroom is used for discussion here.

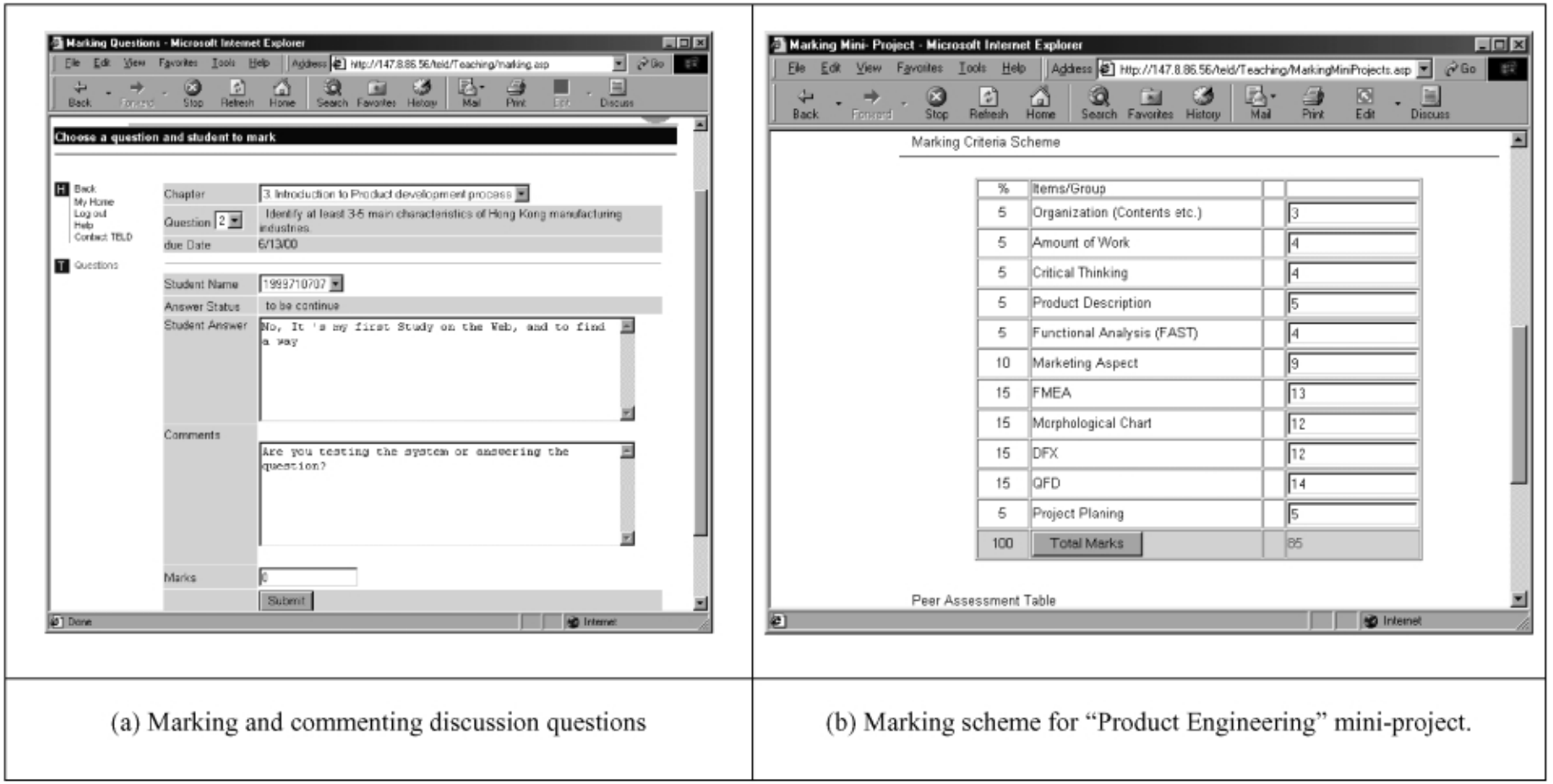
Figure 3 shows sample screens of the TELD course schedule and facilities that are attached to the schedule.

- *Check participation/attendance.* Student attendance in lectures in many universities is not compulsory although strongly recommended. However, participation and attendance are essential in some courses such as 'Product Engineering' where continuous assessments are extensively used during the lectures and tutorials. Both formative and summative assessments are scheduled in accordance with lecture schedule. Therefore, it is essential for students to participate and attend the lectures and workshops. Such attendance and participation should be recorded for the reference purpose when carrying out peer-assessment towards the end. TELD provides a set of facilities for the tutor to call the register/attendance. For continuous assessment, it is necessary to register the attendance or participation. One approach is to open the call for a period of time to allow students to check in themselves. An advantage is that it does not occupy class time and a disadvantage is that some students may forget to do this. Another approach is for the tutor to call the register student by student. The advantage is no student is missed and the disadvantage is that it takes time to do this in the class.
- *Delivering lecture notes.* During the preparation stage, lecture notes and class schedules have been defined. The delivery of the lecturing materials follows the sessions/lessons in the schedule. One session may cover one example or several sections of an example. In order to download the corresponding lecture notes, the tutor only needs to click on the example or section title which has the hyperlink to the original materials. If the materials have been prepared in MS Powerpoint, the file is downloaded to the client computer and opened ready for lecture uses. It should be noted that downloading may be time consuming in the class when the file is very large. It is suggested that the tutor should download the material before the class.
- *Conducting in-class discussion.* It is not unusual for a lecturer to start or conclude a lecture by asking a number of questions to attract students' attention or summarise key points respectively. This is done through a list of in-class discussion questions as prepared in advance. The lecturer may click the corresponding button before or after even during the lecture, depending on his or her plan. Although these questions are for discussion purpose only and not for assessment purpose, students generally expect such answers either during the class or after the class. The lecturer may or not give full answers to these questions in the class. Instead, answers are made available to students after the class by students themselves. This is easily achieved by a single click on the question and the answer page is returned to the student client browser if the answer is entered in advance.

Marking assessments

TELD provides two types of assessment: formative discussion questions and summative mini-project. Students can use TELD to submit their answers on-line. Similarly the tutors are able to mark the student work on-line. Figure 4 shows sample screens for marking homework questions and mini-project.

- *Marking discussion questions.* Discussion questions are usually assigned as homework for students to revise the topic covered by the case study. These questions are for the formative assessment purpose. That is, only a small portion of marks is allocated for each question and the main purpose is for students to get tutors' comments on their understanding of the topic/issues. TELD provides on-line facilities for this purpose. The tutor may choose to make the comments question by question (with a list of the students) or student by student (with a list of questions related to the case study) whichever he or she considers most convenient. When the hyperlink to the student or the question is clicked, a new window is popped up with the empty comment and marking form. The tutor may apply the same comment to a group of students.
- *Marking exercises of mini-project.* In TELD exercises are basically summative assessments. By summative it is meant that the marks account for noticeable proportion of the total mark. In our 'Product Engineering' course, exercises are logically combined to form what is called mini-project. The mini-project is collaborative learning and therefore is organized as group activities. TELD supports for group activities will be discussed in a later section. The mini-project consists of several exercises. Each exercise is basically a case study about a chosen product from a certain aspect. For example, typical case studies include Design for Manufacture and Assembly (DFMA) Analysis, Failure Mode and Effect Analysis (FMEA), Quality Function Deployment (QFD) Analysis, and Morphological Chart (MC) Analysis. These methods and techniques have been explained through examples in the lectures. Students are then required to apply them to a product that their group has chosen to analyse. Students are advised to separate their case studies into chapters of the mini-project report. When marking group mini-projects, tutors usually use some kind of marking scheme which is designed in advance. Figure 4 (b) shows the scheme used for the 'Product Engineering' course.



(a) Marking and commenting discussion questions

(b) Marking scheme for "Product Engineering" mini-project.

Fig. 4. Marking assessments in TELD: (a) marking and commenting discussion questions; (b) marking scheme for Product Engineering mini-project.

On-line peer assessments by students

Peer assessment has become a popular method of differentiating individual contributions within a project team. The method has been proven efficient and effective. The method can be simply described as follows:

- A group mark M is assigned by the tutor to the project.
- Assume a group with n members.
- Each member in the group has a total of $100 \times n$ marks.
- The marks are redistributed to individual members according to their contributions.
- Then the total marks that a member receives are calculated as Ti.
- The individual mark for a member i is then calculated as $Ti/(100n)$.

However effective the peer assessment is, the process is tedious, with many forms to distribute and collect. Afterwards, data must be collated and carefully calculated. There is every reason to computerize the process. This is easily achieved in TELD. Figure 5 (a) shows the screen of the peer assessment form for the students and their project groups. Figure 5 (b) shows the sample screen of using peer-assessment results in calculating individual marks for group members.

Obtaining student feedback through course forum and questionnaires

TELD provides two on-line channels for students to feed their comments to the course tutor(s). One is through the use of the TELD course forum as shown in Figure 6 (a). Students are free to submit any questions about the course to the forum for the whole class to share. Comments may range from about technical topics to general views about the course or its delivery. The tutor is only an equal member of the forum and is able to deal with some of the comments on-line. Comments can be anonymous if the students would like to avoid their identities in a particular comment. Generally speaking, anonymous comments should be avoided in the forum because they defeat the purpose of bi-directional communications.

In addition to the course forum, it becomes almost standard practice to obtain student feedback through questionnaires on the course and the tutors who are involved in its delivery in many universities worldwide. TELD provides on-line questionnaire facilities for this purpose, as shown in Figure 6 (b). Each student is qualified for submitting one questionnaire to the TELD system while student identities are not maintained in the database in order to keep the feedback anonymous. After all the students submitted their questionnaire, TELD calculates the statistics.

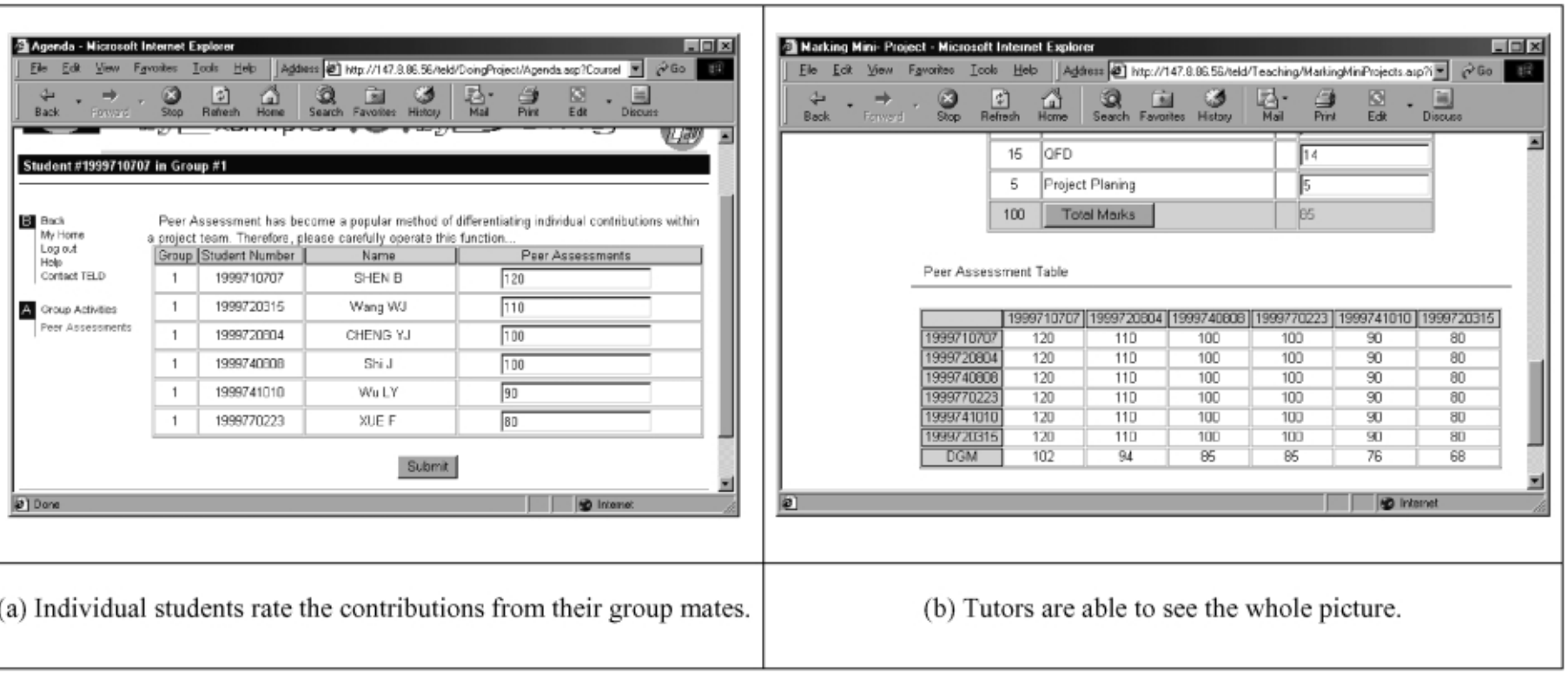
CONCLUDING DISCUSSIONS

This paper has discussed the TELD.net courseware engine as a virtual classroom using the context of the delivery of the Product Engineering course. The emphasis has been placed upon the proactive roles that the virtual classroom play in encouraging student involvement and collaboration in the process of teaching and learning, especially in class activities. From the master course schedule, a number of facilities are readily accessible. For example, both the tutor and students are able to record student attendance and/or participation in class activities on-line. Corresponding lecture notes are easily accessed through the master course schedule from anywhere at any time. In-class discussions can be conducted by posting the tutorial questions associated with the class. TELD also acts as a virtual study room for students to discuss homework questions and conduct mini-project exercises during and/or after the lessons. On-line marking facilities are provided for the tutors to make timely comments on students' work. In addition, the course tutors are able to obtain students' comments on the course materials and the course delivery process through questionnaires and course forums. All these on-line facilities encourage the authors to explore the uses of TELD in other courses.

In order to further improve and expand the TELD capabilities, several directions deserve immediate investigation in addition to a number of routine improvements. Firstly, a questionnaire editor is needed so that different questions can be incorporated into the questionnaires to suit the requirements of other courses and universities. At present, only three questionnaires following the format at the University of Hong Kong are used to obtain student feedback on the Product Engineering course, and lecturers and tutors (demonstrators) who are involved in the delivery of the course. A questionnaire editor would be necessary.

Secondly, a similar limitation exists with the marking scheme for mini-project. At present, the scheme is based on what has been used for marking our Product Engineering mini-project. In order for the TELD to support other courses, it is necessary to have an editor for defining various marking schemes used for different courses.

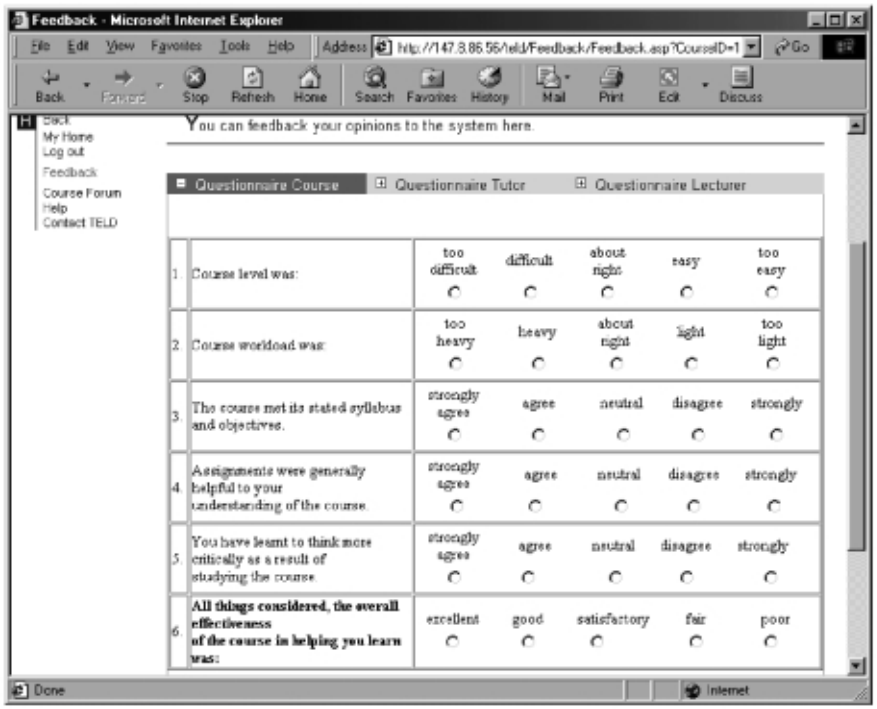
Thirdly, the facilities for answering homework questions only support textual descriptions and do not support questions and diagrams. This may not be sufficient for many courses that extensively require equation and diagram editing. In this case, more diagramming and equation editing functions are needed in TELD. Alternatively, students may use existing word processors to edit their answers and use commercial drawing packages to produce diagrams. It is possible to upload these original files onto the TELD database. The tutors then read the original documents when marking the answers.



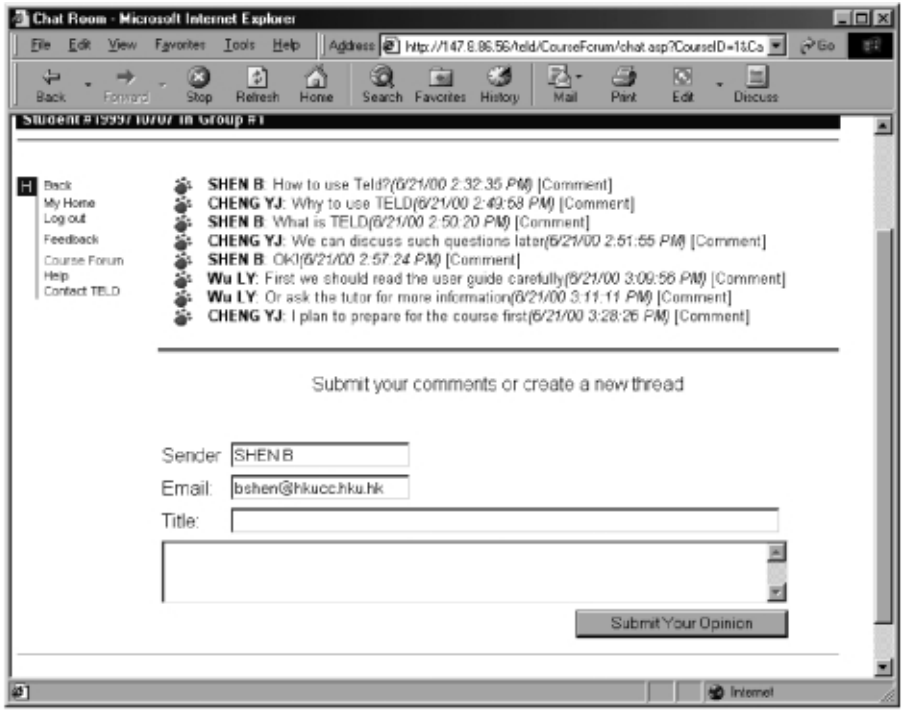
(a) Individual students rate the contributions from their group mates.

(b) Tutors are able to see the whole picture.

Fig. 5. Peer assessment by individual students and group results: (a) individual students rate the contributions from their group mates; (b) tutors are able to see the whole picture.



(a) Questionnaires for obtaining student feedbacks



(b) Course forum for encouraging discussions.

Fig. 6. Course forums and questionnaires for obtaining student feedbacks: (a) questionnaires for obtaining student feedbacks; (b) Course forum for encouraging discussions.

Fourthly, other forms of assessment may be useful. For example, questions of multiple choice type are popular for students to test their own understanding of a topic themselves. Therefore, the TELD question editor should support this type of self-test.

Finally, on-line examinations are not included in TELD. Some thoughts have been given to provide such facilities to support on-line exams. For example, examination sessions are arranged within a specified time period. The corresponding web pages containing the exam questions are made available to students who take part in the exam. However, there are technical and social constraints of doing this. Technically, students often need to answer questions using diagrams and equations. Students with limited skills of using computerised sketching and equation editing facilities may be unnecessarily disadvantaged. This may be compensated by giving them extra time. Socially, on-line examination may not be acceptable to many universities because of difficulties in preventing plagiarism. This occurs particularly where exams take place at a distance without close invigilation, even with exams of the open-book type. One possible solution is to use video conferencing facilities to monitor the student identities and on-line communications with the invigilators. Alternatively, students are required to attend exams at specified exam centres where strict invigilation is maintained.

Technically, the above issues can be addressed by incorporating appropriate facilities into TELD. In fact, ongoing efforts are being made in these areas. It is expected that they would be provided in the next release in the near future. TELD with such enhanced facilities are expected to play increasingly important roles in the future education within the environment of virtual classrooms/study rooms.

Acknowledgements—This work has been financially sponsored through a Teaching Development Grant from the University of Hong Kong and Hong Kong University Grant Committee.

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