Teaching a *Clean Coal Technology* course based on learning by services

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ABSTRACT: The *Clean Coal Technology* course has been reformed to include the use of the virtual learning environment of modular object-oriented dynamic learning environment (Moodle). The authors describe the background of the course reform, the design of the virtual learning environment, the implementation and the tracking procedure, to determine its success. The teaching model provides a new way of teaching clean coal technology, and one that is an effective service for teachers and students.

INTRODUCTION

Clean Coal Technology is one of the professional courses in the mineral processing discipline and is an energy project in the National 863 Programme, which is a Chinese Government programme to foster the development of technology. Clean coal technology studies include coal preparation, coal transformation, advanced combustion, flue gas purification and reuse of resources, pollution, and efficiency. It is a follow-on course for other majors, with various content that includes fluid mechanics, mining, special mining and organic chemistry. The students have difficulty in learning some parts of the course, such as that dealing with fuel cells and coal transformation, which has a negative impact on their engagement with the course and learning outcomes. Teaching in the class is carried out with a combination of traditional teaching methods and multimedia. More specifically, the goals of the reform of this course are to improve the students' interest, improve knowledge acquisition, and develop the ability to identify, analyse and solve problems. The reform of the course is the subject of this article, with the result that it is now more interactive and provides students with adequate learning resources.

LEARNING BY SERVICES

The theory of network distant learning is rooted in the ideas of learning by services, with the services identified by the material to be learnt and implemented to meet the needs of distance learning and management. The concept originated from David Sewart of the Open University, in the United Kingdom, over the need to support distance learning students in their studies. These support needs included teaching content, guidance and counselling via an interactive exchange between teachers and students. This process offers continuous support for student learning, as well as a better service [1]. A systematic approach was taken to reforming the Clean Coal Technology course guided by educational psychology [2]. The design is a model of the services required for on-line teaching reform of the Clean Coal Technology course, as shown in Figure 1.

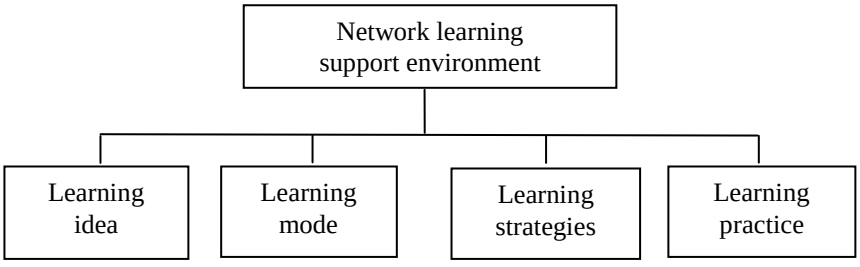

Figure 1: Model of learning by services.

This model is guided by modern learning theories and applies effective learning strategies to the study of the curriculum. Special attention was paid to the teaching strategies and methods of operation required by a virtual learning environment. The development of a prototype from this model was used to firm-up all the elements of the system.

COURSES INFORMATION MODEL

Clean Coal Technology Course Model

The authors studied a blended mode of learning for the Clean Coal Technology course. This combines on-line network teaching with face-to-face contact. Blended learning allows appropriate learning techniques and technology to be employed dependent upon the learner and the material being learnt [3].

The blended learning mode makes use of a virtual learning space supported by the network. The Moodle (modular object-oriented dynamic learning environment) open source learning tool was used to provide the networked learning support. Moodle was developed by Martin Dougiamas, an Australian teacher, as a free open source e-learning platform and is currently one of the most widely used e-learning platforms in the world. As a result of the latest award from the Centre for Learning and Performance Technologies (C4LPT), Moodle is ranked tenth for all sorts of educational software and was first in course management in 2010. This system of *learning by services* is supported by Moodle.

The first step is to set up the basic open software environment or WAMP (Windows/Apache/MySQL/PHP) on the Moodle Windows server. Moodle, then, can be configured, its performance optimised and tailored for the client [4]. The last step is to add the digital learning resources, as shown in Figure 2.

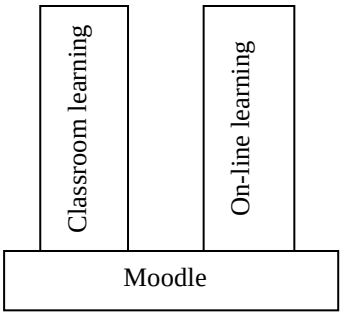

Figure 2: Blended learning mode of teaching for the Clean Coal Technology course using Moodle.

Design of the Virtual Learning Environment

Unified Modelling Language (or UML) was used for the design of the on-line learning functions, as shown in Figure 3. The functions include course management, assignments, chatting, voting, forums, testing and interactive evaluation.

Course Management

A teacher with permission can fully control the course settings, including that of involving other teachers or selecting course format by week. The system includes forums, a voting system, questionnaire surveys, assignments, a chat room, notification of curriculum changes, and so on. Most of the texts (such as resources and forum posts) use a WYSIWYG editor. The evaluation scores from forums, quizzes and assignments can be viewed on the same page (downloaded as a spreadsheet file), including a comprehensive user log and statistics for each student activity. Details are provided of each module (the last access time and the number of accesses), participants in discussions, and so on. Each student is on the mail system and forums. Teachers can define their own ratings and scores for forums and assignments. This can be backed up as a zip file and restored on any Moodle server.

Assignments

Teachers can specify a deadline for an assignment and the score it will be marked out of. Students can upload work (in any file format) to the server. Late homework may be allowed, but teachers can clearly see the status of the assignment for the entire class (scoring and evaluation) on one page. Teacher feedback will be displayed in the student's work page, and there is an email notification feature if the teacher wishes a resubmission.

Chat, Voting, and Forum Modules

For chatting, the students can interact with the teachers via the module at any time, and the interactive page includes a variety of vivid pictures and friendly expressions. For voting, the students can complete a vote and the teacher can see their choices. In the forum, the courses, type of users, and other topics can be discussed; and the forum posts can include photos, pictures and attachments. These posts can be browsed and each person may subscribe to a forum, so the

posts will be sent by email. A teacher can easily change the subject of a forum. If specified for the forum, the time on the forum can be limited.

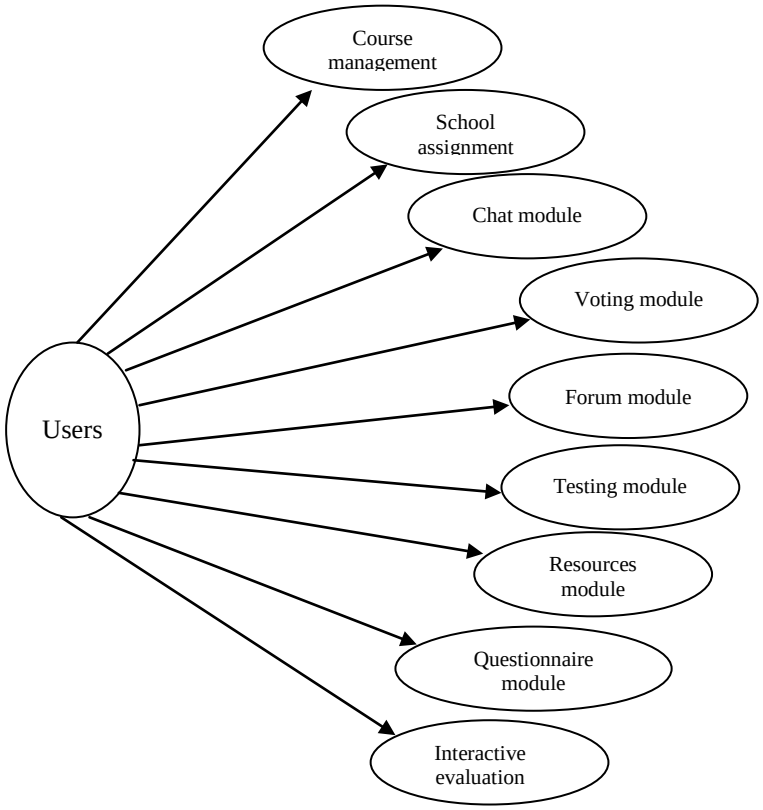

Figure 3: The basic functional design of Moodle.

Test Module

The teachers need to define the question bank containing the test questions. Examination questions can be saved in different categories to be easily reused. The marking can be automatic and re-testing can be allowed. The students may try several tests as specified by the teachers, with random questioning, so as to reduce cheating. The tests can contain HTML and images from external files. Some questions allow for one or more answers. This may include filling in blanks (words or phrases), matching questions, random questions, calculation problems and embedded answer questions. Various topics in Moodle can be backed up from the international standard learning management system.

Resource Module

Resources on the system can be displayed as a document, for example, in formats such as Word, PowerPoint, Flash, or video. Files can be uploaded and managed by the server. Links to external Web resources can be incorporated into curriculum material.

Questionnaire Module

As an analytical tool, the system questionnaires COLLES (constructivist on-line learning environment survey) and ATTLS (attitudes towards thinking and learning survey) have proven to be effective and a text and graphical report is available. Data can be downloaded as an Excel spreadsheet or CSV text file, and students' answers compared with the average of other classes.

Multiple Evaluation Mechanism

The students can evaluate samples provided by teachers and the teachers score the evaluations. Teachers can provide sample documents to practise.

THE IMPLEMENTATION AND TRACKING EFFECT OF THE REFORM OF THE COURSE, CLEAN COAL TECHNOLOGY

Since 2012, students have been praising the reformed Clean Coal Technology course using blended teaching. The course has rich learning resources, a flexible interactive format, and is supplemented by face-to-face student-teacher contact. There are 120 scheduled class hours, extended by 50 hours by the face-to-face teaching, for a total of 170

hours. The blended teaching saves classroom resources, extends the limited classroom time, and also improves the teaching.

In addition, the use of the course platform ensures quality and encourages visits [5]. The log statistics module can be accessed to track the users, the course, track by date, or the subject, as shown in Table 1. There were over 7,000 visits in a year. This result demonstrates the success of the teaching reform of the course.

Table1: Course tracking record.

Time	IP address	Name	Action
December 12, 2013	1.189.209.30	User 1	User view
December 12, 2013	1.189.209.27	User 2	Course view
December 12, 2013	1.189.209.29	User 3	Survey view form
December 12, 2013	1.189.209.30	User 4	Resource view
December 12, 2013	1.189.209.328	User 5	Course view
December 12, 2013	1.189.209.37	User 6	Journal view
December 12, 2013	1.189.209.37	User 7	Journal add entry

IMPACT ON ENGINEERING AND TECHNOLOGY EDUCATION

The curriculum reform with blended teaching has had an important impact on engineering and technology education. It can been seen from Figure 4, that the number of courses has grown, from 1 to 32; the number of users, from 30 to 1,029; and the monthly view frequency to 3,890. This reflects students' interest in the courses has increased significantly.

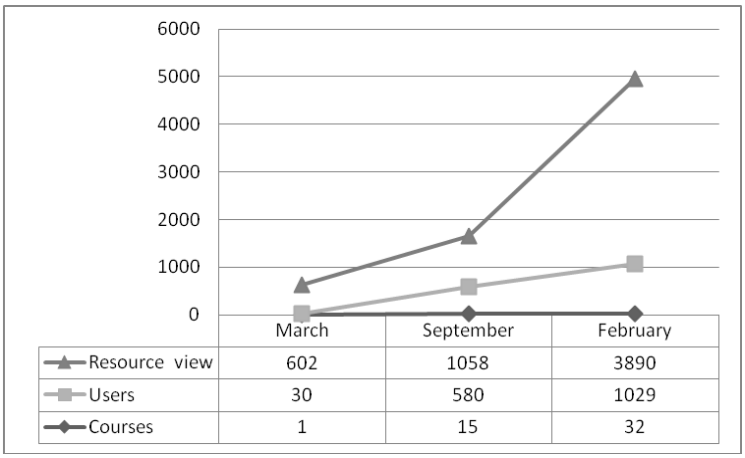

Figure 4: The effect of curriculum teaching reform.

Student Engineering Capabilities

For engineers, the improvement in IT capabilities is an important move. The authors have carried out a survey of student engineering capabilities [7]. The survey investigated engineering competency before and after the course. The survey included responsibility, professional knowledge, team communication, and knowledge of the literature, as shown in Figure 5.

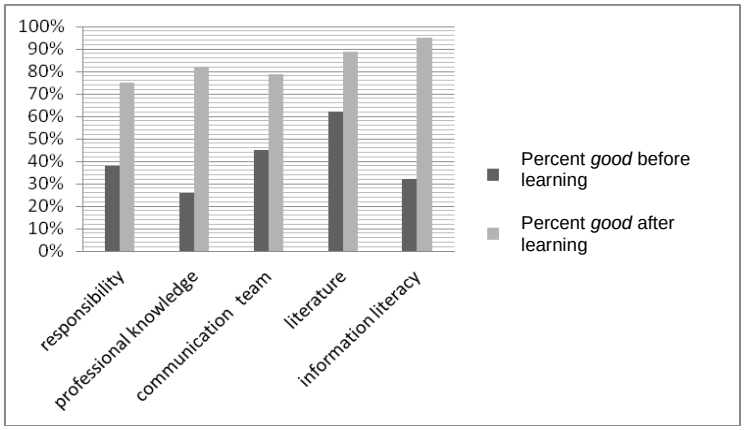

Figure 5: Engineering students' competency improvement before and after teaching.

CONCLUSIONS

The results show that the teaching reform of the Clean Coal Technology course was a suitable development for students. The teaching evaluation data illustrate that the implementation of the reforms has improved students' learning ability. The authors suggest that other courses also could benefit from implementing similar reforms.

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