Archives of Materials Science and Engineering

Volume 28
Issue 11
November 2007
Pages 691-694

International Scientific Journal
published monthly as the organ of
the Committee of Materials Science
of the Polish Academy of Sciences

Teaching of material science matters using e-learning techniques

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Received 15.10.2007; published in revised form 01.11.2007

ABSTRACT

Purpose: The paper presents the usage of educational e-learning system introduced in Institute of Engineering Materials and Biomaterials. The available activates and possibilities of introducing e-learning methods in teaching of materials science matters such as Fundamentals of Materials Science were presented. Novel instruments in e-learning system like virtual laboratories were also presented.

Design/methodology/approach: Utilization of e-learning system in materials science teaching was presented. Presented e-learning platform was elaborated as a modern distance education tool and contains didactic materials used for lectures and materials science classes. The paper contains the description of learning within the mixed mode. The use possibilities of the virtual laboratory were presented.

Findings: Utilization of e-learning techniques in teaching of materials science matters seems to be very promising when introduced to high education level but continues improvements of applied instruments must be performed.

Research limitations/implications: Larger population of students should be tested so as to give measurable results, which would imply what needs to be worked on and what changes to introduce in order to improve the e-learning process.

Originality/value: The course presented in this article confirms that e-learning enables the introduction of the new education formula, which may enclose advantages of traditional teaching and distance education as far as materials science is concerned.

Keywords: E-learning; Computer aided teaching; Virtual laboratory

EDUCATION AND RESEARCH TRENDS IN MATERIALS SCIENCE AND ENGINEERING

1. Introduction

E-learning systems separate lecturer from student in time and space for the greatest duration of lectures. They are found as identity of technology of remittance for teaching and studying persons, disengagement of communication between lecturers and students, individualization of programs of student occupations, high level of self-observation and self-control of progress of studies by the students themselves. An advantage of e-learning systems is this same repeatable quality of education process. There are no time limitations place and number of studying persons. Estimations of results are made by the computer, always according to identical criterions [1-4].

There are many definitions of the e-learning process. One of them characterizes it as the means of introducing education, which can be used in many different education modes, in traditional and distance education and philosophies of education such as behaviourism and constructivism.

E-learning is based on usage of different net distributed technical tools and the development of computer technology, broad stream access to the internet and computers increasingly common in a household, makes this means of communication become widely used in education. What increases grows fast is in particular the number of trainings meant for the workers of big companies, public administration and higher education. It is also becoming more popular

in middle and secondary schools. The development is highly financed by different European Union programmes supporting e-learning. It's main goal is to adjust education and teaching systems in European Union to based on economy i.e. information technology and knowledge [1-10].

E-learning may be realized in many ways. Available methods and techniques can be grouped in five categories:

- time accessibility,
- practical techniques,
- student - teacher cooperation,
- relations to traditional learning,
- level of formalization.

Student - teacher cooperation in e-learning systems can be realized in courses with presence of teacher or courses without participation of teacher, but basing on multimedia information and instructions and as a independent learning, based on different kinds of accessible information in electronic form, in peculiarities contents of www sites, but also with conversations with other persons (e.g. chats, discussion forums, e-mails, communicators etc.).

2. E-learning system

Institute of Engineering Materials and Biomaterials of Mechanical Engineering Faculty in Gliwice created in October 2004 an e-learning platform based on Moodle open source project (fig. 1). E-learning system was elaborated as a modern distance education tool and contains didactic materials used for lectures and materials science classes as well as instructions for laboratory classes in the Institute, available for students and teachers. It is also used for interactive communication among students and the Institute employees [10-14].

Moodle is an open source software package written in php language designed to help educators in creating quality online courses. The word Moodle is an acronym for Modular Object Oriented Dynamic Learning Environment. It has been evolving since 1999 (since 2001 with the current architecture) and has been translated into 61 different languages. Such e-learning systems are sometimes called Learning Management Systems (LMS), Course Management Systems (CMS) and Virtual Learning Environments (VLE), education via Computer-Mediated Communication (CMC) or Online Education [8].

Main advantage of Moodle software is the capability to run without modifications on various computer systems such as Unix, Linux, FreeBSD, Windows, Mac OS X, NetWare and any other system that supports PHP, including most web host providers. The data is stored in a single database MySQL and PostgreSQL, but it can also be used with commercial databases. This system is easy to install and upgrade. Moodle is free and has no license costs. It can be installed on as many servers as required at no additional cost.

Reaching out the growing interest for remote education, Institute of Engineering Materials and Biomaterials started a distance learning platform based on the "Moodle" project. It has offered the access to electronic materials, that are addition for processes of traditional education the contents selection and the presentation manner depending on the teacher's choice. He can choose from numerous modules integrated in the Moodle system. First of them are the HTML or plain text internet sites; thanks to WYSIWYG editor formatting of text, putting tables or images is very easy and visually similar to services of MS Word Editor.

Module assignment includes aims to comprehend, dates of completion and maximum mark for it. Students will be able to send one file to fulfil the task. On a single page the teacher can look through every file, gather information about file sent with delay or in advance and to record marks and comment. With a delay of half on hour system will send notifications to the students with use of electronic post.

The forum module is probably the most important component. Here take place all discussions. With addition of new forum, teacher has possibility of choosing different types of discussion, such as straight discussion on one theme, general forum accessible for all, or one thread of single user.

Quiz module makes possible creation and testing in form of quizzes consisting of multiple choice questions, yes/no type questions and short answers exacting questions. Questions, ordered in categories are placed in database and can be used again in frames of that course, or even transferred to other course. Quizzes can allow repeated tests of finding solutions. Every test is automatically checked and teacher can decide whether to the test comment or to correct answers.

Module lesson delivers content in an interesting and flexible way. It consists of a number of pages. Each page normally ends with a multiple choice question. Navigation through the lesson can be straight, forward or complex.

Presentation - enables teachers to quickly and easily create a resource that looks and acts like a Power Point presentation without using any software outside of th Moodle. The advantage of this is that most users are familiar with the layout and will find navigation through the slides in the presentation intuitively. It is a comfortable environment for many users.

The object oriented construction of Moodle system ensures, that each of elements is independent from the other parts and can be used many times in any course or even as independent educational material. System Moodle supports such approach in two areas: building of educational content by built-in tools and importing prepared contents with use of external application. Introduced contents can be transferred to other courses, imported or exported.

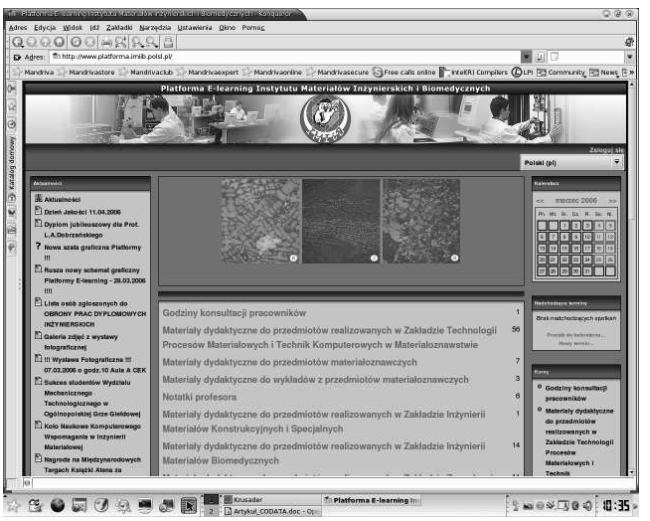

Fig. 1 Main screen of e-learninrg system based on Moodle software applied in Institute of Engineering Materials and Biomaterials

3. E-learning methods in material science teaching

3.1. E-learning in fundamentals of material science

The Institute performs studies on introducing e-learning methods in teaching of material sciences matters. E-learning Platform was also used to test teaching efficiency of mixed mode method with reference to Fundamentals of Materials Science for the first-year students (Fig. 2) of the Faculty of Mechanical Engineering of Silesian University of Technology in Gliwice [10].

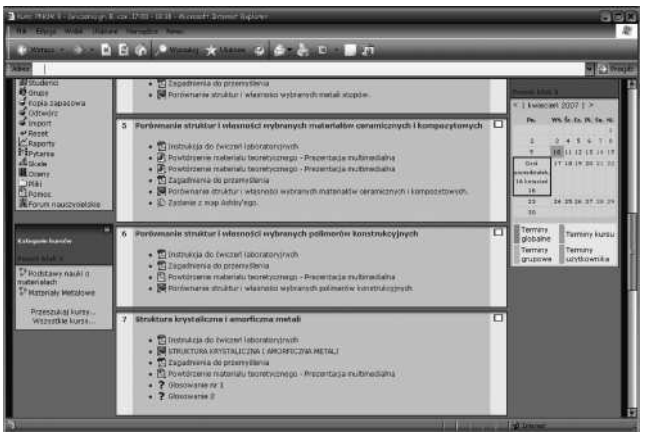

Fig. 2. Teacher's view of examples of the e-learning tools in the interactive course

The research was carried out on the group of 270 students, having a constant access to the internet, who were divided into two equal groups: traditional and online one. The traditional group had two types of classes: in even weeks - laboratory classes, when students got acquainted with apparatuses and made measurements in accordance with the instructions referring to the table exercises. In uneven weeks - table exercises, when teachers checked theoretical preparation of the students and commented on the results of the measurements, or they dealt with particular tasks. The online group in even weeks had identical classes. Instead of table exercises they took part in an online course available on the Institute educational platform. The course was divided into ten theatrical parts. The each part contained the following e-learning tools: exercise instructions, presentations consisting of theoretical part referring to each and every exercise, drawings, animations, individual and automatic evaluation test, exercises to do and send in within a set time, voting, checking student's preparation for a chat, discussion forum and chat [7, 13].

The prepared course was available only for the group of online students. The time of chat was unequivocally named by the teacher and the students. Voting took place sporadically just before the beginning of a chat. Students were individually informed about the results of the test referring to each exercise, as well as about the evaluation including comments on the exercises that had been sent in. Test results and evaluation of the exercise did not influence the fact whether the student was given a credit or not in the subject. The credit depended on the total assessment resulting from the final test given to both groups simultaneously, testing same skills and knowledge.

Basing on performed final exam form laboratories of Fundamentals of Materials Science (Table 1) the obtained results are found to be very similar for both groups, which means that distance education supported teaching is as effective as traditional methods. Each participant could get 23 points.

Table 1.
Statistic description of the final exam results

Statistic description	Traditional group	Online group	Total result
Average	11.90	11.99	11.94
Middle result	12	12	12
The highest result	21	21	19
The lowest result	4	5	4
Standard deviation	3.04	3.30	3.16

The quality assessment of the answers shows that traditional students group was better at open questions, whereas the other was better at the closed ones. It results from the fact that the first group didn't attend table exercises, whereas the others hardly answered the open questions in a written form. The participants of the online course answered the questions in the survey 'Have the didactic materials offered by platform (instructions, presentations, tests, voting, tasks) supported your learning process?' in the following ways (Fig. 3).

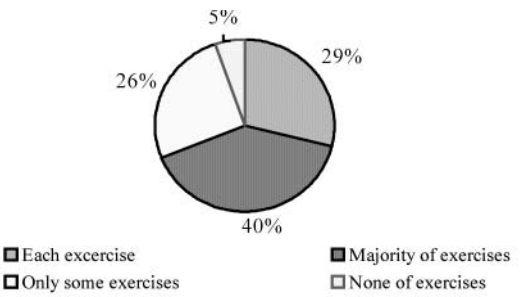

Fig. 3. Chart representing answers of students on a given question

They also thought that this education method is more effective, which may result from the fact that it was the first time they worked using this method (Fig. 4).

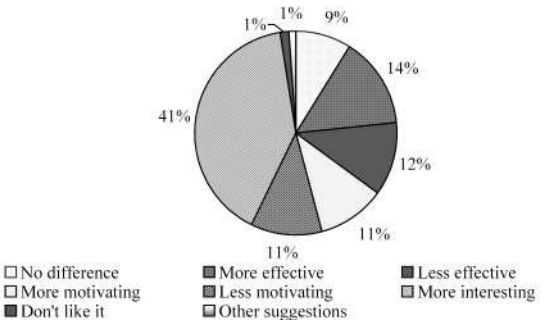

Fig. 4. Chart representing answers of students on a question: How do you find effectiveness of online learning in comparison to traditional methods

3.2. E-learning and virtual laboratories

The continuous progress of the computer technology opens new ways of the computer science activities. The virtual reality can be effectively adapted to education process using both traditional and e-learning methods. Material science virtual laboratories are an open simulating and didactic medium improving the realization of educational process. From didactic point of view, virtual laboratory can be treated as a basic form of learning previous to work on the real equipment. Remote or e-learning students without exercises in real laboratory should have their classes in the virtual reality as well as it could be also an exchange from a theoretical knowledge to practical competence.

In the virtual laboratory the virtual simulations of real investigative equipment installed in the laboratories of Institute of Engineering Materials and Biomaterials are placed. Additionally users will find there instructions and educational materials needed for education of training experiments, educational animations, tests and presentations. The laboratory does not consist only of machines. Didactic helps are also very important for processes of active teaching. Presented here interactive periodic table of the elements and the iron-carbon equilibrium diagram contains the compendium of knowledge on the given subject, and makes possible the cooperation with students by enabling easy and immediate access to necessary data [12].

One of the examples of implemented virtual laboratories is the virtual workroom of the light and confocal microscopy. H's only one of many laboratories placed in the virtual reality. This workroom gives unique chance to acquire experience with metallographic microscopes given to persons without access to real investigative equipment and to prepare their future users. Virtual microscope simulations used for microstructures observation for such persons are the only method for introduction and presentation of these investigative tools and their application in material engineering [14].

The interface of virtual devices and laboratories is created using network programming adequate to the kind of device, according to the conception of built virtual laboratories and thus introduced to e-learning system.

4. Conclusions

The introduced course realized on e-learning platform presented in this article confirms that e-learning method enables the introduction of the new education formula, which may include advantages of traditional teaching and distance education as far as material science is concerned. The method of blended learning doesn't involve any changes as far as the role of the teacher is concerned; the only things that change are: ways and methods of communication and instructing students. Students consider this form of learning far more interesting. Exact analysis must be carried out only after the next few courses will be prepared for other subjects.

Creation of the virtual laboratory meant to a reproduce real functional equipment and thus preparation of students to real work on the device with better skills. Virtual post gives possibility the of access for unrestricted number of students simultaneously and is accessible on every computer connected to the net end e-learning system.

E-learning systems are being rapidly developed and it's only a matter of time, when such systems become an integral part of all Higher Education teaching and learning in the future.

Acknowledgements

Research was financed partially within the framework of the Polish State Committee for Scientific Research Project No. N50720932/4094 headed by Prof. L.A. Dobrzański.

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