The Practice of Using Blended Learning in Teaching IT-Courses

N. Yu. Ershova, I. V. Klimov

***Abstract*—The features of blended learning in teaching the disciplines "Computer Science" and "Software Engineering" for bachelors and masters trained in "Information and Computer Science" using LMS Moodle were considered.**

***Index Terms*— E-learning system, blended learning, learning outcomes, competency matrix**

I. Introduction

NOWADAYS the criteria of CHOOSING means of e-learning are thoroughly formulated [1] and a classification of learning process depending on the number of online technologies used for delivering the content and the manner of cooperation between the participants is suggested [2]. Thus the experts distinguish traditional learning, traditional learning with web-support, blended learning (BL) and complete e-learning. Blended learning is considered to be the most proficient and promising model of learning process organization [2]. Blended learning suggests that 30-80% of the course is managed online while a teacher combines in-class learning with e-learning. The world practice of blended learning development confirms that the model can be successively carried out in technical institutes, where the majority of subjects are natural and engineering sciences.

An important feature of blended learning is also one of the main principles of e-courses designing – the principle of backward design according to which "the development of an e-course starts not with the search of content and development of informative part of the subject, but with defining planned learning outcomes and choosing adequate methods of their evaluation" [2].

In case of high school education the results of learning are intercultural and professional competencies of a graduate, which are being formed. So it is necessary to build a competency matrix defining what knowledge, skills and practical experience make up such competencies. Then the strategy of teaching is defined: types of learning, criteria for evaluation of learning outcomes and the manners of cooperation between the participants in learning process aimed at maximum student engagement in virtual and real cooperation. The selection and structuring of learning materials are managed during the last stage.

Modern learning management systems have a comprehensive set of tools for managing learning process in general and supporting independent work of students. For instance, the LMS Moodle (Open-source learning platform) enables students to read texts, prepare for seminars and communicate on forum. All these things enhance understanding of the material and consolidate subject knowledge. Moodle supports many languages and that proves its popularity among users.

Further we will consider the examples of blended learning using LMS Moodle.

II. Studying "Computer Science" Course As a Part Of Bachelor's Degree In "Information And Computer Science"

The professional academic results matrix of the students who study Computer Science within "Information and Computer Science" degree program is shown in Table 1.

As the discipline is taught in the first year of studies for the Bachelor's Degree, blended learning is carried out in proportion 70 (traditional forms of learning – lectures and practical lessons in display rooms) to 30 (e-learning – the revision of lecture material and its consolidation in forms of self-testing, independent work, topical and final testing).

Online resource is placed in learning management system and is available on http://dssp.karelia.ru/ivk-stud/moodle. Online course "Computer Science" is organized in such a way that the students can learn or revise certain topics individually, then master the material by doing practical tasks and finally do the test.

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Table 1

The professional competency matrix of students who study Computer Science within "Information and Computer Science" degree program

Professional competency	**Practical experience**	**Skills**	**Knowledge**
PC-5 Is able to develop software components, use modern tools and technologies in software engineering	5.1. Gained the experience in developing software components in Pascal	S1. Is able to make an algorithm of computational task S2. Is able to make a program, make its interference suppression and modification in integrated programming environment	K1. Knows the basics of algorithm theory and algorithmic languages K2. Knows the principles of program design K3. Has the software engineering skills K4. Knows the standard algorithms of computational tasks K5. Knows the basics of one programming language of high level
	5.2. Gained the experience in using modern tools and technologies in programming	S3. Is able to perform accountings using e-tables S4. Is able to make structural schemes with the help of applied programs S1. Is able to make a program, make its interference suppression and modification in integrated programming environment	K1. Is introduced to the algorithm theory and algorithmic languages K2. Knows the principles of program design K3. Ways of programming technology K6. Knows numerical methods of solving simultaneous algebraic equations, methods of mathematical logics and algorithm theory K7. Knows the ways of working with information of different kind in textual and table processors
PC-7 Is able to make presentations showing the results of work	7.1. Gained the experience in making presentations showing the results of work	S5. Is able to process textual information S6. Is able to create e-presentation	K8. Knows the ways of working with information of different kind in textual processors K9. Knows the rules of preparing the presentation

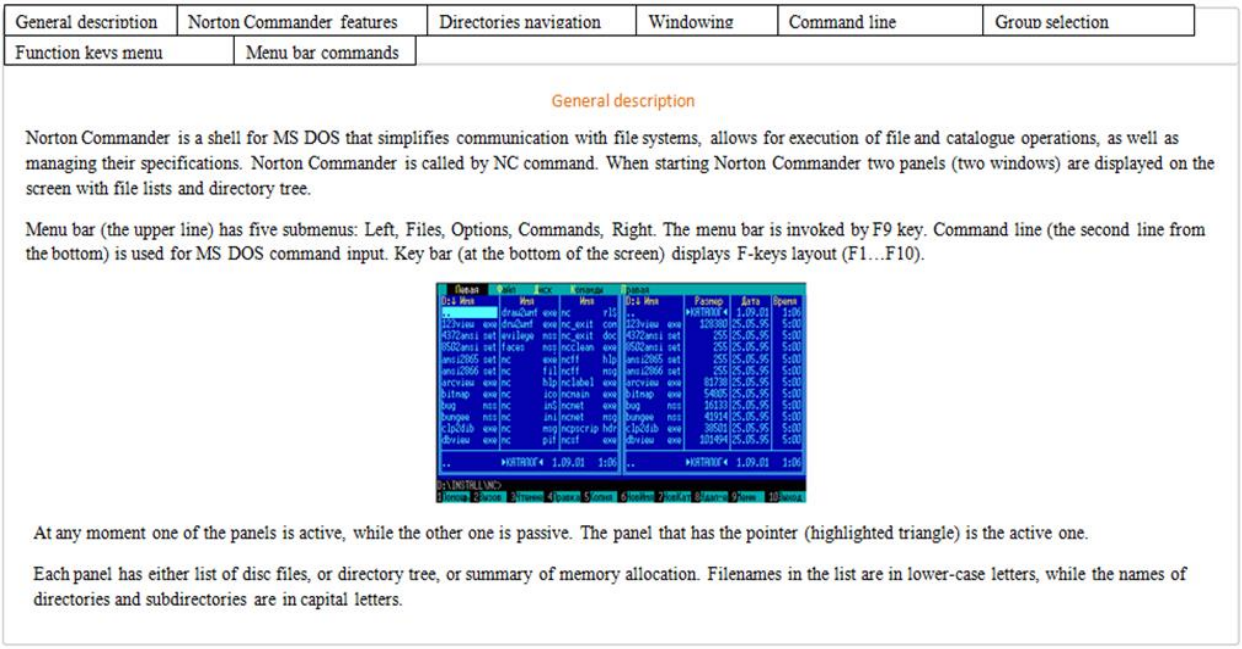

Fig. 1. Fragment of the notes on the topic "Norton Commander Shell".

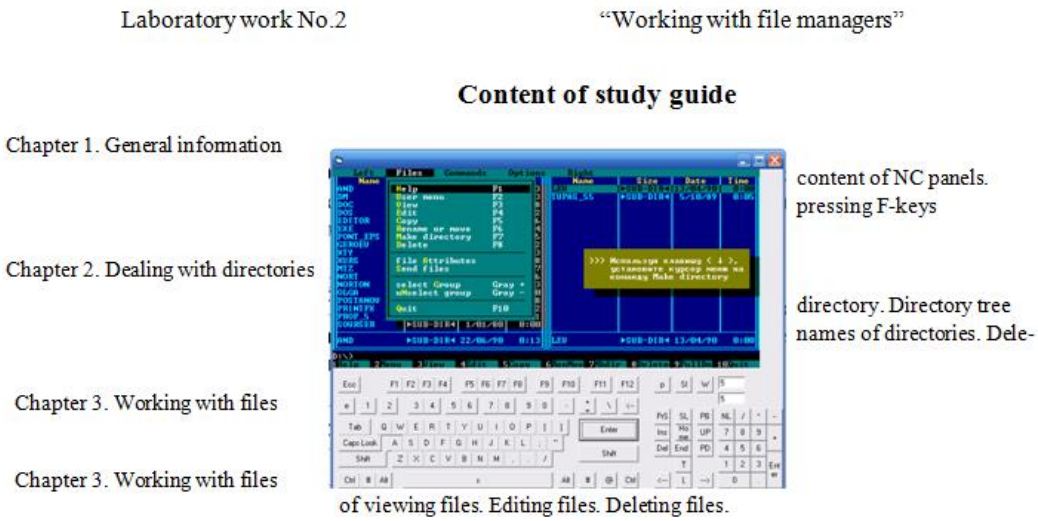

Fig. 2. The example of work with the virtual machine.

Let's consider the process of studying the topic "Operating System Shells". The lecturer gives general information on the shell programs. The student studies this material more thoroughly in learning management system Moodle. "Norton Commander" (NC) is used as an example of a shell program in this course.

At the first stage of individual work the students is introduced to theoretical material through the notes of the lecture (Figure 1). For easy reading the text is divided into relevant parts tagged by tabs what later helps the student to effectively analyze his mistakes occurring during the testing.

Then the student goes to the second stage of learning – laboratory work. The course of laboratory work is described in detail in corresponding methodological instructions (section "Laboratory practice"). Usually students get quickly tired from just reading the text. That is why methodological instructions are composed in such a way that they contain minimum textual information and the main learning goes in a form of working with virtual shell on a virtual machine. In this manner a student can gradually get the main skills required for efficient work with NC.

At the third stage of learning the student works individually with NC on a real ECM under teacher's instruction. The laboratory work is considered to be finished when all the tasks listed in the methodological instructions are completed and the test on corresponding topic is successfully passed.

All the elements of this course can be assessed with rankings created by the teachers. All grades can be viewed on the page of course's grades which has various settings of displaying and grouping the grades. There is a convenient page displaying the latest changes to the course where the teacher can see new enrolled students, new messages in forum, attempts of passing the tests and other elements of the course [3]. Besides it is possible to browse blog entries and see all the actions of different users during the course.

III. Studying "Software Engineering" course as a part of Master's Degree in "Information and Computer Science"

The course "Software Engineering" is taught in the second term of the first year of studies for the Master's Degree in "Information and Computer Science". Theory of software engineering introduces to the principles, models and methods used in the engineering cycle of complex software products development. The aims of the course are learning the conventional basics and cutting-edge scientific and applicable achievements of software engineering, adopting comprehensive approach to solution of the most vital problems occurring in large software projects. Completing this course enables students to develop and manage software projects, accurately estimate costs of a project, carry out structural and functional software testing. In this course blended learning is implemented in proportion 20 (traditional forms of teaching) to 80 (e-learning).

The students are provided with individual work through the web-site of the Department of Solid State Physics of the Faculty of Physical Engineering of Petrozavodsk State University (http://dssp.karelia.ru/ivk-stud/moodle), essential learning resources can be found at http://dssp.karelia.ru/web/tutorials.shtml and are available from anywhere in the world.

Routine assessment of academic performance and mid-term attestation regarding the results of studying the course are carried out through the reports on individual project that cover the following points:

- Project task;
- Application, goals and objectives of software production;
- Architecture of information system;
- Development of a functional model;
- Control-flow chart of data processing;
- Stages of software application development;
- Functionality of the software application;
- Software application.

Academic activities start with setting a problem, finding the solution to which would require student's individual work with the material posted on the e-learning course (Fig. 3). This stage also includes self-assessment of understanding of the material. In such a way learning process starts with individual work of a student (IWS). In-class work concerns with clarification, answering questions raised by the students, and mainly analysis of the solutions that have already been found by the students and presentation of the new ones. Then in IWS mode students exercise the solutions that were discussed in class, revise the material and automatically assess the topical studies results [2].

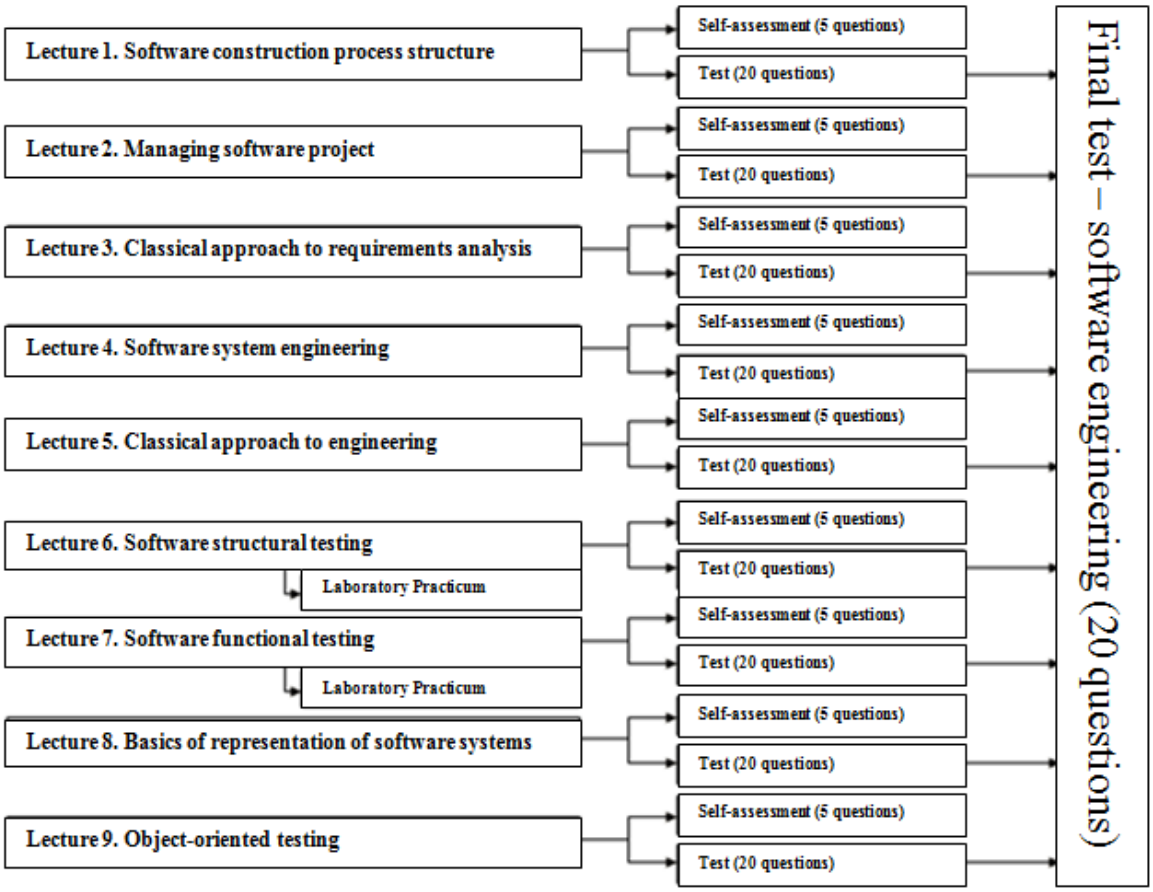

Fig. 3. Structure of lectures on the discipline "Software Engineering".

A distinguishing feature of this course is integration of virtual laboratories thanks to Virtual Programming Lab (VPL) add-on designed for LMS Moodle (Fig.4). VPL allows uploading the programs to the server, provides for role-based access to the materials, and enables both group and individual forms of work. Among the possibilities of VPL we should mention the ability to modify and run programs right in the browser, create test cases and search for identical strings in compared files.

Virtual laboratory was created for assessing the students' skills that had been developed while studying the topic "Software functional testing" using the example of "black box". The principle of this method is about getting combinations of data inputs enabling complete check of all the functional requirements for the program. In order to solve the original problem a rather simple example that demonstrated how such testing is done was employed. The students are given an opportunity to write a simple program and check its work with a series of tests. The process of running the program designed by a student is as follows:

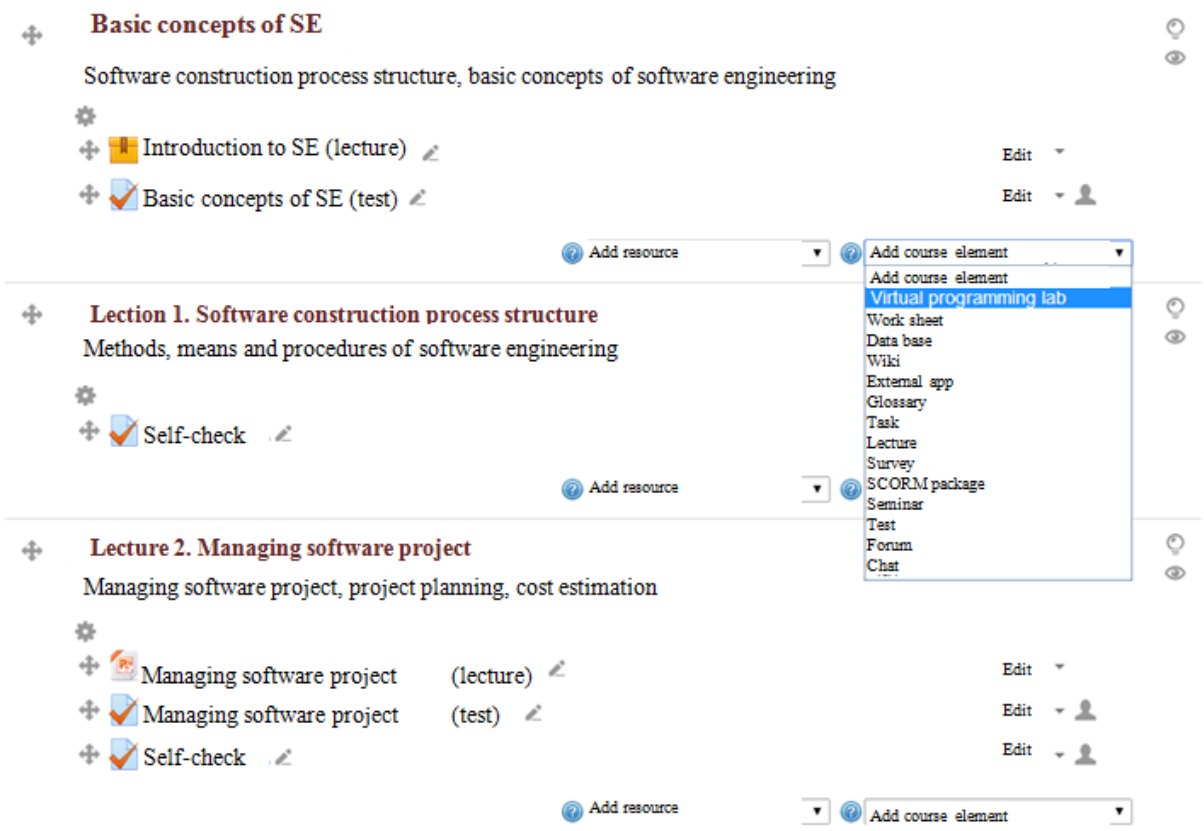

Fig. 4. Adding VPL additions.

- Files chosen by the student for uploading to the server are sent.
- Files chosen by the teacher for this kind of work are sent to the server as well.
- Depending on chosen activity (running, debugging or comparing) a script set up by the teacher is executed. If a script had not been set up beforehand it is executed by default. Programming language is determined according to the resolution specified in saved files.
- The program matches the output of the program with test-cases specified in the file "vpl_evaluate.cases".
- Thus, the files are sent to the runtime server.
- VPL module informs browser that the program execution has started.
- Values of compared files are returned by the runtime server.

The cases used for program verification are available for the teachers only. Adding virtual laboratories allows not only revising the knowledge of the students but their skills and expertise as well.

IV. Conclusion

Applying e-learning resources to education process in blended learning offers multifold possibilities for enhanced learning in chosen field. Existing modern learning management systems afford teachers ample scope in managing education activities and provide for interactive communication. Correctly made e-learning course provides an opportunity to make allowance for students' individual patterns of learning: level, type of cognition, speed of learning. It focuses their attention primarily on the results of education: knowledge, skills, expertise, provides for students' involvement in the education process while enhancing their motivation and academic performance.

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