Enhancing the quality of administration, teaching and testing of computer science using learning management system

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Abstract: In the 21st century, the digital technologies are firmly implemented in all part of industry and services. Communication and also cooperation is often realized only via electronic connection. Using of modern concepts based on information and communication technologies in education too is still growing. That requires modern approach in control, teaching and testing process, which is commonly carry out by LMS. The authors analyze the using of learning management systems and e-learning in Slovakia. They try to describe computer science e-learning courses created mainly for blended learning at the Department of Informatics, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Slovak republic. They describe their own experiences in managing the teaching process with -LMS, present interactive dynamic visualizations and finally present the outcomes of survey about electronic testing.

Key-Words: Computer science course, teaching, e-learning, LMS Moodle, on-line testing

1. Introduction

In the 21st century, the digital technologies play a significant role in whole human activities. They are implemented everywhere from modest domestic appliance, entertainment technology, medically technology up to sophisticated technology in a military or space program. Personal and also business correspondence is often realized only via electronic connection. We use tools for collaborations. Using of modern concepts based on information and communication technologies is still growing. Educational organizations must react on this situation, which requires modern approach in control, teaching and testing process. This is commonly carried out by LCMS.

The authors of the papers are assistant professors at the Department of Informatics, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra, Slovak republic, in the middle of the Europe. They are post-doctoral and their work partially intervenes to the field of electronic teaching and its methodology. They describe their own experiences in managing the teaching process in electronic environment, present interactive dynamic visualizations and finally present the outcomes of survey realized during their doctoral study.

2. E-learning

The electronic education (e-Learning) and LMSs markedly contribute to the fulfillment of the dreams of many pedagogues, cyberneticists and theorists at the beginning of the third millennium. They were introducing their models in the early 20th century, but they had no sufficient tools to their effective implementation at that time [17]. E-Learning has brought many other automated components to the programmed learning.

The e-Learning has the main characteristics of learning anywhere and anytime. It can construct an independent and individualized learning

environment and break through the restrictions of the conventional learning [18].

With the rapidly advance of information and communication technologies, e-Learning provides online learning environment which allows study to everyone with mobile equipments anytime and anywhere. It brings conventional learning into a novel status, breaks through the restrictions of the conventional learning and constructs an independent and individualized learning environment [10]. Teachers may be replaced for time or space. Students can carry out interactive learning activities with self-discipline through CMS. In accordance with the relation between e-Learning and conventional learning, conventional learning is a teacher-centered mode. Teacher and students must teach and learn at the same time and place. Students obtain knowledge passive. On the contrary, e-Learning is a student-centered mode. Teacher guides students to learn, emphasis is on group action, virtual and collaboration community. Students must learn active. Although e-Learning have been implemented for a period of time in internal educational institutions, it is not all perfect. It lacks a sense of reality and interaction among teacher, classmates and dynamical learning environment [18].

Advances in highly interactive computing technology now makes it possible to realize personalized learning. Modern e-Learning systems need to continually probe the learner, find out at that instant what he wants to know, and what he can and cannot do. Based on this dynamic gathering of information and taking his pre-defined learning preferences and constraints into considerations, the modern e-learning system must then be able to offer personalized support and learning solutions in real-time. Such an approach combines real-time assessment, learning, and pedagogical considerations into one seamless learning activity [5].

E-learning researchers found that [15]:

1. E-learning should be learner centric: E-learning systems should put the user/learner at the centre, and also become a key component for managing individual knowledge. In particular, e-learning systems should help the learner in continuously assessing the state of their knowledge, and recommending an effective learning path.
2. E-learning should be highly personalized: E-learning systems should develop a very good knowledge of the learner in order to personalize the learning experience, therefore maximizing the effectiveness of learning. In particular, e-learning systems should take into account the learner's learning style, interests, preferences, current activities and goals.

In general, e-learning is the delivery of education and training courses over the Internet and/or Intranet. It can be defined as a mixture of content (on-line courses or courseware) and communication (reaching online, emails, discussion forums) [23]. The Internet has markedly simplified study material distribution and has improved communication between the students and the teacher.

If we want to make a global view on e-Learning we have to divide it into two categories:

- e-Learning in the company environment,
- e-Learning in educational organizations.

The researches dealing with the differences between schools and companies education are missing. The reasons are in different goals and different target group of education. We could describe differences in a few points:

- the goals of employers are short-term, universities are oriented on long-term goals,
- the universities prepared their graduates in wide spectrum of knowledge and skills, company specified their needs more narrow,
- universities choose structure of the subjects, define mandatory and selective subjects and their syllabus before study start, company has the training only such a part of working content and most of workshops are voluntary and reflect on actual situation on labor market,
- companies preferred commercial companies oriented on e-Learning, universities much more use open source electronic solution or free on-line courses,
- companies often buy complete courses, universities usually create their own courses,
- companies often use on-demand courses (hosting) or SaaS solution (software as a service), where employer pays only for a actual engaged employee, universities use free access into their courses for all students in the class.

New facts are discovered daily, the amount of knowledge constantly grows and they must be reflected in the curricula, e.g. the study programs must be regularly innovated [8]. According to the

points mentioned above universities and companies must cooperate in e-learning methodology too.

Next chapters describe only experiences and results of research works at universities e-Learning. The research about connection between our methods and quality of knowledge and skills of graduates in market labor has not been done yet.

3. E-learning technology

The process of e-learning implementation on the university level should consider regional circumstances and relations [11]. In Slovak and Czech education regions some universities have chosen the path of creating of their own learning and management environment (e.g. Technical University of Liberec and Masaryk University in Brno). But most of the universities combine form of learning using one of a number of commercial or free LMS (CMS, LCMS). Learning Content (Course) Management Systems (LCMS) are mostly web-based systems that combine the management and administrative functionalities of LMS and CMS to author, approve, publish and manage learning content. They are developed to facilitate the collaborative creation of content, organization, control and to manage the publication of documents in a centralized environment [9].

In Slovak and Czech there are used Claroline, Fle3, ILIAS, MS Class Server, WebCT, Eden, Enterprise Knowledge Platform, LearningSpace, eAmos, eDoceo, Uniforms, uLern, Aspen, Oracle iLearnin, NETOPIL School and Moodle [2]. In our opinion, the best "investment" to the future and the most suitable solution in recent conditions at the Slovak universities seems to be an educational platform CMS Moodle (good price, continuously development and active community). Moodle is a free web application that educators can use to create effective online learning sites [13]. Moodle is increasingly appearing also in secondary schools. Companies in Slovakia (usually banks and telecommunication operators) prefer environment adjust to their company requirements. Most of them have implemented iTutor, which is a commercial solution.

Constantine the Philosopher University in Nitra is the 4th greatest university in Slovakia. We use LMS Moodle as central environment for five faculties and all departments. In last few years were created many courses for supporting teaching and also for testing process. These courses are used to being at the level of university departments, occasionally at the faculty level (usually). The e-learning portal for registered teachers and students is available at http://edu.ukf.sk. Its twin for on-coming e-learning projects is available at http://amos.ukf.sk. The e-learning portal communicates with LDAP server, which is interconnected with academic information system (students' profiles) and SAP/SOFIA (employees' profiles). Thanks to this interconnection it is not necessary to register portal's users manually. LDAP server serves not only for authentication but also as central data storage for other information systems. It stores detailed information about staff and students, their roles and privileges in various information systems of the university. This solution assures real and current data continually. In addition, user's account is automatically blocked or revoked after leaving study or termination of employment [7].

Fig. 1 E-learning portal integration to the information systems of the university [7]

4. Computer Science Courses

The authors of the papers teach (partially guarantee) computer graphics, discrete mathematics, programming and database systems in bachelor study program Applied Informatics (full-time and part-time study) and master study programs in specialization Informatics (only full-time study) at the Department of Informatics, Faculty of Natural Sciences, Constantine the Philosopher University in Nitra. They are all compulsory subjects. The process of study is the same for all mentioned subjects. Students of enumerated full-time study branches have one lesson of lecture and two lessons of practice per week (this is a typical weekly hour allowance for subjects which ends with final grade examination). Every student is required to be enrolled in the on-line course because it provides students with electronic study materials, tests, questions and tasks.

Natural science departments typically have bigger electronically support like the others. It is the same in our university, even there is still many departments, which do not yet support their teaching electronically.

There are recommendations about course structure, sources and activities, but they are not compulsory for whole university. In our department

we use Department template and we try to divide each course into:

- *Information about subject,* e.g. syllabus, rules of assessment, IDE download, list of recommended literature or links, discuss forum).

- *Lessons (sections)* - each of the lessons corresponds to one theme from content of subject and provides study materials in form of texts, pictures, presentations, animations and interactive teaching support which add much more clearness into the teaching process in comparison to common computer graphics textbooks provided to students.

- *Final part* dedicated to the final exam.

The sections are public gradually in relation to face to face lectures in full-time study program. The whole course, public from the beginning of the semester is only for part-time study program [24].

Fig. 2 Lesson in Programming 2 - course demonstration

4.1. Teaching texts and presentations

Teaching text in pdf or html format is compulsory part of each lesson. It contains study materials parts of which were presented during the lecture. In some lessons presentation from the lecture to help the students to understand some important terms using their graphic demonstration is added.

4.2. Communication and collaboration

E-Learning requires more intensive and more individual cooperation between learners and teachers than the traditional methods do. To be actively present in their virtual classes, the students must do much more than to switch his/her computer on and read and complete their assignments. Without interaction with the educator and classmates, the outcomes of the process are questionable [8]. As on-line instructors (of blended learning) we likely confirm that. We recommended three way communications:

- *personal message* – the message is directed to the specific students. It consist some kind of personal information, which is not appropriate to public (in Moodle implemented as Send Message),
- *collective message* – the message is directed to the specific group of students. It consist some kind of information without response requirement (e.g. cancel of lecture, in Moodle implemented as QuickMail),
- *public message/question* – the message is directed to all participations. This type is usually implemented like Forums where everybody may answer on it.

Using and changing all kind of communication in accordance with situation is good for increasing of mention interaction. We highly recommended use on-line environment for communication, because all of messages are stored on server.
On-line environments offer also tool for direct interaction and collaboration with students such as chat and wikis. We had not used it yet.

4.3. Applications and interactive aids

The principle of demonstration is used in education for many years. The knowledge is than better catchy and more permanent when we perceive it by as many senses as possible. Survey shows that also in subject with strong mathematical background like optimization, interactive dynamic aids are sufficient for facilitating the teaching and learning [21]. Interactive electronically aids are especially good for algorithms visualization and physical process demonstration. Our courses provide students with animations and interactive teaching aid mostly created in Adobe Flash, Java and Delphi. They contain animations and interactive animations according to what object or transformation property should be presented.

For example [20] in Computer Graphics course are used Flash animations to explain how transformations and algorithms work, and there is also interactive teaching support available with the purpose to better understanding of computer graphics algorithms and methods. This type of teaching aid enables the students to test algorithms in practice using whatever inputs.

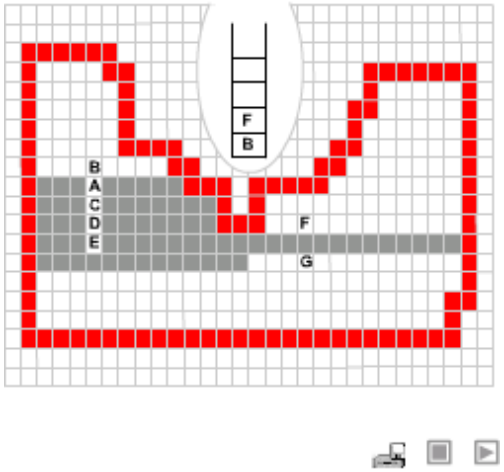

Fig. 3 Flash demonstration of Line Seed Fill algorithm

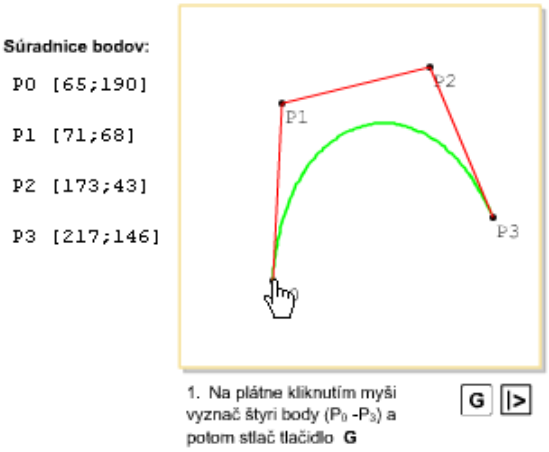

Fig. 4 Interactive flash demonstration of Cubic Bezier Curve

These applications are determined to the full-time students for working with them mainly during their lessons, and they and the part-time students too may use them during their individual studying and preparing for the computer graphics exam.

In Programming course we usually visualize trace table of algorithms and demonstrate recursive algorithms (Java applets, Delphi applications).

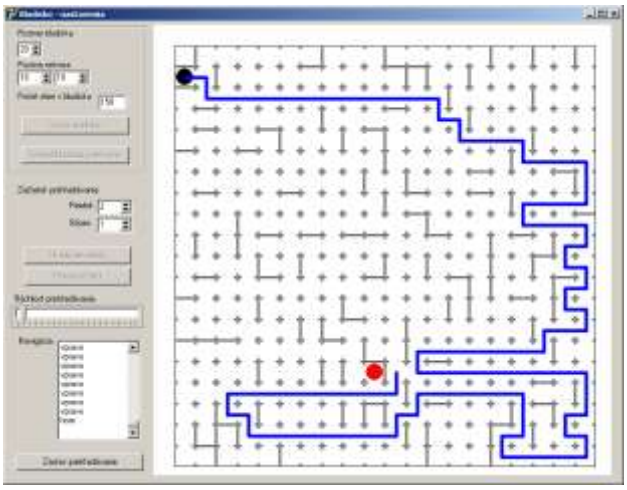

Fig. 5 Demonstration of backtracking – Maze problem

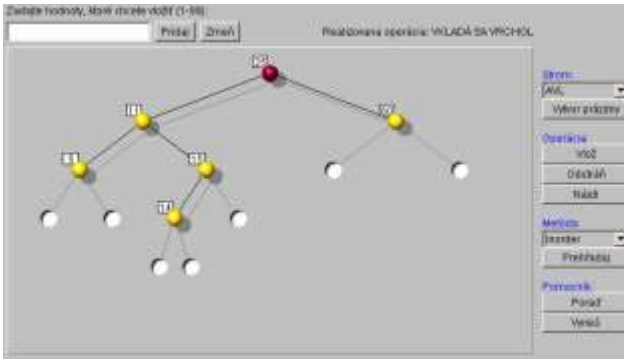

Fig. 6 Demonstration of self-balancing binary search tree

In some subjects we also supplement the explanatory text parts with sufficient quantity of movie clips saved in swf format created in Macromedia Captivate application. Utilizing the clips we managed to present basic practical techniques in specific IDE (MS Access, Delphi, NetBeans). Instead of spoken commentary, we use a simple text comments written in the "bubbles" [4]. Student does not need to switch on the speaker and also he can stop the movie clip any time he wants.

The aim of the surveys in Computer Graphics and Programming ([19], [16]) was to verify efficiency of using interactive aids in teaching process. Control and experimental groups were set up. Students in experimental group might handle with aids. The outcomes show that there is a significant different in students theoretical knowledge, but only in part where students reflect on questions with open answer. Manipulating with interactive aids influences the progress of knowledge, but influence to development of practical skills is minimal.

4.4. Questions and tasks

The students besides the teaching texts, the presentations, the animations and the interactive teaching aid have possibilities to solve Questions and Tasks. Their single items are ordered logically from simple to more complicated. Students during solving gradually construct their own partial solutions. It leads to solving of partial problems solutions and their complex represents of origin problem solution.

5. Electronically testing using LMS

Computer-assisted teaching (Computer Based Learning), significantly increase students' knowledge, as well as create an incentive to learn. This is confirmed by research conducted in England and Australia [14]. Effort of the automated evaluation increased in the last two decades, particularly with the development of distance education. Some studies have even confirmed the weak difference between the results of students educated in a traditional way with teachers and students using online system with automatic feedback [12]. Based on the analysis, we found that some of the universities have own electronically testing systems e.g. QuizIt (Chemware Ltd, New Zealand), WBPES (Web-Based Public Examination System, Dhaka University, Bangladesh) [6] or ASSYST (Assessment SYSTEM, University of Liverpool), WOES (The Web based Online Examination System) [22], TRAKLA2 (Helsinki University of Technology), PILOT (Platform-independed Online Tools, Johs Hopkins and Brown University). Last two mentioned systems work on visual principle in the interaction with the user (learning by doing, the same principle like flash application in Computer Graphics or Programming course). Due to visualization of the right solution they are suitable as support for self-study. None of the mentioned system was suitable for our purpose so we decided realized the final theoretical examination electronically also in Moodle Quiz (but in the controlled environment of the classroom). It makes the monitoring of students' learning activities and learning outcomes more effective. Improvement of LMS system implied significant shift to the active using of electronic tests.

5.1. Quizzes in Moodle

There are two different approaches. The first approach is to create test precisely question by question. Using this way we typically make up standardize test. Questions are usually shown in the same sequence for all attendees. The second approach, preferred in e-learning, is to set up a question bank with categories. Tests are generated randomly from the prepared database, according to the sets for specific category. Questions in the database have been elaborated and most of the course's curriculum can be tested this way. For example the question bank in Computer Graphics course consists of nine categories which include almost hundred questions. The question bank in Programming course consists of twenty-eight categories with almost 250 questions.

Test using like feedback or motivation

Students are testing during lessons and their results only partly influence subject final evaluation. The most important role of testing we can see in feedback during lessons because we have possibilities to consult students´ answers correctness. We used this method in subject Computer Graphics. The final examination is realized face-to-face and consists of written and oral parts.

In Computer Graphics course we use only the typical type of question for electronically testing, multiple choice (Fig. 7).

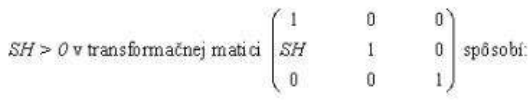

Fig. 7 Question from category 2D transformations

Test using for final score

Students are testing during final examination. Final evaluation is expressed as a percentage of this result and practical part. We used this method in subject Programming. Questions must be worded understandable and all answers set up precisely. E-testing is very "susceptible to injury", especially in open answer questions, therefore question bank should be supervised by other specialist.

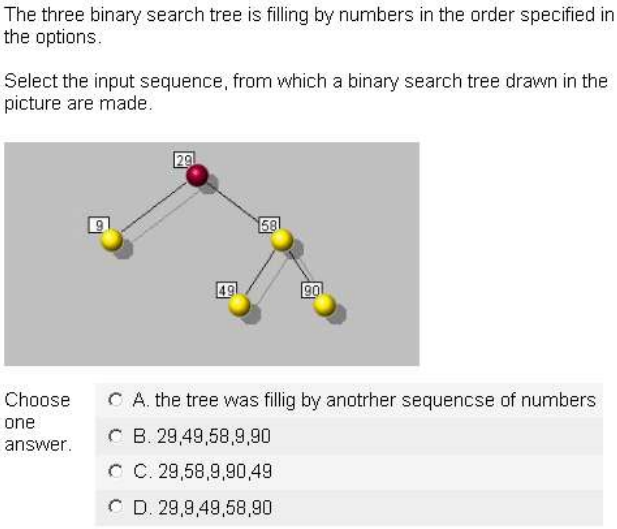

Fig. 8 Question from category Binary Search Tree

Every test has also a time limit and is displayed in full screen pop-up window with JavaScript security (e.g. ban on copy&paste). In our opinion, the time limit is compulsory for test using for scoring. Immediately after the attempt, students should get only score, because information is flowing among students very quickly.

6. Survey about electronically testing

The main research took place during three years among the students of the Department of Informatics after the end of the semester, usually after final exam from Programming. In the last phase we realized national research on selected group of secondary school teachers and university teachers of Informatics.

The characterization of research group might be described:

Phase 1 (P1) – students were tested in „traditional way" using pen and paper.

Phase 2 (P2) – students were tested using computer (practical part) at the end of the first semester and using online testing in Moodle (theoretical part) at the end of the second semester.

Phase 3 (P3) – students were tested only using Moodle.

Students in master study programs have specialization Informatics with mathematics, biology, English, French and German languages, ecology, physics, geography, music, technical and physical education.

Table 1 Basic information about respondents (A – Applied informatics, M - Master study programs in specialization Informatics)

Phase	Number of respondents			Gender	
	A	M	sum	F	M
P1	55	39	94	10	84
P2	14	24	38	3	35
P3	62	35	97	X	X

The survey responses exposed that despite the significant positive relationship to the electronic testing still dominates partial distrust of computerized assessment tests (due to open answers). In P2 the automated evaluation was less acceptable. It was the pilot testing year and we confess that there was a lot of bugs (e.g. assign of wrong answer). This fact probably negatively influences students' opinion to possibility of testing knowledge using automated tests (figure 9). Relative frequency descends from 79 % to 39 % in comparison with phase P1.

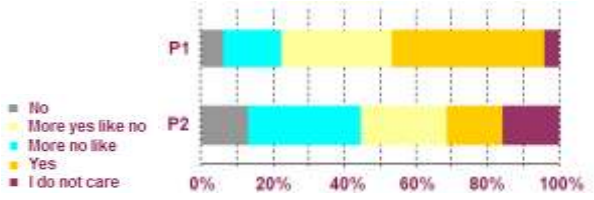

Fig. 9 Perceptual division of answer on question: „Do you prefer using automated testing in the future?"

In P2 there was a question with these opportunities about their final grade. (From top to down of graph: "I am very unsatisfied. Grade did not sum up my knowledge and skills", "I am unsatisfied, but my knowledge and skills are not really better.", "I am satisfied, but I think I did not do my best.", "I am very satisfied, grade sum up my knowledge and skills."). In winter semester (P2 - W) increased number of students satisfied with the final grade. We assume that it was reaction on computer integration to the part of final exam (in P1 whole final exam was made only using pen and paper). In summer semester (P2 - S) where we used a Moodle tests number of satisfied student decreased.

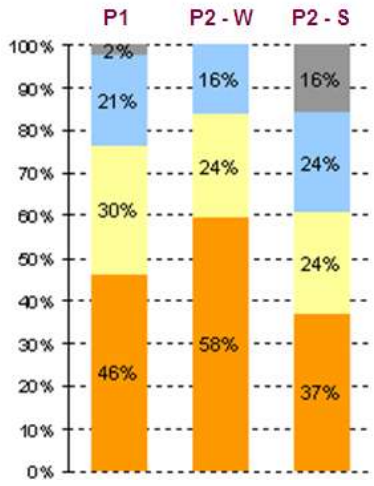

Fig. 10 Perceptual division of answer on question: „Are you satisfied with your final grade?"

In phase P3 we asked our students next question: "Automated evaluation of tests using computer according do predefined conditions might be more acceptable compare with evaluation by a teacher. Which is your attitude to this statement?" The results are in table 2.

Table 2 Attitude of student (question describe above)

absolutely agree	agree	neutral	disagree	absolutely disagree
25 %	29 %	26 %	14 %	6 %

The concept of electronic testing is perceived more positively than the concept of traditional paper tests. Figure 12 shows the result of scaling, in which student compared the traditional paper and electronic testing in P2. They reflect on concepts using the nine seven-point bipolar scales.

For example, if student choose for term classical testing point one in S1, it means that he perceived it to be completely objective, on the contrary point seven means to be completely subjective. The middle point (4) refers to the neutral perception.

We used following scales:
(S1) objectivity vs. subjectivity, (S2) effective vs. inefficient, (S3) modern vs. outdated, (S4) suitable for all vs. suitable for small group of students (S5) difficult vs. easy (S6) convenient vs. inconvenient (S7) examines theoretical knowledge vs. examines the practical knowledge (S8) interesting vs. boring, (S9) giving rise to fear and stress vs. does not fear and stress.

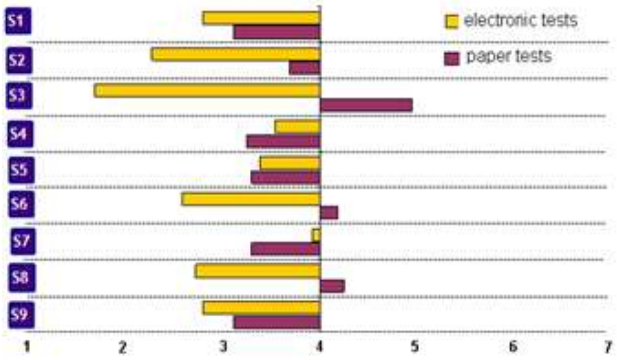

Fig. 12 Comparison of traditional paper and electronic testing (scale are described above) in P2

The same questions were asked to another group of students in P3. Results show again that also students which were tested only in online environment consider it as modern, effective and comfortable way. Neutral outcomes were achieved in scale about difficulty and about the stress. We obtained positive outcomes in all scales.

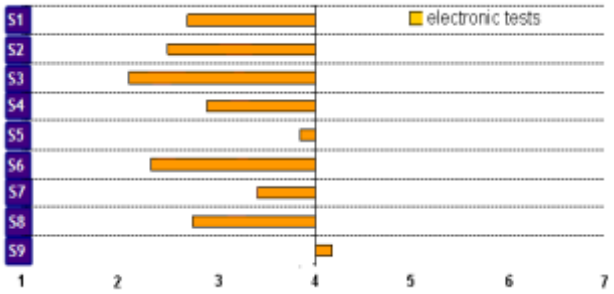

Fig. 11 Electronic testing (scale are describe above) in P3

In final phase of survey the teachers were questionnaire. 40 % of them had earlier experiences with electronic testing (Moodle, MS ClassServer) or they planned to implement it in their school. Their opinions on electronic testing were surprised. We expect a little bit of traditional view, but the answer exposed their modern thinking. Electronic testing was marked as strongly objective, modern, effective, interesting and comfortable. Students do not need special experiences. But they also thought that this type of testing rising the fear and stress.

The surveys confirmed ([19], [3]) that students preferred questions with close answer (multiple choices) and after that they tried to fill open answers (short or calculated). Due to time restrictions, questions without predefined answers often stay empty. In programming testing we build up the

database of questions and tasks that would require an active knowledge application and programming skills for correct answer, and in which the correctness of responses could be evaluated automatically. Guess is very hard, because all distractors (wrong possibilities) usually look better like correct answer. In spite of them, there is still a group of student, who only want to have a try without preceding training, they guess answer and finished test in a quarter of time. In close answer questions, we recommend using more than one correct answer and penalties for wrong answers. It also suppress the guesses, it means students answer only if they are sure about it.

Students sensed testing in Moodle as good designed, intuitive and modern. Students appeared to prefer view of each question separately before view of all the test questions at once, where they have to scroll the screen. The biggest complaints from the students and partially from teachers are directed to display the remaining time, which make rise of the nervousness.

6.1. Advantages and disadvantages of electronic testing

Advantages and disadvantages described below are summarization of authors own experiences. During researches we found out differences between the students´ and the teachers´ point of view [3].

Teachers´ view on advantages

- Higher objectivity of testing.
- Prevention of depreciation of test.
- More students tested in a shorter time.
- Reduction of teachers' workload.
- Modern conditions for students' self-control.
- Unlimited possibilities of question numbers.
- Instant feedback.
- Attempts portfolio.

Students´ view on advantages

- Strictly conditions.
- Quick and precisely.
- Student could be more creative.
- Reduction of fear.
- Instant feedback.
- Reduction of teachers' workload.

Teachers´ view on disadvantages

- Insufficient number of computers.
- Content of testing is limited only on knowledge.
- Reduction of students' expression.
- Absence of social contact.
- Students' problem with computer manipulation.
- Health risk.
- Dependence on electric source.

Students´ view on disadvantages

- Disturbance of communication between student and teacher.
- Teacher takes earlier work into consideration.
- Computer does not give an advice.
- Strictly formulated answer. Less of own expression.
- Result cannot be "rope in".

7. Conclusion

We analyzed the possibilities of systems suitable for teaching process testing supporting and enabling simple results achievement and we finally chose Moodle as the most accessible alternative for educational organizations. Content of the online courses and electronic teaching aids cannot be considered as final. Each semester should be evaluated and prepared according to the students' results. Some activities and sources could be changed or omitted, new assignment added etc.
We have been using presented online courses since 2007 (4 academic years, about 100 students per semester). During these years, the courses were improved until today versions. By using of them we gained greater insight into the students' activities.

If we concentrate on the opportunities that LMSs offer for distance and blended learning, we found out that we have numerous activities and modules for learning improvement. Teacher for example may hide and show sources and activities, set up a role of students, set up materials only for the concrete group. It make possible to differentiate the education Teacher could react on recent situation and adapt the environment. Electronic learning system can make possible to personalize the education. The electronic study materials make possible quicker and simpler actualization and multimedia integration. Education is being more flexible. The application of individual tools, activities and methods in a particular LMS is also a way of combat against plagiarism [17].

Electronic learning systems provide possibility to save all information about student's activities in one place. Teacher could monitor student's activities after his login into system. Systems offer submitting the file, testing manage the communication and cooperation too. We can say that Moodle facilitates teacher to keep his methodical portfolio dynamic and offer electronic students´ portfolio in every moment.

The online testing procedure using LMSs is probably the most widely used and the quickest way to test students without prejudice [17]. It ensures the objectivity of the assessment or possibly reducing the degree of subjectivity. Bajaras [1] wrote: "It is becoming increasingly clear that there are many reservations, worries, objections and questions about e-learning from the pedagogical, professional, and sociological point of view that must be taken seriously". One of the findings of our survey was that students not clearly prefer computer testing and evaluation to teacher's assessment. They prefer combine form of testing, where teacher still plays the essential role. They also require to control of automated evaluated tests. The survey shows that in spite of positively view to e-testing this method still remain very sensitive, mainly in tests using for grading.

In addition, first year students usually do not study actively. The reasons for such a disinterest of the rest of the group might be only assumed. Lack of experiences with this form of study might have acted as a major inhibitor. Therefore we recommended to create a group of self-tests with the same conditions as the final test, especially if it is marked. More self-tests during whole study course facilitate students to adapt their activity according to electronic environment requirements.

Some people have suggested that technology can save us. But everything has its advantages and also disadvantages. Anything won't be fully acceptable. Future, especially in area of educational methods, is unpredictable. It is sure that young people like mailing, reading web pages, writing wikis, blogging and "living in social nets". Maybe this is the way how to direct our observation. Education needs to become WWW … Whatever, Whenever, Wherever.

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