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Postulates for Modeling an E-Learning System of Informatics for Class Teachers

Abstract

The main goal of this paper was to indicate the possible use of a specific model of e-learning for computer science teachers in Serbia. Taking this aim into account, the authors accurately indicated the subject of the proposed research: development of a model system for the implementation of e-learning for the level of higher education in Serbia for teachers, with a special emphasis on informatics education. This e-learning model indicates equal participation of major areas of information technology and pedagogy and teaching methodology, pedagogy, ICT and media. The proposed research subject is of high importance in the development of the education system in Serbia and as such is adapted to the needs of a knowledge society and to realize the scientific contribution to the subject area. This work represents a good starting point for further work and continuing research presented, referring to the concrete results of research by the author.

Keywords: *e-learning model, methods, informatics*

Introduction

E-learning has been present as facilitated learning and increased use of information and communication technology for about fifteen years. E-learning and the interactive approach allow students to easily master the curriculum, learn by experimentation, simulation of the execution of a particular process, or simply check the knowledge and facilitate communication between teachers and students. Modern teaching and e-learning are conducive to the development of abstract

thinking and provide planning guidance and individual progress in acquiring knowledge. The key advantage of e-learning lies in the ability to manage the entire process of real-time training. The e-learning model is a "tool for survival". It introduces us to the basic principles and processes of e-learning, provides advice for harmonizing the methods of teaching tasks and provides the principles that lead to the efficient model transformation of information for display online. In this paper, while designing the model of e-learning, methodology of e-learning through the web, the specific environment of our universities and methodological principles for creating online courses are fully covered. E-learning is a logical continuation of the development of education, which students and institutions eagerly embraced and as a solution of modern times. At the same time, it resolves the problems of communication between the institution and students and distribution of materials in a much more comfortable way than any previously known technology.

In our country, the practice of e-learning in higher education has not been thoroughly studied empirically, and neither in teacher training colleges. That is why e-learning in teaching practice lags behind theoretical principles. It is not possible to download the model and the organizational system of e-learning as a whole from the countries in which it is studied and applied in practice. We need to create our own approaches to e-learning in the realization of the program, i.e., our own strategies for learning. Besides, what in other countries is not an innovation any longer, in our teaching practice is. That is the case with e-learning. So-called "courseware" tools are available on the market, can be used in the development and implementation of e-learning. Although courseware tools facilitate the preparation and conduct of the course, that complex area requires inclusion of a team of experts from various disciplines (subject experts, methodologists, teachers, designers, computer experts, etc.). Therefore, in addition to mastering the technologies to create e-learning, what is very important is interdisciplinary team work and managerial skills.

The introduction of e-learning forms, which if well planned and properly applied, is opening new possibilities for both teachers and students. In order to encourage and facilitate the introduction of e-learning in the classroom, it is necessary to improve the concrete possibilities of this form of teaching. It is particularly important to define a clear and achievable vision and strategy for the introduction of teaching through e-learning. It is necessary to improve the quality of higher education using methods and technology of e-learning through the transfer and adaptation of knowledge and experiences from European universities, as well as creating our own models of the organization of e-learning.

Good and proper strategic positioning and planning of e-learning as an integral part of the educational process and a quality and sustainable support system of

e-learning have a critical impact on the performance and results of the implementation of e-learning in higher education. There are world trends consisting in establishing virtual universities which offer fully online education and qualifications through e-learning. Frequently, these universities appeared while modernizing the correspondence forms of teaching, and because of geographical features they have a long tradition and are very numerous in the United States and Canada. However, these universities are present in the European region as well, providing opportunities of online education, which very successfully supports the basic academic education and lifelong learning system.

The ruling attitude is that there must be modernization of teaching with the aim of increasing the efficiency of learning, in other words raising student ability to apply knowledge. The modern learning theory for the digital age, connectivism, has a need for experimental verification of the e-learning model and organization of systems to establish a clear roadmap to teaching practice. E-learning is also a challenge and a tool to enhance and improve the educational process in this country and one of the foundations for new and better ways to manage knowledge. Intensive introduction of e-learning in the educational process, the implementation of the model and the organization of the system, have become a priority of modern higher education institutions worldwide.

Problems of creating a model of e-learning for class teachers

Informatics education for teachers is a specific problem because it should provide elements that allow the teacher to apply information and communication technologies and tools for teaching in a variety of areas and in a manner that is consistent with the general pedagogical and methodological principles. One of the required areas is the field of computer science, which requires that the teacher has a sufficiently broad and deep knowledge in the field of informatics.

E-learning methods that have been created for this research are practical, complex, dynamic models, elaborate, transformed, digitized and methodologically designed multimedia teaching units on the basis of teaching programs. The value of the method is determined by the criteria of their applicability, and how much they really affect the efficiency of learning in computer science. This means that teaching contents are modeled by adequate methodological transformation of programs that are set aside for research. For each method we form a special system of instructions for every level of student knowledge, or for a particular group of student abilities. The model takes into account the following relations: student-teacher, student-student and student-teaching material and function and position of students, professors and teaching mate-

rial. In particular, the educational outcomes show the level of the knowledge application of the student.

As information technology is based on a number of different fundamental areas (computer science, mathematics, engineering discipline, etc.) and is characterized by extremely dynamic development, it is essential that the teacher teaches informatics to build their own flexible informatics skills so they will ensure:

That in the context of the teaching content, whose principal object is informatics or ICT itself, the teacher is able to adequately convey to students the relevant informatics knowledge.

That the teacher is able to adequately use computer knowledge also in teaching in non-informatics areas.

These two requirements imply that teachers are supposed to be able to follow the development of information technology and its application, thus to have the knowledge and skills concerning the ideas and methods of the new information technologies and methodological transformation of content.

Such research improves promotion of e-learning for teaching profile, by constructing a model including methods and tools for acquiring flexible computer knowledge. Informatics education at every level is crucial for building a society that is based on knowledge. There has not been any research in our area so far on the efficiency of learning with the use of e-learning in computer science, although research into this area in the world is very intensive, which confirms the topicality of the proposed research.

Explanation of research needs for e-learning

The importance of the research is to overcome the current demand for the traditional model of teaching that is predominantly used in the teaching methods of introducing e-learning and new forms of work, as it is known that the traditional teaching is lagging behind in assimilating new technologies.

The reason for the research is the knowledge that the contents which hold the characteristics of modern science in integrated programs of teaching are contrary to the learning abilities of students, and that the usual model of teaching is faced with the problem of inefficiency. So far, the few studies conducted have shown that the redefinition of the program does not produce the desired results in terms of increased efficiency. The presented research is focused on the teaching of computer science. It is necessary to determine the possibilities of e-learning application in the classroom, at the same time respecting the general pedagogical value. Also, we should determine the reasons for e-learning, with a clear educational purpose, insufficiently integrated into teaching.

The scientific contribution of this research is the systematization of the theoretical and empirical knowledge about the models of e-learning in higher education, as well as finding an optimum method of e-learning in order to establish clear methodological signposts for further scientific research. It is believed that this research will improve the conditions for the implementation of informatics curriculum content, thanks to the innovative empirically based approach to teaching and learning. The need for this research stems from the fact that systems of e-learning in the classroom and their use in teaching computer science so far have not been studied in a comprehensive, systematic way yet.

The aim of the research model of e-learning

The main goal of this research is to develop models of e-learning in order to gain flexible informatics skills among class teachers, and define and verify the environment for the application of e-learning methods and appropriate techniques and tools to enable flexible implementation of the teaching contents and the use and effectiveness of permanent evaluation. The model includes the following basic elements:

1. The architecture of extensible software support for the implementation of different models of e-learning based on open standards and open sources (open source);
2. Methods and software tools for determining the effectiveness of the implemented models of e-learning through student achievement that can be objectively measured using standardized tests as measuring instruments.

The proposed model should provide a simple and flexible use for teachers and students and remodeling without touching the source code.

Research hypotheses:

The basic hypothesis: The use of adequate models of e-learning in teaching computer science gives more flexible informatics knowledge, developing practical skills and habits of students to use information and communication technology, general increase in the quantity and quality of knowledge, as well as an increase in student interest in adopting various applications of knowledge using IT technologies.

Sub-hypothesis:

a) Student achievement in the current, traditional model for teaching computer science for teachers is not satisfactory;

b) Using an appropriate e-learning model gives better results in teaching computer science than the traditional model.

The study confirmed the main research hypotheses. This means that the specific model of e-learning in teaching information technology has a positive effect on academic achievement and significantly improves the efficiency of the educational work. The research is oriented towards substantial change, modernization and improvement of the direct teaching of computer science, but is expected to be a contribution in other areas based on increased practical skills in the field of informatics. In this sense, the results obtained allow for understanding the possibilities of applying different models of e-learning management and e-learning methods in teaching computer science as well as in the cases beyond informatics.

Phase of the research, applied methods and sample design

The first phase of the research was related to the analysis of the existing theoretical knowledge on the models of e-learning in higher education, with an emphasis on the e-learning model in teaching computer science for teacher profiles and methodological aspects of the transformation of educational facilities for the implementation of online teaching and organization of learning based on program content.

The second phase was the development of an e-learning model which resulted in more efficient learning in the field of informatics and the experimental verification of this model. The research was undertaken through the following steps, which also represent the tasks of the research:

1. Analysis of existing solutions in the field of e-learning models and software support for e-learning.
2. Specification of the software system architecture to support the implementation of e-learning.
3. Syllabus of existing curricula for teacher profiles teaching computer science
4. Specification of the e-learning model for teacher profiles teaching computer science.
5. Initial examination of the program content of information technology in the experimental and control groups.
6. Teaching with the use of the created e-learning model.
7. Examination of the effects of the suggested solution.
    a. Final testing of students in the experimental and control groups.
    b. Comparing students' competencies before and after the teaching by using models of e-learning.
8. Analysis and interpretation of the results of theoretical and empirical research on the effectiveness of learning using e-learning in computer science.
9. Final considerations and future directions of research.

The sample for this study was formed from the population of the first-year students of the Faculty of Education in Sombor and Teacher Training Faculty with directional class teaching. The students from the Faculty of Education in Sombor were the experimental group, and the students from the Faculty of Education in Belgrade were the control group.

Balancing the groups was performed by trimming after initial testing (pretest), so that each group contained sufficient statistics and an equal number of students. Pretest determined the respondents' initial level of motivation and knowledge of Informatics. After equalizing the groups, the experimental group underwent teaching with the use of an e-learning model, and the control group was taught with the use of traditional teaching methods in teaching computer science.

The dependent variables of the experimental studies were pedagogical achievement, psychological motivation, problem solving, and independent variables were the methods of learning such as traditional methods of learning and the e-learning model.

After completing both courses, the post-test was performed by the same test post-test, it measured the knowledge and motivation in both groups. Also, the same problem was given to both groups at the end of the course and it measured success in solving a problem. At the Faculty of Education in Sombor, a computer laboratory was used for classes and lectures. As the support of e-learning, an open source platform for distance learning, video conferencing systems and applications needed for creating teaching methods of e-learning models were used.

Some research results

Table 1. Results of a two-factor system of analysis of covariance differences in solving problems for the determination of the strategy of analysis

	Mean	Standard deviation	Test of arithmetic differences	
	$\bar{\chi}$	s	F	P
EG (Experimental Group)	3.336	1.217	8.115	0.005
CG (Control Group)	2.269	1.392	0.443	0.507
E-learning	3.450	1.077	0.030	0.852
Traditional	2.156	1.405		

The table shows the legitimate assumption of variance homogeneity (F=1.235, P=0.300). The assumption of the homogeneity of regression coefficients is also justified (F=0.789, P=0.376). The differences between the achievements of the users of e-learning teaching materials (EG) and those without (CG) are statistically significant (F=8.115, P=0.005). The users of e-learning learning materials were more successful in solving problems, as their achievements in e-learning teaching materials, on average, were higher than the achievements of those who had to deal with materials prepared in the traditional way (χ_{exp}=3.336, χ_{contr}=2.269). Table 1 also shows the distribution of the performance of both groups. The problem was made up of several parts, the solution was evaluated separately. The maximum overall achievement means that the problem was solved correctly.

Table 2. Results of a two-factor system of analysis of covariance differences in performance in solving problems to identify strategies of reasoning and interpretation

	Mean	Standard deviation	Test of arithmetic differences	
	$\bar{\chi}$	s	F	P
EG (Experimental Group)	4.169	1.564	11.215	0.001
CG (Control Group)	2.866	1.461	0.858	0.356
E-learning	4.518	1.541	0.502	0.480
Traditional	2.890	1.223		

The assumption of the homogeneity of variance (F=1.298, P=0.278) and the assumption of the homogeneity of regression coefficients (F=0.013, P =0.909) were eligible. There was a significant difference between the average achievement of the users e-learning teaching materials and those without (F=11.215, P=0.001). The users e-learning learning materials had been successful in the problem of reasoning methods and interpretation, as evident from the higher average total performance of the users of e-learning learning materials according to the users who were prepared to tackle them in the traditional way (χ_{exp}=4.169, χ_{contr}=2.866).

Table 3. Results of a two-factor system of analysis of covariance of differences in performance in solving problems to determine the methods of evaluation

	Mean	Standard deviation	Test of arithmetic differences	
	$\bar{\chi}$	s	F	P
EG (Experimental Group)	3.418	1.272	4.756	0.031
CG (Control Group)	2.784	1.135	7.809	0.006

	Mean	Standard deviation	Test of arithmetic differences	
	$\bar{\chi}$	s	F	P
E-learning	3.216	1.304	0.007	0.931
Traditional	2.453	0.892		

Loss Levene F-test (F=1.244, P=0.297) and the test of the homogeneity of regression coefficients (F=0.648, P=0.422) confirm the eligibility of the assumptions of homogeneity of variances and homogeneity of the regression coefficients. Therefore, we can proceed with the analysis of the differences between the achievements of the groups. Analysis of differences between the average achievements of the users of e-learning teaching materials and those without was statistically significant (F=4.756, P=0.031). The users of e-learning teaching materials were successful in solving problems of evaluation strategies, as shown in their higher average achievement (χ_{exp}=3.418, χ_{contr}=2.784).

Conclusion

E-learning courseware, in terms of used strategies, is more effective than traditional learning materials, therefore, it should be further promoted. Promotion of its preparation can be one of the fundamental tasks of the education of prospective teachers, as well as subsequent lifelong learning among teachers. A prerequisite for the promotion of e-learning material preparation, irrespective of their purpose and nature, is the positive attitude of the future teachers to teaching content in this area. According to research on the generation of prospective teachers, this condition has been fulfilled. The results show that in the young generation there is increased willingness to use ICT in education, preparation and dissemination of e-learning materials. There is a surge in the popularity of the content, associated with using authorized tools, therefore software for producing e-learning educational materials.

Development of a model of e-learning for computer science class teachers is of high significance in the development of education adapted to the needs of a knowledge society and to realize their scientific contributions to the subject area. The main scientific contribution of the proposed research is to build a system for the management of the educational process in the field of e-learning through the implementation of different models of e-learning and continuous evaluation and adaptation of the models. In this sense, the results of this study provide an insight into the capabilities of different models of e-learning management and e-learning methods in teaching computer science as well as other subjects.

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