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E-learning Model for Bachelors, Specializing in Mathematics and IT

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Abstract

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Today's world comes with the necessity of training highly qualified specialists in mathematics and information technologies. It requires creating a special model, based on applying a number of particular pedagogical approaches. A version of this model has been designed in this work. The model of five modules is based on applying complex integrative, differentiated, learner-centered, competent, and vocationally oriented approaches. A pool of e-learning resources allows to compile a professional thesaurus of bachelors, thus creating a unified system of e-learning. Our model lays emphasis on the individual peculiarities of learners: enhancing their cognitive processes, computer-assisted self-efficiency, and individual style of studying. All the above gears toward accumulating the necessary experience of project activities of bachelors, and team work. Monitoring the results is implicated in accordance with the established system of assessment of assignments of different level of complexity. The monitoring methods, used in the model, allows to evaluate the level of development of information competence of bachelors specializing in mathematics, and computer science. The pedagogical experiment was conducted in order to check the effectiveness of the developed model. The results demonstrate a significant increase in the number of students of experimental groups with a high level of formed information competence. It also confirmed the statistical data analysis using χ^2 hypothesis test and Student's t-test, thus proving the effectiveness of the created model.

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Keywords: Information competence, computer science, integrative approach, differentiated approach, e-learning.

1. Introduction

In today's world of fast-pacing information technology, one of the topical tasks set before higher educational institutions is finding and using student teaching modes that would provide future graduates the ability to work with present-day information systems at organizations, innovative manufacturing industries and research centers, in relevance with employers' demands and the

popularity demands of the labour market. This brings about the necessity of training highly qualified specialists in Mathematics and Computer Science.

1. E-learning Model for Teaching Bachelors

2.1 Information Competence of Bachelors Specializing in Mathematics and Computer Science, and its structure

The information competence of bachelors specializing in mathematics and IT, can be viewed as an integral personal quality manifested in the ability to operate on different kinds of information. This can be aided with the engagement of state-of-the-art IT media in the process of professional activity. Information competence can also be seen as the ability and willingness to continuously improve ways of professional implementation in accordance with the changes occurring in the area of information technology. The structure of the considered competence consists of three components: knowledge, operational activity, and personality. The information competence is a major part of professional competence of bachelors, specializing in mathematics and computer science. Its formation requires creating of a special model, based on applying numbers of particular pedagogical approaches. A variant of such five-modules model has been designed to for the purpose of this work.

2.2 Model structure and contents

To form and develop information competence in intending bachelors specializing in mathematics and computer sciences, we have worked out a corresponding pedagogical model based on applying complex integrative, differentiated, learner-centered, competent, and vocationally oriented approaches. It comprises of 5 related modules: purpose, methodology, content, organization of process, and assessment.

Implementation of the model implies resorting to e-teaching media. To organize this, a range of e-learning resources has been devised in computer related disciplines studied by intending bachelors specializing in mathematics and information technologies.

A pool of e-learning resources presented in the MOODLE system allows to compile a professional thesaurus of bachelors, thus creating a unified system of e-learning. Theoretical material and tasks presented in those courses can form a unified problematic field of professional activity and education. All this represents a set of mechanisms for the implementation of integrative and profession-oriented approaches (Makletsov, 2013).

In our model, we resort to tiered assignments, such as mechanisms for implementation of differentiated approach. They can consist of several parts, only one of which, relatively simple, is mandatory. Students are given an opportunity to choose out of the array of supplementary assignments, in order to receive additional credits necessary for future excellent grades. This allows students to fulfil the assignments they consider interesting, and less ambiguous. Besides, e-courses can contain a set of several alternative assignments. This variability allows to draw out an individualized learning design for each student, thus raising an interest in the subject of study.

Our model lays emphasis on the individual peculiarities of learners; enhancing their cognitive processes, and computer-assisted self-efficiency. The influence of individual peculiarities of graduates towards information technologies, job search, employment, diligence, and flexibility in the process of professional activity has been demonstrated in the works of many scholars (e.g. Hsu, W. K., & Huang S. S., 2006). Application of various active and interactive learning methods, such as, business games and web quests, serves this purpose. Due to this, intending bachelors accumulate the necessary experience of project activity and team work.

The studying style (as well as cognitive style) of individual students, becomes prior for the successful formations of professional competence and, in particular, information competence of those specializing in mathematics and IT. A studying style is an individual or peculiar way of learning. This style can be purposefully developed and adjusted through applied learning methods and educational technologies. It should be noted, that learner-centered educational process implies taking into account the characteristics of each student, but it does not imply the complete and absolute adjustment to the inclinations of students, thereby restructuring the entire training activities. Taking individual differences of bachelors into account within the framework of common educational process is most expedient. Its implementation requires providing students with the opportunity to choose their own path of learning within a unified educational program. The applying of e-learning extends the capabilities of the individualized educational processes, by simplifying its organization technology, e.g. by adding various additional information and learning process automations. Thus, modern electronic educational tools provide opportunities for the organization of learner-centered education. That's why they are an effective way of formation of personal cognitive styles. It is needed for form educational capabilities towards self-development, that, in turn, develops the competence of the students professionally (Makletsov, & Khabibullona, 2015).

Monitoring the learning results is implicated, in accordance with the established system of assessment of assignments based on different levels of complexity, aided by the systems of automated intermediate and final testing, practical tasks checking, psychological tests, and conducting surveys. Each of the mentioned monitoring methods evaluates the level of development of information competences of bachelors specializing in Mathematics and Computer Science.

2. Evaluation of Effectiveness of the Model Design

In order to conduct checking of the effectiveness of implementation of the e-learning model into educational process of intending bachelors specializing in «Mathematics and Computer Science», we conducted a pedagogical experiment. Its participants were 140 students of the Institute of Mathematics and Mechanics, named after N. Lobachevsky at Kazan Federal University.

During the experiment conducted for two years, lectures were delivered in two classes; experimental, and control groups respectively.

At the beginning of the formative experiment, as well as at the end of each academic year (after studying of each training course), both the control and experimental groups had: assessment of the students' knowledge in the studied subjects at the time of examinations in the form of tests, assessment

of laboratory tasks, submission of assignments, tests; with the aim of detecting the enhancement of individual peculiarities students' cognitive processes, and surveys; with the aim of determining the level of their self-efficiency.

While over 70% students of experimental groups on average had insufficient level of the development of information competence prior to the experiment, the amount of such students decreased almost to 16% after conducting the experiment. The same values in control groups changed from 66% just to about 54%. Also, the number of students, having a high level of information competence, grew in the experimental groups from 3.6% to 32%. In control groups the values changed only from 6% to 11% . (Makletsov & Starshinova, 2015).

The tables 1 and 2 demonstrates the amount of students with different levels of information competence development, prior to the experiment and after the experiment.

Table 1. The amount of students of experimental groups with the different levels of information competence development.

		Very low level	Low level	Medium level
Experimental group	Prior to the experiment	28,3%	41,8%	26,3%
	After the experiment	7,0%	9,2%	51,8%

Table 2. The amount of students of control groups with the different levels of information competence development.

		Very low level	Low level	Medium level
Control group	Prior to the experiment	25,0%	40,9%	28,0%
	After the experiment	15,9%	37,9%	35,6%

3. Conclusion

The designed model involves constructing the contents and structures of the educational processes of bachelors specializing in mathematics and IT, using unified e-learning system, selecting theoretical materials, developing a set of leveled practical vocationally oriented tasks in accordance with the set of pedagogical approaches and principles, as well as formation of the personal cognitive style. The conducted statistical analysis employing the χ^2 hypothesis test and Student's t-test shows that applications of the developed model increases the level of formed components of information competence in intending bachelors, thus proving it effective.

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