Artículo de investigación

Development of thematic plans of the discipline "Computer technologies in scientific research" on the basis of models of competency classes

Разработка тематических планов дисциплины "Компьютерные технологии в научных исследованиях" на основе моделей классов компетенций

Desarrollo de planes temáticos de la disciplina "Tecnologías informáticas en la investigación científica" sobre la base de modelos de clases de competencia.

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Abstract

When designing thematic plans of disciplines, the interrelation among competencies in the areas of student training is not taken into account, which leads to didactic and economic risks. To minimize these risks, it is proposed to use competency classes, which are a tool for combining competencies according to their meaning. Through the example of the discipline "Computer technologies in scientific research", an algorithm for constructing competency class models for the formation of thematic plans of disciplines is considered. The results of the research are implemented at the South Ural State University and the South Ural State University of Humanities and Pedagogy. They are used in the

Аннотация

При проектировании тематических планов дисциплин не учитывается взаимосвязь компетенций направлений подготовки студентов, что приводит к дидактическим и экономическим рискам. Для минимизации экономических и дидактических рисков предложено использовать классы компетенций, которые представляют собой инструмент для объединения компетенций по смыслу. На примере дисциплины «Компьютерные технологии в научных исследованиях» рассмотрен алгоритм построения моделей классов компетенций для формирования тематических планов дисциплин. Результаты исследования

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preparation of Masters in the economic and technical areas of training. The software implementation of the described algorithm for designing thematic discipline plans on the basis of competency class models will make it possible to eliminate a subjective approach and minimize economic and didactic risks. It is planned to introduce this program for various disciplines and areas of training.

Keywords: Training of personnel, thematic plans of disciplines, classification of competencies, modelling.

внедрены в Южно-Уральском государственном университете и в Южно-Уральском государственном гуманитарно-педагогическом университете. Они используются при подготовке магистров экономических и технических направлений подготовки. Программная реализация описанного алгоритма планирования тематических планов дисциплин на основе моделей классов компетенций позволит устранить субъективный подход и минимизировать экономические и дидактические риски. Планируется внедрение данной программы для различных дисциплин и направлений подготовки.

Ключевые слова: Подготовка кадров, тематические планы дисциплин, классификация компетенций, моделирование

Resumen

Al diseñar planes temáticos de disciplinas, no se tiene en cuenta la interrelación entre competencias en las áreas de capacitación de los estudiantes, lo que conlleva riesgos didácticos y económicos. Para minimizar estos riesgos, se propone utilizar clases de competencia, que son una herramienta para combinar competencias de acuerdo con su significado. A través del ejemplo de la disciplina "Tecnologías informáticas en la investigación científica", se considera un algoritmo para construir modelos de clase de competencia para la formación de planes temáticos de disciplinas. Los resultados de la investigación se implementan en la South Ural State University y la South Ural State University of Humanities and Pedagogy. Se utilizan en la preparación de maestrías en las áreas económicas y técnicas de capacitación. La implementación del software del algoritmo descrito para diseñar planes de disciplina temáticos sobre la base de modelos de clase de competencia permitirá eliminar un enfoque subjetivo y minimizar los riesgos económicos y didácticos. Está previsto presentar este programa para diversas disciplinas y áreas de capacitación.

Palabras clave: Capacitación del personal, planes temáticos de disciplinas, clasificación de competencias, modelización.

Introduction

The problem of providing security is one of the most important problems for any organization. Integrated security includes not only the organization of protection of social actors from emergencies and from insufficiently protected working conditions, illegal intrusion into the personal information space, but also the ability to properly assess external factors and respond promptly and adequately to them. Only simultaneous consideration of all factors provides an effective system of integrated security (Antonyuk et al. 2011). These features give grounds for considering the training of personnel as a complex information and analytical system, functioning in the conditions of uncertainty and risk.

The traditional approach to solving problems in the conditions of risk and uncertainty is the application of methods based on the use of specialists' knowledge and intuition. The result of applying this approach is the recommendations for decision-making, based on experience. For example, the recommendations are known aimed at training personnel in the conditions of introducing systems of automated design of technological processes at machine-building enterprises (Bogatenkov & Yusubov 2016) and information-measuring systems at energy-intensive enterprises (Gelrud & Bogatenkov 2016). A promising approach to solving problems in the conditions of risk and uncertainty is the use of modelling techniques

that minimize the existing risks. There are methods of analyzing socio-economic systems using models of eigenstates (Mokeyev & Vorobiev 2015), modelling the processes of functioning of stakeholders, designing technological processes for multitool lathe machining on the basis of matrix accuracy models (Yusubov 2013), compliance with the requirements for the safe operation of the electric power system on the basis of constructing the models of state (Bogatenkov et al. 2016).

Formultaion of the Problem

Topical issues of the academic excellence initiatives are management models and the role of state, methods for assessing efficiency and allocating funding among higher education institutions.

The subject of our research is a system of competencies designed for working and training in modern conditions. For example, communicative competence in e-learning is represented as a system of knowledge, skills, abilities, and motivational dispositions of teachers (Zlatić et al. 2014). The structure of professional competence includes motivational, value, and operational components (Khudyakova & Filatova 2013). There are known comprehensive approaches to the formation of competencies of managers in the educational environment (Bayarystanova et al. 2014) and to the information and communication competence (ICC) of future ecologists (Akeshova et al. 2014), which is treated as an activity in compliance with certain criteria and as a result of demonstrating behavioral problems in the performance of work (Meyers 1998). Research in this area is mainly related to the issues of ensuring the quality of training of specific specialists in accordance with the competencies of educational standards. For example, the methodology is known of information security training for university students (Polyakov 2006) and the formation of ICC for a future primary school teacher (Zaitseva 2011). At the same time, it should be noted that the effectiveness of the training system is largely determined by taking into account the interrelations of its elements. For example, the issues of association of students from different training directions into the classes for conducting lectures on similar disciplines, taking into account the relationship between basic and received education, are traditionally solved on the basis of the use of specialists' knowledge and intuition. With this approach, two options are possible: the first option is connected with merging of groups into classes; the second one is realized without association. With the first option, there can be didactic risks, since while providing requirements for the formation of knowledge of students of one training area, identical requirements for students of other training areas are not provided. With the second option, there can be economic risks, since the educational organization pays the teacher for the work during the lectures in proportion to the number of groups. According to research in the field of vocational pedagogical education, there is a high percentage of inaccuracy in the planning of training (Gnatyshina et al. 2016), which requires taking into account the interrelation of competencies in the design of personnel training, with the minimization of economic and didactic risks.

Taking into account the interrelation of competencies in the design of training is difficult, because competencies are heterogeneous textual information, consisting of a set of words that are difficult to analyze. For example, it is expedient to combine synonyms into one class according to meaning, but this is difficult to do because of their different spelling. In information retrieval systems, to work with such information, its classification by keywords is used. A promising direction for investigating the interrelation of business processes of personnel training is the classification of competencies according to the purpose, character, field of activity and level of education (Bogatenkov 2013). Economic and didactic risks associated with the subjective nature of the design of competencies can be minimized as a result of the establishment of semantic links among them based on the formation of models of competency classes that are a tool that combines the competencies of different levels of education and training directions according to their meaning.

Thus, the problem of taking into account the interrelations in the system of personnel training is topical. The problem can be solved on the basis of modeling of competency classes, which will enable to design the thematic plans of disciplines taking into account the interrelations of competencies, to associate the groups of students from different training directions into classes for conducting lectures on similar disciplines, etc.

The problem of effective development of thematic discipline plans taking into account the interrelations of competencies can be solved on the basis of models of competency classes. The aim of the study is to construct models of competency classes for the development of thematic plans of disciplines, taking into account

the interrelations of competencies of the student training directions being combined.

Construction of Models of Competency Classes for the Development of the Thematic Plan of Lectures

As a result of realization of the strategic initiative "Implementation of mechanisms to ensure the concentration of resources in breakthrough areas and abandonment of inefficient directions" (Strategic Initiatives n.d.), the South Ural State University has proceeded to a new structure, which eliminates inefficient units and which consists of 10 higher schools and institutions (The New Structure of the University). As a result of merging the Institute of Economy, Trade and Technology with the International Department and the Department of Economics and Management and the Department of Economics and Entrepreneurship, Higher School of Economics and Management has been established (Higher School of Economics and Management). As a result of such an event, departments have been created which combine the personnel training of the related training directions, and this opens the organizational opportunities to deliver lectures on similar subjects.

For the effective formation of thematic lecture plans, it is necessary to build competency models that are a set of keywords determining the semantic content regardless of the form of spelling. Examples of competency models for economic training areas (FSES of HE in FT 38.04.01, FGOS VO po NP 38.04.02, FGOS VO po NP 38.04.03, FGOS VO po NP 38.04.04, FGOS VO po NP 38.04.05) are given in Table 1, and for technical training areas (FGOS VO po NP 15.04.01, FGOS VO po NP 15.04.02, FGOS VO po NP 15.04.03, FGOS VO po NP 15.04.04, FGOS VO po NP 15.04.05, Bogatenkov et al. 2017), in Table 2. The basis for constructing models of competency classes is the idea of combining them according to the criterion of minimizing economic and didactic risks as a result of analysis of their models. The minimization of didactic risks is achieved as a result of taking into account all competencies formed at a certain stage of training. Economic risks are minimized by combining competencies according to meaning as a result of elimination of duplication and the synonym words. A model of the competency class is a model formed as a result of combining the models of competencies included in the class.

For economic directions (Table 1), the model of the class of competencies formed within the framework of the discipline "Computer technologies in scientific research" will be as follows:

1. Conducting independent scientific research in accordance with the developed program using information technologies (1.1+5.1+4.1)

2. Search, collection, processing, analysis, systematization and generalization of information using information technologies (1.2+3.2+4.2+4.1)

3. Use of quantitative and qualitative methods of estimation and forecasting using information technologies (2.1+3.1+4.1)

4. Preparation of review, scientific report, scientific publication, report, analytical materials using information technologies (2.2+3.3+5.2+4.1)

For technical directions (Table 2), the model of the class of competencies formed within the framework of the discipline "Computer technologies in scientific research" will be as follows:

1. Conducting independent scientific research in accordance with the developed program using information technologies (1.1+5.1+4.1)

2. Search, collection, processing, analysis, systematization and generalization of information using information technologies (1.2+3.2+4.2+4.1)

3. Use of quantitative and qualitative methods of estimation and forecasting using information technologies (2.1+3.1+4.1)

4. Preparation of review, scientific report, scientific publication, report, analytical materials using information technologies (2.2+3.3+5.2+4.1)

Table 1. Examples of competency models for economic directions

Direction	Competency	Model of knowledge
38.04.01 Economics	PC-3*) ability to conduct independent research in accordance with the developed program	Conducting independent research in accordance with the developed program (1.1)
	PC-9 ability to analyze and use various sources of information for conducting economic calculations	Analysis and use of the information sources (1.2)
38.04.02 Management	PC-4 ability to use quantitative and qualitative methods for conducting applied research and managing business-processes	Use of quantitative and qualitative methods (2.1)
	PC-8 ability to present the results of the conducted research as a scientific report, paper or presentation	Preparation of scientific report, paper or presentation (2.2)
38.04.03 Personnel management	PC-17 mastering the methods of estimating and forecasting risks in personnel management, methods of analysis of injuries and occupational diseases	Methods of estimating and forecasting (3.1)
	PC-24 possession of skills in the search, collection, processing, analysis and systematization of information on the research topic, preparation of reviews, scientific reports and scientific publications on topical problems of personnel management	Search, collection, processing, analysis and systematization of information (3.2); Preparation of a review, scientific report, scientific publication (3.3)
38.04.04 State and municipal administration	PC-12 the ability to use information technologies to solve various research and administrative problems	Use of information technologies (4.1)
	PC-14 ability to systematize and summarize information, prepare proposals for improving the system of state and municipal administration	Systematization and generalization of information (4.2)
38.04.05 Business-informatics	PC-12 ability to conduct scientific research to develop strategic ICT solutions	Conducting scientific research (5.1)
	PC-1 ability to prepare analytical materials for the evaluation of activities and development of strategic decisions in the field of ICT	Preparation of analytical materials (5.2)

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Table 2. Examples of competency models for technical directions

Direction	Competency	Model of knowledge
15.04.01 Mechanical engineering 15.04.02 Technological machines and equipment	PC-20 ability to develop physical and mathematical models of machines, systems, processes, phenomena, and objects related to the professional sphere, develop methods and organize experiments with the analysis of their results	Development of models and methods (1.1)
	PC-21 ability to prepare scientific and technical reports, reviews, publications on the results of studies	Preparation of scientific and technical reports, reviews, publications (1.2)
		Application of computer technologies (2.1)
15.04.03 Applied mechanics	PC-1 ability to identify the essence of scientific and technical problems arising in the course of professional activity and, to solve them, engage the corresponding physico-mathematical apparatus, computational methods and computer technologies	
	PC-2 ability to apply the physical and mathematical apparatus, theoretical, calculated and experimental methods of research, methods of mathematical and computer modelling in the process of professional activity	Application of computer modelling (2.2)
15.04.04 Automation of technological processes and productions	PC-17 the ability to develop methodologies, work plans and programs for scientific research and advanced technical developments, prepare separate assignments for performers, scientific and technical reports, reviews and publications based on the results of the studies	Development of methods, work plans and programs for scientific research (3.1)
	PC-18 the ability to manage the results of scientific research and commercialization of rights to intellectual property, to carry out its fixation and protection	Management of the results of scientific research (3.2)
15.04.05 Design and technological support of machine-building productions	PC-57 ability to carry out mathematical modelling of processes, tools and systems of machine-building production using modern technologies for scientific research	Mathematical modelling using modern technologies (4.1)
	PC-60 ability to perform collection, processing, analysis, systematization, generalization of scientific and technical information, foreign and domestic experience in the direction of research, choose methods and means to solve practical problems	Collection, processing, analysis, systematization and generalization of scientific and technical information, experience (4.2)

The model of competency classes allows developing an effective thematic plan of lectures by uniting groups of students from different training directions into classes.

Development of the Thematic Plan of Lectures on the Discipline "Computer Technologies in Scientific Research"

As an object of research, we consider the thematic plan of lectures on the discipline "Computer technologies in scientific research" for the preparation of Masters in five economic areas: 38.04.01 Economics, 38.04.02 Management, 38.04.03 Personnel management, 38.04.04 State and municipal administration, 38.04.05 Business informatics. To conduct combined lectures, it is necessary to develop a unified thematic plan of lectures for a set of groups that meets the requirements for the formation of knowledge in accordance with the competence of the corresponding educational standards (Zaitseva 2011, Gnatyshina et al. 2015, Bogatenkov 2013, Strategic Initiatives n.d., The New Structure of the University).

On the basis of models of competency classes, a typical thematic plan is formed, which is given below.

Theme 1. Conducting independent scientific research in accordance with the developed program with the help of ICT: Internet conferences, Web-seminars, personal electronic diaries, etc.

Theme 2. Search, collection, processing, analysis, systematization and generalization of information using ICT: search engines, Internet, MS Office, electronic resources of the joint fund "Science and Education", libraries for working with electronic resources, E-library, Scopus, etc.

Theme 3. Use of quantitative and qualitative methods of estimation and forecasting using ICT: statistical methods for processing experimental data, the method of eigenstates, etc.

Theme 4. Preparation of the review, scientific report, scientific publication, presentation, analytical materials with the help of ICT: registration of the scientific research results and electronic resources in various funds, publication of scientific articles on the Internet, MS Office, personal electronic diaries.

The thematic plan of lectures on the discipline "Computer technology in scientific research" was developed and implemented in the educational process of training of Masters in economic directions at the South Ural State University.

Ultimately, this algorithm is planned to be implemented in the software allowing automating the creation of thematic lecture plans. This will allow eliminating the subjective approach in the preparation of thematic plans and minimize economic and didactic risks. It is planned to implement this software for different disciplines and areas of training.

Conclusion

When designing thematic plans of disciplines, the interrelation of competencies in the areas of student training is not taken into account, which leads to didactic and economic risks.
To minimize economic and didactic risks, it is suggested to use competency classes, which are a tool for combining competencies according to meaning.

Through the example of the discipline "Computer technologies in scientific research", we consider an algorithm for constructing models of competence classes for the formation of thematic plans of disciplines. The results of the research are implemented at the South Ural State University.

The software implementation of the described algorithm for planning the thematic plans of disciplines on the basis of competency class models will allow eliminating the subjective approach and minimize economic and didactic risks. It is planned to introduce this program for various disciplines and training directions.

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