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ASSESSMENT OF THE PROCESS OF ACQUIRING PROFESSIONAL COMPETENCIES BY STUDENTS

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Abstract

According to federal state educational standards of higher professional education, students acquire certain competencies in the learning process. Assessing the degree of their development is a rather difficult task. It should be borne in mind that competencies are acquired by students not immediately, but gradually, while mastering several disciplines. To solve this problem, modeling the learning process as a process of the system functioning will help. The modeling of such a process must be dynamic and therefore Petri nets can be used. This work is devoted to the description of the possibility of using Petri nets to solve this problem. When developing the model, a number of limitations and hypotheses were accepted. In particular, the quality of the acquired learned competencies is expressed by a dimensionless value, the actual level of acquired competences by the learner is determined by assessment tools during the passage of disciplines and practices. When creating, an attempt was made to take into account the fact that each academic discipline has the goal of mastering a certain part of the group of competencies and all disciplines are logically connected. As a result of modeling, the relative change in competencies as a result of students' training was studied.

Keywords: Learning process, disciplines studied, competencies, modelling, Petri nets

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1. Introduction

The introduction of federal state educational standards (FSES) in institutions of higher professional education is based on the implementation of the competence-based approach (Efremova, 2017). The competence-based approach in pedagogical activity is usually understood as a methodological orientation, which allows, by relying on a system of interrelated concepts, ideas and methods of action, to provide and support the development of a unique individuality, the development of thinking and speech, independence and personality culture (Atanov et al., 2015; Nazmutdinov & Yusupova, 2013). Competence in FSES is understood as the ability of students to apply knowledge, skills, personal qualities and practical experience for successful activities in a particular area (Kononova et al., 2013). The pedagogical process becomes focused on the acquisition of universal (CC), general professional (OPK) and professional competencies (PC) by students. The greatest difficulty is the development of methods and tools for assessing the level of competence formation (Marina et al., 2018; Vasilieva, 2017). A lot of works are devoted to the teaching of disciplines, in which this process is considered in detail, but the methods of quantitative assessment, which allow automating the process of monitoring the acquisition of competencies and the compliance of the level of competencies with the requirements of employers, have been given much less attention, and at the moment there is no single system of quantitative assessment of general cultural and professional competencies. graduate (Atanov et al., 2015; Kononova et al., 2013; Marina et al., 2018; Pirskaya, 2012; Vasilieva, 2017). A review of Russian sources on the development of models for measuring the integral educational results of university graduates revealed:

- their limited number. The works of Atanov et al. (2015), Belyaeva et al. (2018), Efremova (2017), Fortier and Michel (2003), Kononova et al. (2013), Nazmutdinov and Yusupova (2013), Yushin and Korogodina (2012) and others, in some moments close to the problem under study;
- the lack of a unified approach and universal criteria for the attainability of results, the difference in the units of measurement of the result;
- incompleteness of methods that give a visual representation and a quantitative indicator of the level of competence formation of a university graduate.

2. Problem Statement

The analysis of publications allows us to note that studies in the field of assessing the level of mastering competencies have not yet been sufficiently developed. The question of the practical application of the quantitative assessment of competencies has not been sufficiently studied, therefore the topic is interesting and promising for future research. In particular:

- Steps for the transition to competence-based learning in modern teaching practice;
- Identifying reliable means of measuring the quality of mastering competencies (qualitative or quantitative indicators).

Below we will look at each problem.

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2.1. Steps for the transition to competence-based learning

The process of obtaining competencies is difficult to formalize because:

- Being a systemic integrative category, competence is not derived reductively from its components and is not reduced to them. It represents a qualitatively new step in the hierarchy of the educational ladder, the ascent to which requires a certain, albeit primary, experience of activity (Yushin & Korogodina, 2012).
- Each professional competence is made up of a number of components that reflect the student's degree of formation of the required theoretical knowledge, practical skills and experience in solving professional problems, as well as his individual and personal qualities (Shamsutdinova & Prokofieva, 2014).

To assess the sequence of teaching disciplines, to form a qualitative or quantitative assessment of competence, it is required to have an idea of the mechanism of its formation. This can be helped by a model of the process of forming students' competencies. The solution to this problem is possible through the creation of a simulation model. One of the possible approaches to creating such a model is described in this article.

2.2. Identifying reliable means of measuring the quality of mastering competencies

Competence-based learning inherently includes the following elements:

- Students move forward when they master the content and skills, not because they passed with one or another positive assessment.
- Transparency about where students are located empowers them and enables teachers to better tailor teaching to their individual needs.
- Assessment is an ongoing part of the learning cycle, not a final judgment at a time when the student has no hope of changing the outcome.
- Students must be able to demonstrate that they can transfer their knowledge to new contexts, applying skills to tasks they have never faced before.

A lot of works are devoted to the teaching of disciplines, in which this process is considered in detail, but the methods of quantitative assessment, which allow automating the process of monitoring the acquisition of competencies and the compliance of the level of competencies with the requirements of employers, have been given much less attention, and at the moment there is no single system for quantitative assessment of general cultural and professional competencies. graduate (Atanov et al, 2015; Kononova et al., 2013; Marina et al., 2018; Pirskaya, 2012; Vasilieva, 2017). A review of Russian sources on the development of models for measuring the integral educational results of university graduates revealed:

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- lack of a unified approach and universal criteria for achieving results, the difference in the units of measurement of the result;
- incompleteness of methods that give a visual representation and a quantitative indicator of the level of formation of the competencies of a university graduate.

3. Research Questions

In course of the study the following questions were raised:

- How is competence formed in the process of teaching various disciplines?
- What competencies develop most quickly in the process of teaching students?
- How do the competencies change in each course of study of students?

4. Purpose of the Study

Supposedly, the answers to the issues raised above will help achieve the goal, contribute to the study the process of changing competencies during the training of students and help to identify the features of the development of competencies in different courses of study of students.

5. Research Methods

The author used universal methods of scientific research, as well as methods of comparative and statistical analysis. The work uses research methods to create a list of competencies formed in the process of teaching each discipline, statistical research methods to quantify competencies and modelling.

5.1. Accepted hypotheses

Since the learning process is difficult to formalize, the following hypotheses are accepted in the work:

- The quality of training of trainees is assessed by the level of competencies acquired by them, which is expressed by a dimensionless value, taking, for example, values from 0 to 100.
- The work does not take into account the possible mutual influence of the levels of various competencies on each other, an increase in the level of competencies due to the student's activity and independent extracurricular work, as well as the general atmosphere of the educational institution.
- The actual level of the competencies acquired by the trainee is determined by assessment tools during the passage of disciplines and practices aimed at this competence, for example, the average scores received by students in the study of the relevant disciplines.

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5.2. Theoretical representation of the learning process

Students receive education while studying various disciplines. According to the Federal State Educational Standard, they all last for several groups:

- basic disciplines (denote B1, B2, B3, etc.);
- variable disciplines (denote V1, V2, V3, etc.);
- disciplines of the student's choice (we denote DV1.1, DV1.2, DV2.1, DV2.2, etc.);
- optional disciplines (denote F1 and F2).

The list of disciplines depends on the direction and profile of student training. Of course, the study of each discipline is associated with some other disciplines. Consequently, the competencies acquired by students are acquired through the study of several disciplines. As an example, consider the training of students in the direction 09.03.02 Information systems and technologies. When studying, students must study 9 elective disciplines according to the curriculum. During the training of students in the direction 09.03.02, 14 different competencies are formed.

Table 1 is a list of what competencies are needed to study each discipline. It should be taken into account that students have some competencies even before entering a university, while studying in a secondary or specialized secondary educational institution. These competencies are not formed all at once in the study of disciplines, but gradually, during all four years of study. There is a competency formation matrix. For the disciplines under consideration, the competencies being formed are shown in Table 2.

Table 1. Competencies required in the study of disciplines

Discipline name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Chemistry	+													
Usability research of a software product									+					
Experimental data processing	+													+
Introduction to the specialty	+									+				
Automated production control systems in the oil and gas industry	+		+											
Technical translation in the field of infocommunication technologies				+	+									
Metrology, standardization, certification in computing	+		+											
Information systems in the oil and gas industry	+							+				+		+
Fundamentals of research activities	+								+	+				+

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Table 2. Matrix of competencies formation

Discipline name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Chemistry	+													
Usability research of a software product									+					
Experimental data processing									+					
Introduction to the specialty	+													+
Automated production control systems in the oil and gas industry												+		+
Technical translation in the field of infocommunication technologies				+										
Metrology, standardization, certification in computing										+				
Information systems in the oil and gas industry												+		+
Fundamentals of research activities									+	+				

When describing the learning process, a directed graph is very often used. In pedagogy, this view is called a learning trajectory, a learning strategy, a situational learning scheme.

5.3. Heading Level 2

In this paper, we propose a model of the learning process, based on the fact that this process is probabilistic in nature, and under certain assumptions, the learning process can be represented as a kind of graph - a Petri net (Bobbio, 1990; Fortier & Michel, 2003; Malkov & Malygina, 2010). The Petri net is able to simulate one of the steps in the course learning process (reading theoretical material, answering questions, searching the Internet, preparing reports, etc.). Arcs between nodes simulate the sequence of steps. From the point of view of applications, the analysis of the dynamics of changes in the markings of the Petri net and the situations arising in this case is of the greatest interest. The Petri net marker simulates a portion of the data stream, and the position - the accumulation and storage of such portions. The data flow for the learning process under consideration is the competencies acquired by students in the course of learning. Since Petri nets allow using any objects, both material and non-material, as tokens. For the learning process, we will consider competencies as tokens in the Petri net model. The functionality of the Petri net makes it possible to determine the change in competencies, to somehow quantitatively characterize the process of accumulating competencies. Each chip denotes a conditional level of competence, which changes several times (conditionally).

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To create a graph and calculate changes in the Petri net, you can use the specialized software CPN Tools. As can be seen in Figure 1 below, on the Petri net fragment, position st stores the student's competencies (denotes the student's knowledge), transition st - the beginning of training (the student entered the 1st year), positions and transitions are indicated by the numbers of the corresponding disciplines (positions 1 - 9 and transitions 1 - 9), transition 1-1 - denotes the beginning of the student's training in the 2nd year, transition 2-2 - means the beginning of the student's training in the 3rd year, transition 3-3 - means the beginning of the student's training in the 4th year. Before the start of training, students have some initial knowledge, competencies are formed at some level. Therefore, the work of the Petri net begins at position sd (Figure 1), which denotes the training of students to the university. Initially, position st contains the 1st conditional unit of each competency (one chip with the corresponding number). In the course of training, the student acquires the appropriate competencies, i.e. the number of chips with the corresponding number in position st changes. This process is indicated by tokens transmitted along arcs, i.e. competencies with corresponding numbers. The competencies that are required in the study of the relevant disciplines are taken from Table. 1 and are denoted by the corresponding tokens transmitted along arcs from the position to the transition. The competencies that are formed in the study of the relevant disciplines are taken from Table 2 and are indicated by the corresponding tokens transmitted along arcs from the transition to the position. In addition, in Figure 1 variable yk is used to denote all the competencies currently available to the student.

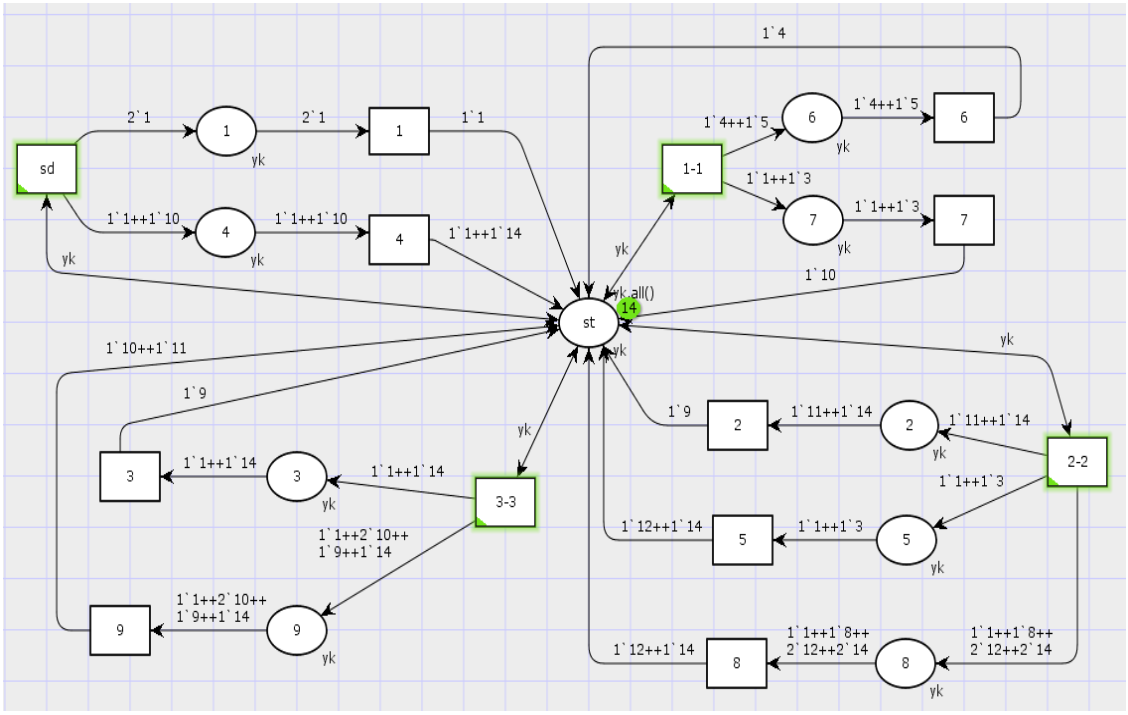

Figure 1. Petri Net

6. Findings

As a result of the research, a model for obtaining competencies by students was proposed, which allows you to clearly see the change in the values of competencies in the process of teaching students. If

you look at the distribution of disciplines by years of study, then using the built-in model, you can assess the change in competencies. So, during the entire learning process, competencies 1 and 9 were increased 3 times, competence 4 - 2 times, competencies 9 and 10 - 3 times, competence 14 - 4 times. Thus, the study showed that competence develops the fastest 14.

7. Conclusion

The study points to the possibility of assessing the degree of mastery of competencies by students in the learning process. The developed model clearly demonstrates the process of teaching students, taking into account the study of various disciplines. In the course of the study, a methodology was proposed for quantitatively assessing the degree of mastering competencies in teaching students.

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