

Visualization of the formation of undergraduate competencies

Visualización de la formación de competencias de pregrado

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Received: 30/05/2019 • Approved: 15/08/2019 • Published 02/09/2019

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ABSTRACT:

The authors describe the mapping technique for visualization of the formation of undergraduate competencies. The authors consider the mapping technique, because it is necessary to find adequate mechanisms to analyze aspects of the relation "pedagogue-student". In addition, the technique allows visualizing spatial information in order to stimulate educational and professional activities of an undergraduate by means of system-activity approach and development of learning technologies. The article gives an example of how to control and manage the formation of undergraduate competencies. The authors come to the following result: the modern mapping technique can be used not only to analyze the processes influencing the formation of undergraduate competencies by means of system-activity and informational approaches, but also to influence the organization of the learning process.

Keywords: competence, mapping technique, model, system-activity approach

RESUMEN:

Los autores describen la técnica de mapeo para la visualización de la formación de competencias de pregrado. Los autores consideran la técnica de mapeo, porque es necesario encontrar mecanismos adecuados para analizar aspectos de la relación "pedagogo-estudiante". Además, la técnica permite visualizar información espacial para estimular las actividades educativas y profesionales de un estudiante mediante el enfoque de actividad del sistema y el desarrollo de tecnologías de aprendizaje. El artículo da un ejemplo de cómo controlar y administrar la formación de competencias de pregrado. Los autores obtienen el siguiente resultado: la moderna técnica de mapeo se puede utilizar no solo para analizar los procesos que influyen en la formación de competencias de pregrado por medio de la actividad del sistema y los enfoques informativos, sino también para influenciar la organización del proceso de aprendizaje.

Palabras clave: competencia, técnica de mapeo, modelo, enfoque de actividad del sistema

1. Introduction

Scientific research and publications devoted to the modernization of education at all levels pay much attention to the student competencies. The concept of «competence» currently has no clear definition and is interpreted depending on the position of the authors. In this article, we define the concept of competence with regard to social order, as well as the requirements of educational standards and employers.

A.V. Khutorskoy (2002) gives the following definition of the concept of competence. The key competence is a set of interrelated personal qualities (knowledge, skills, methods of activity), which are determined in relation to a certain range of objects and processes. These qualities are necessary for high-quality productive activities within this range. In the dictionary of S. I. Ozhegov (1990) the definition of competence is understood as a range of issues in which someone is well aware. According to S.E. Shishov and V.A. Kalney (1999), the concept of competence refers to the field of skills, not knowledge. Namely, the competence is a general ability based on knowledge, experience, values and dispositions, which are acquired through learning. In addition, a competence cannot be reduced neither to the knowledge nor the skills. To be competent does not mean to be a scientist or well educated person. S. E. Shishov and V. A. Kalney (1999) suggest that competence is the adaptation of human behavior to the infinite variety of life situations. This adaptation is closely related to the general ability to mobilize in a particular situation all the knowledge and experience that a person has received in his personal biography.

We believe that a competence is a given social requirement (norm) for the educational training of graduates of an educational institution, which is necessary for their future high-quality productive activity in the relevant field and is aimed at solving practice-oriented problems.

A competence is a formal indicator setting a certain field of professional activity. In addition, a competence is a nomenclature of powers (responsibilities), which are based on special knowledge and skills. Competencies can be compared with stable coefficients that correspond to the indicators of professional activity. In fact, a competence is the minimum (initial) level of suitability for a certain form of such activity, as well as the initial level of official applicability, which determines the list of decision-making rights in this area.

Competencies cover the following three aspects of undergraduate training: instrumental, interpersonal and systemic. Instrumental competencies are professional qualities, i.e. optimal cognitive and self-study skills, as well as an ability to understand the terminology and thinking constructs that are specific for the professional field, master the technological principles and technical means, plan and predict the activity, perform information exchange with the external environment and the management of elementary processes, etc.

The concept of competence is associated with the concept of qualification, which expresses an instrumental aspect of the graduates' competencies. The qualification is related to the graduates' skills and characterizes their professionalism from the point of view of technical and technological knowledge and skills in real time, that is, the possibility to use their professionalism "here and now". The qualification matrix allows to measure parameters of the specialist training more formally and more specifically.

In addition, a competence includes the features of interpersonal interaction skills and communication. This aspect implies to take into account many individual abilities of the graduates. Namely, the ability to manage their own personal likes and dislikes, feelings and relationships, express criticism and self-criticism, positively influence on others and consider their opinions. In addition, individual abilities of the graduates include skills of group activities in general and presence of important for the profession ethical attitudes and values, etc.

A system parameter of competencies is important along with instrumental and interpersonal one. A system parameter implies that undergraduates have the set of skills and knowledge that are important in the wider context of professional activities, i.e. starting with the execution of special functions and ending with making strategic (long-term) decisions for optimization of their professional activities. The whole set of knowledge and skills are important and allow to see a part and the whole, as well as to reach the level of high art. In addition, the system parameter of competencies assumes that graduates take the functions of leadership and is responsible for the quality of professional actions and the decision making. In addition, the graduates have strong will, ability to self-study in different fields, the right to their own opinion, etc.

Therefore, the competencies define parameters of knowledge and skills, as well as rights in professional activity of graduates. Nevertheless, competencies are not in a direct and single-

valued relation with the list of knowledge and skills, which undergraduates acquire at a specific educational institution by means of functional-activity approach.

In contemporary literature, there are many works in the field of formation of professional competences and in the field of standardization and evaluation of the quality of education based on the competence approach. For example, you can specify works (Kamalova and Zakirova, 2015; Khuziakhmetov, 2016; Shefer et al., 2018), which examine the formation of competencies at different levels of education. There are works considering the factors influencing the formation of competencies (Kirillova et al., 2015). However, the works devoted to visualization of the process of the competence development are not enough. This method we will call the mapping technique method for visualization of the formation of undergraduates' competencies.

As a rule, in the scientific community maps are used as an assessment tool for the international potential and monitoring of public health (Labry de et al., 2016). There are articles on mapping in education, but they do not take into account the qualification requirements for graduates from employers (Lawn and Rees, 2007), although the modern learning process is based on the formation of competencies established by the educational standard and demanded by employers.

2. Materials and methods of research

We use the mapping technique, i.e. a method of graphic, semantic, symbolic description and systematization of any material and abstract object. The method allows a comparison of the number of elements in order to their consistent description, group and generalize initial data for building models of objects (Lynch, 1982; Trochim and Kane, 2005; Mittelmark et al., 2006; Vavilina and Skalaban, 2015). In our case, the method allows to control the formation of undergraduates' competencies.

Currently in the scientific literature, there are no universal maps that take into account a number of specific criteria to evaluate the formation of competencies. These criteria include requirements of different standards, organization of educational process and management of educational and professional activities of students aimed at obtaining results. Creation of a formation map of undergraduates' competencies is meant to be know-how in the field of universal evaluation of competencies in educational activities. Experimental studies confirm that the use of such maps is effective. In addition, the approach to visualize the formation of undergraduates' competencies is patented by one of the authors. Note that the described mapping technique is the original one. However, the mapping technique was previously used in various fields of research, for example, in social and medicine researches (Blanchard et al., 2017; Bon-Martens van et al., 2017; Das and Turkoglu, 2018; Kraineva and Shefer, 2017).

A model is a simplification and idealization of real processes, which can be represented as a map. An advantage is that the map is metaphoric. According to M. Mittelmark, the mapping process is a drawing of images representing the world around us (Mittelmark et al., 2006; Vavilina and Skalaban, 2015). Mapping makes the formation of undergraduates' competencies easy understandable (Fig.1).

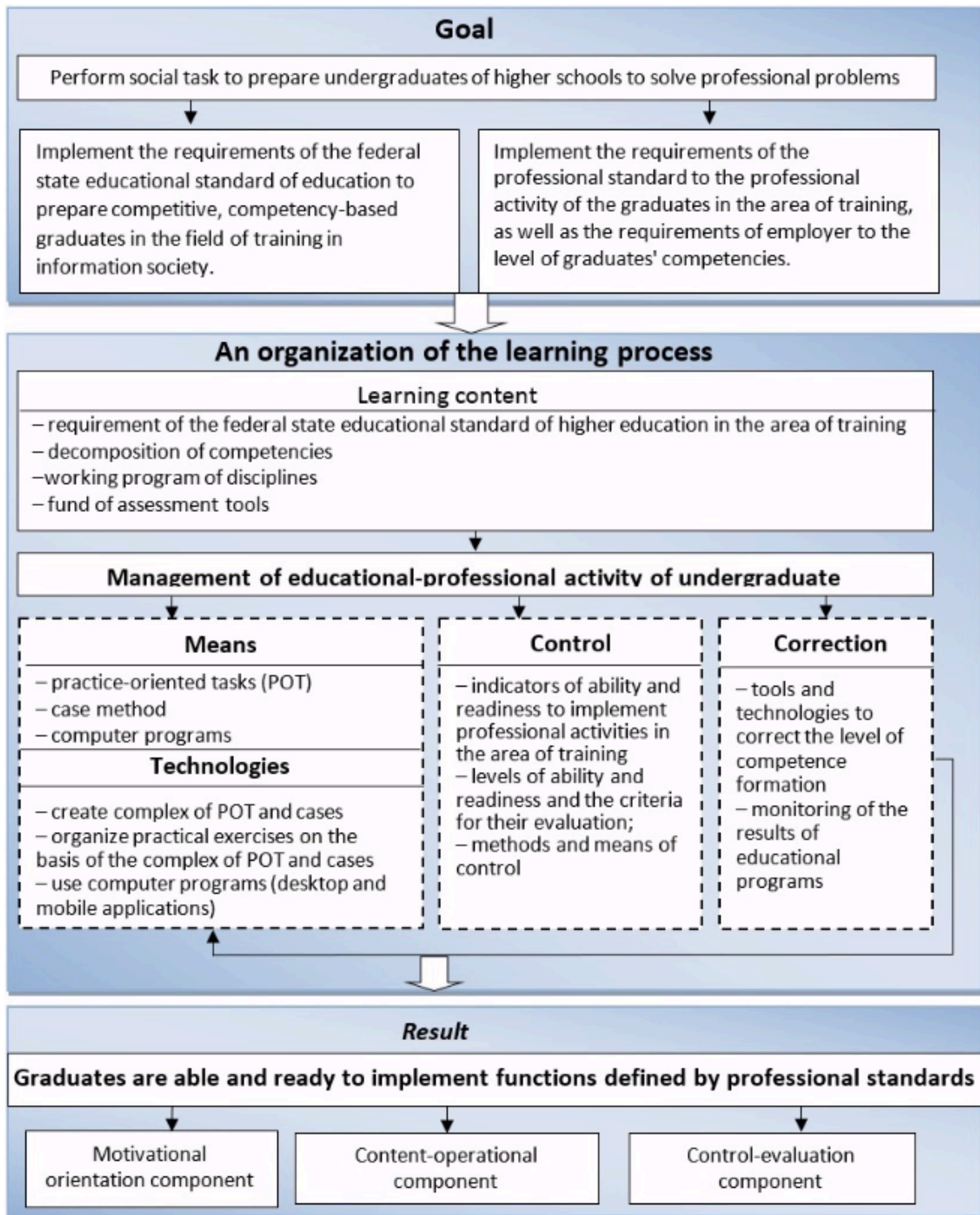
Dissemination of the project-based approach to planning, as well as to evaluation of prospects and efficiency of the formation of undergraduates' competencies, leads to a need for the mapping method for planning, monitoring and evaluation of management of educational-professional activity of students. In the design process, the teaching methods in higher school are modernized, because the methods are used to develop, accompany and manage educational-professional activity of students. Here the mapping is a method of systematization, audit of social request to the preparation of undergraduates, as well as available to a teacher problems and resources. Therefore, the mapping involves an analysis of not only the social context (goal), but also the wider management context (tools, technologies, control, and correction).

In the narrow sense, the mapping of competencies is a tool of pedagogical research, which can be applied at the stage of development of teaching methods to form undergraduates'

competencies by means of functional-activity approach (Fig. 1).

Figure 1

A map to control the formation of undergraduate competences



In pedagogical research having applied character, the considered group of maps is represented by technological (route) maps, which describe step-by-step implementation of technologies to form competencies defined by federal state standard of higher education in a specific field of study.

For example, the following General professional competencies (GPC) of undergraduates in the field "System of land use and cadasters" are formed:

GPC-1 is ability to search, store, and process, analyze information from various sources and databases, and present the information in the required format using information, computer and network technology.

GPC-2 is an ability to use the knowledge on land resources in order to the resource management and determine measures to reduce anthropogenic impact on the territory.

GPC-3 is an ability to use the knowledge of modern technologies of project cadastral and other works connected with the system of land use and cadasters.

In order to analyze the success of formation of the above undergraduates' competencies in the field "System of land use and cadasters", we formed and offered to the employers the questionnaire based on the platform UNIT4 ([Kraineva and Shefer, 2017](#)).

The number of respondents completed the questionnaire is 55. The questionnaire included the questions, the analysis of which presented in table 1.

Table 1
The analysis of employers' answer the questionnaire

#	Question	Possible answer	% choice of answer
1	What skills in various types of land surveying and cadastral works with information from various sources and databases should the graduates have?	<ol style="list-style-type: none"> 1. search for information 2. store information 3. analyze information from various sources and databases 4. provide information in the required format using information, computer and network technology 5. have experience of work with input devices of computer to create multimedia presentations (audio, video information on the computer) 6. be competent user of the Windows operating system 	<p>12</p> <p>8</p> <p>15</p> <p>15</p> <p>15</p> <p>35</p>
2	Which of the modern technology should the graduates possess to show the ability to use the knowledge on land resources in order to rational use the resources and determine measures to reduce anthropogenic impact on the territory?	<ol style="list-style-type: none"> 1. information, computer and network technologies 2. GIS technology 3. land information system 	<p>25</p> <p>40</p> <p>35</p>
3	Is it possible to evaluate the formation of competencies by using knowledge of modern technologies of project cadastral and other works connected with system of land use and cadasters?	<ol style="list-style-type: none"> 1. Yes 2. No 	<p>87</p> <p>13</p>

3. The results of the study

The using of visualization maps can be one of the diagnostic tools using to form the level of undergraduates' competences. The field of application of such maps is associated with the assessment of the results of the basic level of education programme development, both for

the start and for the intermediate and final diagnostics of undergraduates.

The respondents of the questionnaire were land surveyors, geodesists and cadastral engineers, managers and leading experts of cadastral chamber and firms, as well as firms dealing with real estate evaluation. The analysis of the questionnaire is given in Fig. 2. In the analysis of the results, the answer to the 4th question is not taken into account, as it has an open answer.

According to the questionnaire (Fig. 2), the undergraduates trained by correspondence run better with the practice-oriented components and quite commonly use information, computer and network technologies in cadastral and other types of work that are the basis of professional activities.

The use of such technology allows undergraduates to create innovative product and be in professional demand on the labor-market. Such high level of professional motivation can be connected with the fact that the majority of undergraduates trained by correspondence is already working in the field related with system of land use and cadasters.

Figure 2

Analysis of results of the questionnaire of employers

	12	8	15	15	15	35	25	40	35	87	13
search for information											
store information											
analyze information from various sources and databases											
provide information in the required format using information, computer and network technology											
have experience of work with input devices of computer to create multimedia presentations...											
be competent user of the Windows operating system											
information, computer and network technologies											
GIS technology											
land information system											
Yes											
No											
1. What skills in various types of land surveying and cadastral works with information from various sources and databases should the graduates have?											
2. Which of the modern technology should the graduates possess to show the ability to use the knowledge on land resources in order to rational use the resources and determine measures to reduce anthropogenic impact on the territory?											
3. Is it possible to evaluate the formation of competencies by using knowledge of modern technologies of project cadastral and other works connected with system of land use and cadasters?											

However, the level of operations on retrieves and store information is not very high. In addition, the use of ICT can require some differentiation in the organization of undergraduate work in the groups taking into account the level of computer competence of the undergraduates.

Undergraduates' competencies in the field "System of land use and cadasters" meet the requirements of corresponding professional standards, which include the types of activities demanded by employers. These competencies are reflected in the qualification characteristics presented in the state educational standard.

The conducted analysis of the results of the pedagogical experiment shows that the use of visualization maps for bachelors in the field of "Land Management and cadasters" by means of the discipline "Physics of the Earth" is effective. This is proved by comparing the results achieved in the formation of competencies (knowledge, skills) of undergraduates of experimental groups. The achieved results are much higher and better than the control ones.

The study showed the following results:

- 1) in general, the proposed method of using visualization maps in the direction of "land Management and cadasters" means of discipline "Physics of the Earth" is an effective innovative technology;
 - 2) this technique significantly increases the level of expression of the competence approach in the development of undergraduate students.
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4. Conclusion

The use of maps in organization of the undergraduate training allows using independent cognitive activity based on information and communication technologies. Note that the number of levels in maps and their criteria are determined by developers and depend on the purpose of visualization of cartographic materials in the formation of undergraduates' competencies (knowledge and skills) taking into account the requirements not only educational standards but also professional ones.

In the practice of University training the use of the mapping technique is effective not only to manage the educational and professional activity of undergraduates, but also to diagnose the problems of formation of the competencies defined by educational and professional standards of the corresponding field. In addition, the mapping technique takes into account the correspondence of the competencies formation with the requirements of the employers. The use of the mapping technique allows developers consider an impact of system activity and information approaches to organization of educational process. In addition, this method allows taking into account the number of levels of formation of competencies and underlying principles.

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Revista ESPACIOS. ISSN 0798 1015
Vol. 40 (Nº 29) Year 2019

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