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Pedagogical dimensions in the organization of e-learning in higher education

Dimensiones pedagógicas en la organización de e-Learning en la Universidad

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Abstract
It is shown that in E-learning the unit of measurement is the pedagogical category "educational situation". The concepts of "current educational situation" and "degree of fuzzy equality" of educational situations are introduced. An algorithm for determining the way to achieve an educational goal is proposed. A description of the conducted pedagogical experiment is given. based on the obtained data, a conclusion is made about the adequacy of the proposed method of pedagogical measurements to the considered educational process.
key words: educational situation, logical-semantic model, degree of fuzzy equality.

Resumen
Se muestra que en e-learning la unidad de medida es la categoría pedagógica "situación educativa". Se introducen los conceptos de "situación educativa actual" y "grado de igualdad difusa" de las situaciones educativas. Se propone un algoritmo para determinar la forma de lograr el objetivo educativo. Se da una descripción del experimento pedagógico realizado. sobre la base de los datos obtenidos, se concluye que el método propuesto de mediciones pedagógicas es adecuado para el proceso educativo en cuestión.
Palabras clave: situación educativa, modelo lógico-semántico, grado de igualdad difusa.

1. Introduction

The educational process in higher education organizations is increasingly organized as e-learning (hereinafter referred to as E-learning), which implies a transition from the «traditional» forms of its organization to the organization of the educational process in the virtual educational space of the University. «The key is the concept of «training», and the words «traditional» and «electronic» mean its organizational and methodological forms» (Starichenko, Semenova, & Slepukhin, 2014, p. 54).

In the «traditional» form of organization of the educational process, the formative and final assessment is assigned to the teacher, who, using the methods and means of pedagogical diagnostics, controlled the formation and development of the student's competencies and made the necessary adjustments to the educational process.

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However, the transition of the educational process in virtual educational space involves the organization of educational process and its adjustment by means of «educational platforms», i.e. the technical means of computer technology, which makes unsuitable for use in e-learning at the University used in «traditional» form of organization of the educational process, techniques and methods of teaching measurement of the level of formation and development of students ' competencies.

In connection with the organization of e-learning by universities, the creation of «virtual universities», the problem of pedagogical measurements of the level of formation and development of students ' competencies, as well as making adjustments to the educational process in order to ensure that they achieve the levels of formation and development of competencies set in the individual educational goal, becomes particularly relevant.

2. Methodology

Various aspects of organizing and conducting a formative and final assessment of the level of formation and development of students ' competencies in the organization of e-learning at the University, both in the local space of the University and in the global educational space, are comprehensively and in detail considered in modern scientific literature.

In the work of Gulyaev G. (Gulyaev, 2019) it is shown that the virtual educational space implemented by the «educational platform» of the University is individual for each student and there are many educational situations similar in structure to the individual target educational situation of the student.

According to Kuj S. A., the pedagogical category educational situation is applied to the student and is defined as «a purposeful formalized representation of the microenvironment in which the object of research (the student) is located, which significantly affects the object of research, using a system of interrelated, identifiable, informatively defined parameters and relationships» (Tsvetkov, 2017, p. 15).

«If in the design of traditional learning object design activity is a fragment of the content of this learning activity and its procedure, the provision, when a personal-oriented education element of design becomes a fragment of the material, and event in the life of an individual, giving her a holistic experience, in which knowledge is part of him...» (Simonenko & Retivykh, 2003, p. 33).

In the competence paradigm of education, the life experience of the training object (student) is considered from the perspective of the formation and development of cognitive, operational-technological, motivational, ethical, social and behavioral competencies. Then event in a person's life-achievement in education individual educational goal is becoming a competent member of society, with his cognitive, operational-technological, motivational, ethical, social, and behavioral competencies, a quantitative value of the level of formation and development of which is possible in relation to individual educational goals (Sleptsova, The goals of professional training under transition to the competence paradigm of education, 2016).

Then the problem of forming and final assessment of the level of formation and development of students ' competencies in the organization of e-learning in higher education is reduced to the question of finding a quantitative value of the level of formation and development of cognitive, operational-technological, motivational, ethical, social and behavioral competencies at the current time or at the end of the learning process.

«Only by supporting a qualitative, meaningful analysis of certain objects and phenomena with reasonable and reliable measurements, it is possible to provide teachers-practitioners, scientists, methodologists, managers ... with objective scientific information» (Lopatkina, 2012, p. 3). Modern means of assessing the quantitative value of the level of formation and development of a student's cognitive, operational and technological competence at the current time and based on the results of training are considered in the work of Lopatkina E. (Lopatkina, 2012) based on the theory of tests. The paper deals with the issues of pedagogical measurements in education, pedagogical conditions for conducting pedagogical measurements, psychological and pedagogical aspects of testing in higher educational institutions, taxonomy of individual educational goals, modern approaches to structuring educational achievements. The directions and problems of modern Russian and foreign research on measurement and testing in education are considered. Based on the theory of tests, the questions of formalization and scaling of results are considered. Examples of traditional control and assessment tools for assessing the level of formation and development of students ' competencies and modern control and assessment tools are given, as well as questions of their applicability depending on the level of the educational institution, various external conditions and personal qualities of students.

Tretyakova T. (Tretyakova, 2013) questions of pedagogical measurements and their role in assessing the quality of education are considered from the point of view of their development of the methodological foundations of pedagogical measurements, improving the accuracy of measurements, creating methods for interpreting measurement results, improving methods for scaling the obtained data. It is shown that «the effectiveness of work on evaluating the quality of educational achievements depends on how operationalized the quality indicators are, presented in the form of standards, criteria and indicators that can be measured or expert opinion» (Tretyakova, 2013, p. 118). The method of forming and final assessment of the level of formation and development of individual competencies in students, based on the model of linear hierarchical analysis (HLM), is proposed. The article considers the HLM model of the educational process, issues of scaling the results obtained, and practical recommendations for creating systems for forming and final evaluation of learning results.

Zvonnikov V. (Zvonnikov & Chelyshkova, 2016) proposes a biparadigmal methodology for forming and final assessment of the level of formation and development of individual competencies in students, the development of which is conditioned by the need to structure a variety of methods of forming and final assessment used in educational institutions of various levels, the increasing role of pedagogical measurements in the quality management of education, and the expansion of the technical capabilities of computers and technological capabilities of «educational platforms» in the organization of e-learning.

In the work of Baxter J. A. and Lederman N. G. (Baxter & Lederman, 1999), pedagogical measurements are considered from the point of view of the pedagogical content of methods and techniques used in organizing and conducting the formative and final assessment of the student's achievements. New forms and methods of pedagogical measurement of the level of formation and development of the student's competencies are proposed, such as concept maps, interviews, multimode assessments, multiple-choice exams, graphic materials for conducting a «graphic» exam, etc..

In the paper Spiel C., Schober B. and Reimann R. (Spiel, Schober, & Reimann, 2013) pedagogical measurements are considered from the point of view of creating pedagogical models of the educational process and conducting pedagogical measurements of the level of formation and development of students ' competencies. It is shown that from the point of view of pedagogical science, pedagogical measurements are associated with the analysis of the effectiveness of the educational process in relation to the issue of achieving the individual educational goal of the student and its optimization (the ratio between costs and benefits. E-learning in higher education is considered as a program that implements the model of the educational process using software.

Recommendations for modeling and measuring competencies in this model for higher education institutions are given.

The work of Frey A., Kroehne U., Seitz NN., Born S. «Multidimensional adaptive measurement of competencies» (Frey, Kroehne, Seitz, & Born, 2017) is of the greatest interest in relation to the issue of pedagogical measurements in the organization of e-learning in higher education.the authors consider the method of multidimensional adaptive testing (MAT) when measuring complex multi-parameter competencies. A model of the process of conducting pedagogical measurements is presented, based on which it is shown that MAT can use the method of a multidimensional index of maximum priority to conduct multi-parameter pedagogical measurements without losing the accuracy and adequacy of the results obtained. It is shown that the high efficiency of MAT is mainly due to the fact that method takes into account preliminary (initial, initial) information when evaluating the level of formation and development of the student's competencies. A multidimensional adaptive testing environment is presented as a software module for «pedagogical platforms» of educational institutions, the use of which allows you to organize the development, Assembly, configuration, and application of multidimensional adaptive tests in the virtual educational space of the University to assess the level of formation and development of students ' competencies (Frey, Kroehne, Seitz, & Born, 2017).

The works of Avanesov V. (Avanesov, 2012), Golubev N. (Golubev, 2014), Gura V. (Gura, 2015), Pohl S. (Pohl, Haberkorn, & Carstensen, 2015), Kaiser G. (Kaiser & Brand, 2015) , Blömeke S. (Blömeke S, Zlatkin-Troitschanskaia, Kuhn, & Fege, 2013) , Weinert S. (Weinert, 2019) consider various aspects of organizing and conducting pedagogical measurements of the level of formation and development of competencies of students in educational institutions of various levels.

However, despite the abundance and depth of pedagogical research conducted in this area, we are forced to state that there are no significant results in the development of a unified approach to pedagogical dimensions in the organization of e-learning in higher education. The methods of organizing pedagogical measurements considered in scientific works are either aimed at measuring individual easily formalized, for example, cognitive and activity, competencies of the student based on the theory of tests, or they represent the obtained assessments in a form that does not allow making conclusions based on them and making managerial decisions about correcting the educational process in the virtual educational space of the University.

Accordingly, the lack of unified assessment methods and evaluation scales makes it impossible to develop a single software module of pedagogical measurements integrated into the well-known «educational platforms», which provides a unified approach to organizing and conducting a formative and final assessment of the student's achievements in the virtual educational space, and most importantly - correct decision-making based on the evaluation of management decisions to adjust the educational process, depending on the results obtained during the evaluation, in order to ensure the optimization of the educational process, guaranteed achievement of the student's educational goal.

Thus, development of techniques and methods formative and summative assessment of level of formation and development of students ' competences in e-learning at the University is a relevant pedagogical problem solving which has theoretical basis and known methods of practical implementation to ensure correctness of ongoing educational measurement in the virtual educational space of the University.

The organization and conduct of formative and summative assessment of level of formation and development of students ' competences in e-learning at the University consider in relation to the logical-semantic model of e-learning (Sleptsova, Formation of students’ social competence in a virtual educational environment, 2019) , (Sleptsova, Sokolova, Shamanina, & Gubanova, 2020), (Zhulanova, 2014) .

The educational goal of e-learning is to provide the state and society with a competent specialist with cognitive, operational and technological, motivational, ethical, social and behavioral competencies.

The unit of measurement of the level of formation and development of cognitive, activity, motivational, ethical, social and behavioral competencies of a student in the competence paradigm of education is the pedagogical category «Educational situation».

«It seems to us that the transition to the competence and acmeological paradigms, ... , involves the choice of other units of analysis – not knowledge and not individual individual competencies. This unit can be an educational situation» (Zhulanova, 2014, p. 107).

Then the educational situation $\tilde{A}=\{\mu_y(Y_i)/ Y_i\}$ where $Y=\{ Y_1, Y_2, ..., Y_i\}$ – is a set of competencies of the student, and $\mu_y(Y_i)$ is a quantitative indicator of the level of formation and development of the corresponding competence

It is clear that $0\leq \mu_y(Y_i)\leq 1$, where 0 is a complete lack of competence, and 1 is the maximum level of its development.

Then the educational space of the University has a set of educational situations of the form $\tilde{A}=\{\mu_y(Y_i)/ Y_i\}$, where in the target individual educational situation the student has the maximum level of competence development, that is $\mu_y(Y_i)=1$ for all Y_i, and $\tilde{A}^0=\{1/ Y_i\}$. Accordingly, there are input educational situations where $\mu_y(Y_i)=0$ for one or more competencies of Y_i , and intermediate educational situations $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$ where $0\leq \mu_y(Y_i)< 1$.

Then the educational process is a transition graph $\tilde{A}_1 \rightarrow \tilde{A}_k \rightarrow .... \rightarrow \tilde{A}_n \rightarrow \tilde{A}^0$ from the student's input educational situation to the individual target educational situation, which corresponds to a change in the values of $\mu_y(Y_i)$ from 0 to 1.

Assumption 1. Let the learner be a current educational situation $\tilde{A}_0$, whose structure is completely similar to the target individual educational situation $\tilde{A}^0$, but for which the values $\mu_y(Y_i)$ reflect a quantitative assessment of the level of development of the learner's competencies at the current time.

Assumption 2. The student is in an initial, intermediate, or target educational situation $\tilde{A}_i$ in the virtual educational space of the university $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$, where the degree of fuzzy equality with the current educational situation $\tilde{A}_0$ is the maximum for all $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$.

Definition 1. Degree of equality of educational situation $\tilde{A}_0$ with the educational situation $\tilde{A}_i$, we dene: $\mu(\tilde{A}_0, \tilde{A}_i)= \cap (\mu(\tilde{A}_0)(Y_i) \rightarrow \mu(\tilde{A}_i)(Y_i)) \ \& \ (\mu(\tilde{A}_i)(Y_i) \rightarrow \mu(\tilde{A}_0)(Y_i))$, for all possible Y_i belonging to the set of values Y.Thus, the educational process of e-learning in virtual educational space of the University is reduced to a sequence of the form $T^1 \rightarrow \tilde{A}_0=\tilde{A}_1 \rightarrow S_1 \rightarrow T^2 \rightarrow \tilde{A}_0=\tilde{A}_k \rightarrow S_k \rightarrow T^k \rightarrow ..... \rightarrow \tilde{A}_0=\tilde{A}_n \rightarrow S_n \rightarrow T^n \rightarrow \tilde{A}_0=\tilde{A}^0$, where T1 - test task number 1 of the set $T = \{ T^1, \dots, T^n \}$, and S_1 - pedagogical situation number 1, set $S = \{ S_1, \dots, S^n \}$ of pedagogical situations «losing» that the student develops appropriate individual educational situation of the target competence.

Under the pedagogical situation, we understand «a set of conditions and obligations that arise spontaneously in the pedagogical process or are specially created by the teacher for the purpose of forming and developing the student's personality» (Simonenko & Retivykh, 2003, p. 81).

Practical implementation of theoretical provisions was carried out by us on the basis of the Federal budget educational institution «Voronezh state pedagogical University» in 2018-2020 by creating experimental groups of students in the field of training «Pedagogical education», the profile «Technology», for which the curriculum was presented as a space of educational situations $\tilde{A}=\{\mu_y(Y_i)/ Y_i \}$, where $Y=\{ Y_1, Y_2, ..., Y_6\}$ there is a cognitive, operational and technological, motivational, ethical, social and behavioral competence.

In the first approximation, educational situations included 6 competencies (cognitive, operational and technological, motivational, ethical, social and behavioral competence). The step of changing the quantitative value for each competence was taken as 0.1. Thus, the virtual educational space of the University was formed, consisting of a finite number of educational situations $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$.

At the beginning of training, each student from the experimental groups passed a test to determine their initial level of formation and development of cognitive, operational-technological, motivational, ethical, social and behavioral competencies, which determined their current educational situation And the exact values of the quantitative indicator $\mu_y(Y_i)$ of the level of formation and development of their respective competence.

After that, the results obtained by the student were compared and the educational situation $\tilde{A}_i$ was determined from the educational space $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$, the degree of fuzzy equality with which is the maximum possible.

Then consider that the student is in a situation $\tilde{A}_i$ of educational space $\tilde{A}=\{ \tilde{A}_1, \tilde{A}_2, \dots \tilde{A}_n\}$ and it can be applied to the transitions $\tilde{A}_0=\tilde{A}_i \rightarrow \tilde{A}_{k-1} \dots \tilde{A}_{k+1} \rightarrow \tilde{A}_{n-1} \dots \tilde{A}_{n+1} \rightarrow \tilde{A}_0=\tilde{A}^0$ until the condition $\tilde{A}_0=\tilde{A}^0$, which means that individual educational goal of the student is achieved.

Thus, the equally equal, valid and possible возможны $\tilde{A}_0=\tilde{A}_i \rightarrow \tilde{A}_{k-1} \dots \tilde{A}_{k+1} \rightarrow \tilde{A}_{n-1} \dots \tilde{A}_{n+1} \rightarrow \tilde{A}_0=\tilde{A}^0$, or $\tilde{A}_0= \rightarrow \tilde{A}_{k-1} \rightarrow \tilde{A}_{n+1} \rightarrow \tilde{A}_0=\tilde{A}^0$, that is individual educational trajectory to achieve the individual educational goals of the learner varies depending on the ability of the student to learning, motivation, attitude to learning etc.

3. Results

View the learner as the current «Educational situation», the structure of which is similar to an individually-tailored educational situation gives the opportunity to individualize educational process and to optimize it based on personal values for each trainee quantity of $\mu_y(Y_i)$ of degree of formation and development of his / her cognitive, operational-technological, motivational, ethical, social, and behavioral competencies in e-learning at the University.

Introducing the degree of equality of educational situations makes it possible to relate the current level of competences of the learner (current educational situation) with a pre-prepared elements of the University educational space (primary, intermediate, and target educational situation) that enables to automatically build an individual educational process as the shortest path in the space of educational situations.

The experiment was attended by 60 students, arranged in 4 experimental groups, each of which during the year was trained according to the curriculum, presented as a space of educational situations. Students themselves determined the time of training, the teacher, who served as a tutor, was available daily from 8 to 20 hours of each day. Only the level of formation and development of students ' cognitive, operational-technological, motivational, ethical, social and behavioral competencies was monitored.

As a result of the tests at the initial time, 34 individuals were assigned to the input educational situation $\tilde{A}_1$, 14 people to the input educational situations of the lower level $\tilde{A}_2$, $\tilde{A}_3$,.... $\tilde{A}_{16}$, 10 to intermediate educational situations of the second level $\tilde{A}_{21}$, $\tilde{A}_{30}$,.... $\tilde{A}_{36}$, 2 to intermediate educational situations of the third level $\tilde{A}_{44}$, $\tilde{A}_{46}$.

As a result of the implementation of the curriculum, 55 individuals reached the target educational situation. 2 individuals were expelled from the Federal state educational institution «Voronezh state pedagogical University», 3 were unable to complete the curriculum even with the help of a tutor.

Of the 55 indivuduals who achieved the educational goal in terms of the level of formation and development of cognitive, operational and technological, motivational, ethical, social and behavioral competencies, 6 achieved it in less than 20 educational situations, which is approximately equivalent to 5 months of training in the classical

form of educational process organization, 9 less than 30 educational situations, the remaining 40 people spent all the allotted time, successively passing all the educational situations of the curriculum.

View of the virtual educational space of the University with e-learning as many educational situations $\tilde{A}=\{\mu_y(Y_i)/ Y_i\}$, the elements of which are quantitative indicators $\mu_y(Y_i)$ the level of formation and development of student cognitive, operational-technological, motivational, ethical, social, and behavioral competencies allow you to implement this representation means «educational platform» of the University.

The individual educational trajectory of the student in this case is a sequence of transitions between educational situations in the direction of the target educational situation, which allows you to optimize it for time and other indicators by means of the «educational platform» of the University.

Representing the student as a current educational situation, the structure of which is similar to the structure of educational situations in the virtual educational space, allows us to conduct pedagogical measurements in the organization of e-learning in higher education not only on quantitative (cognitive and operational-technological competence), but also on qualitative or relative scales (motivational, ethical, social and behavioral competence).

Introducing the fuzzy degree of equality of educational situations allows to carry out pedagogical dimension in virtual learning environment with e-learning at the University of ka on measurable parameters and the parameters to be measured in a qualitative or relative scale. The result of the conducted pedagogical measurement-comparison of the current level of development of the trainee's cognitive, operational-technological, motivational, ethical, social and behavioral competencies and the set value of these competencies in educational situations of the virtual educational space - allows us to conclude that the trainee is in an educational situation of the virtual educational space of the University, the degree of fuzzy equality with which his current educational situation is minimal.

Accordingly, the individual educational trajectory of achieving the target educational situation can be optimized for temporary and other factors that affect the effectiveness of the educational process. Then it is equally possible and permissible to use the paths: $\tilde{A}_1 \rightarrow \tilde{A}_{k-1} \ldots \tilde{A}_{k+1} \rightarrow \tilde{A}_{n-1} \ldots \tilde{A}_{n+1} \rightarrow \tilde{A}_0$; $\tilde{A}_i \rightarrow \tilde{A}_{k+1} \ldots \tilde{A}_{k-1} \rightarrow \tilde{A}_{n-1} \ldots \tilde{A}_{n+1} \rightarrow \tilde{A}_0$ and $\tilde{A}_{k-1} \rightarrow \tilde{A}_{k+1} \rightarrow \tilde{A}_{n+1} \rightarrow \tilde{A}_0$. Thus, the individual educational trajectory of a student changes depending on his personal qualities, attitude to learning, level of knowledge, etc.

Since in educational situations only quantitative values of the levels of formation and development of cognitive, operational-technological, motivational, ethical, social and behavioral competencies are considered, the algorithm for calculating the individual educational trajectory is easily automated by means of the «educational platform» of the University.

Similar approaches to conducting pedagogical measurements in the organization of e-learning in higher education and interpretation of the results are given in the works of Bubnov G. (Bubnov, Pluzhnik, & Soldatkin, 2015), Erpenbeck J. (Erpenbeck & Michel, 2006), Huang SM. (Huang, Hsueh, & Hua, 2008), Öztemel E. (Öztemel & Yavuz, 2009), Sluijsmans D. M. A. (Sluijsmans, Prins , & Martens, 2006).

The authors note that one of the significant disadvantages of the proposed approach is the high technical requirements for the «educational platform» of the University, due to the need to conduct pedagogical measurements of the level of development of students' competencies in real time, as well as the high complexity of measurements on qualitative and relative scales, which can lead to ambiguity of the results obtained.

One of the ways to overcome this disadvantage is the «intellectualization» of the educational platform of the University, the development of new methods and algorithms for modeling complex multi-parameter systems, which include the organization of e-learning at the University.

4. Conclusions

The problem of conducting pedagogical measurements and making correct and adequate managerial decisions based on the results obtained becomes particularly relevant when organizing e-learning in higher education institutions, excluding the teacher from the educational process as a tool for evaluating the student's achievements, and assigning the task of conducting pedagogical measurements and evaluation to the «educational platforms» of higher education institutions.

Due to the peculiarities of the object of training, it is impossible to solve the problem of pedagogical measurements in the organization of e-learning in higher education only by technical means.

Only under the aegis of pedagogy as a science that develops and offers society new pedagogical paradigms, methodological approaches, forms and methods of organizing the educational process, it is possible to organize and conduct pedagogical measurements and make management decisions based on the data obtained, aimed at improving the effectiveness of the educational process.

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