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# INNOVATIVE APPROACH TO ASSESSMENT OF HIGHER EDUCATION LEARNING OUTCOMES IN RUSSIA

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## *Abstract*

The problem of assessment of modern learning outcomes under the multilevel system of training has been investigated. The importance of this problem is due to the transition of the Russian higher education to the usage of the FSES of the third generation. These new standards are focused on the competence-based mode of the quality of ESD. The authors have emphasized the importance of an innovative approach to the organization of the learning process which makes changes to the quality control system and assessment. In the context of the necessity to direct subject matters of the professional training of specialists toward the competence-based mode, the possibilities of an innovation-oriented evaluation of mathematical training of future bachelors and holders of a master's degree have been considered. It has been suggested that mathematical competence is a component of the professional competence that was formed as a result of the multilevel system of mathematical training. To detail the objects of the diagnostic assessment the structure of mathematical competence has been specified. The authors defined the assessment criteria and indicators of the formation of mathematical competence. The authors propose to distinguish the following levels of mathematical competence formation: substantive, interdisciplinary and professional. An innovative approach to the assessment of the results of mathematical training gave an opportunity to identify the meaningful basis for the renewal of the educational policy in the sphere of higher economic education.



**Keywords:** Innovative approach, sustainable development, higher economic education, mathematical competence.

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# 1. Introduction

The current stage in the development of the system of Russian higher education is characterized by the implementation of an innovative approach in which the priority is given to the training of competent specialists who possess the abilities for self-development and self-education.

In the report of the team of Russian scientists, written under the authority of Y. Kuzminov and I. Frumin, "Russian education in 2020: A Model of Education for Innovative Economy," it was noted that higher education should be of innovative nature, which necessitates the introduction of changes to the content of education and new requirements for graduation, taking into account the current and future needs of the society and the state.

## 1.1. Education for sustainable development.

In the age of educational globalization and integration of Russia into common education space, one should take note of the importance of the 2030 Agenda for Sustainable Development adopted by the UN General Assembly on September 25, 2015, which determined the future policy of the world community in social, economic and environmental spheres.

The authors share the opinion that education plays a leading role in the achievement of sustainable development (Schattle, 2008). The UN Decade of Education for Sustainable Development (2005-2014) became the most important event for ESD. The official opening of the DESD took place in Vilnius in March 2005, where the European strategy for ESD was adopted. The Strategy was the first official document on a world-wide scale in the field of creation of the ESD conceptual model.

The third section of the Strategy includes 15 principles of ESD. Let us highlight the following key principles: promoting lifelong learning; public awareness raising and professional training encouragement; the usage of system, multifaceted and interdisciplinary approaches; recognizing the important role of higher education as a main driver of ESD in the development of appropriate knowledge and competencies; the use of innovative technologies and methods that promote active and participatory vocational learning.

The adoption of the Bonn Declaration at UNESCO World Conference in Germany (2009) was the highlight of the DESD. The Declaration stressed that ESD should provide the values, knowledge, skills, and competencies for sustainable living and community involvement.

Generally, the provisions of the Bonn Declaration are largely congruent with the principles of ESD complementing them by the necessity of the monitoring and evaluation of the effectiveness of the ESD. The final stage of the UN DESD was the UNESCO World Conference on ESD held in Aichi-Nagoya, Japan, from the $10^{th}$ to $12^{th}$ of November 2014, which approved the Global Action Programme on ESD. The Global Action Programme has identified five Priority Action Areas for mobilization of the efforts of different states in the field of ESD in short-term outlook. In the context of this work, it is important to single out the following direction: the transformation of the learning environment taking into account the principles of ESD.

Thus, the analysis of the most important international documents in the field of ESD shows the transition to the competence-based education mode intended to ensure the development of the personal ability to adjust to rapidly changing conditions (Scott & Gough, 2010). Competence-based leaning outcomes are clearly reflected in UN and UNESCO documents on ESD. The Bologna process which was aimed at creating the European higher education area, alongside with the DESD was launched in 2005. Considering the simultaneity of these processes, it is important to integrate them into a unified research and educational system.

### 1.2. An innovative approach to the assessment of learning outcomes for the benefit of sustainable development

The implementation of the ESD principles enumerated above requires innovations in the organization of the learning process, introduction of changes into objectives, content, methods, means and forms of organization of joint activity of students and teachers, and the system of monitoring and assessment of the quality of education.

In the context of ESD innovation, the focus in learning is of great attention of scientists in various areas of expertise: sociology, philosophy, pedagogy and economics (Stephanie & Oleson, 2003). The authors share the opinion that innovation as a salient feature of learning is related not only to the didactics, but also to socially significant learning outcomes which are increasingly in demand in the modern labor market (Kolchina & Martino, 2016).

Taking into consideration the above-mentioned, let us consider the innovative approach as a key tool for the implementation of the ESD principles in the function of a new educational paradigm. To do this, let us study the innovative capacity of Russian higher education for the creation of diagnostic tools to assess learning outcomes of the multilevel system of mathematical training of students at universities of economics for the benefit of sustainable development.

## 2. Problem Statement

The authors of the article carried out an analysis of scientific and methodological investigations of Russian and foreign scientists and studied contemporary approaches to mathematical training of students at universities of economics. The results of the analysis revealed a number of contradictions in the existing educational situation.

Let us mention about the following contradiction. Innovative economy requires highly qualified personnel who can use mathematical tools to solve professional problems in the context of implementation of the ESD principles. However, the existing scientific and methodological approaches to the multilevel system of mathematical training do not focus on building competencies of graduates which enable them to deepen knowledge, to solve professional problems using tools and techniques of mathematics in accordance with the direction and level of higher education.

### 2.1. The competence-based mode of learning outcomes

As previously noted, the introduction of the competence-based mode of learning outcomes to the system of Russian higher education gives an opportunity to move from the reproduction of the structure of ready knowledge in the learning process to the development of the ability of the graduate to act in real-life and professional situations (Naumkin, Grosheva, Kondratyeva, Panyushkina, & Kupryashkin, 2016).

Therefore, it becomes important for a student not only to get knowledge but master the competencies which help him to be ready for lifelong learning in accordance with the main principles of ESD.

In its turn, commitment to the formation of a set of competencies of graduates brings forth a problem of methodological support of the transition of the Russian higher education to the third generation of FSES. New standards are targeted at the competence-based mode of the quality of education and require the appropriate professional subject matters (Andryukhina & Fadeyeva, 2016).

### 2.2. The innovative assessment of learning outcomes of the multilevel system of mathematical training of future bachelors and holders of master's degree

In the context of this research, let us characterize the innovative capacity of the multilevel system of mathematical training of future bachelors and holders of master's degree in monitoring of intellectual and personal development aimed at the formation of abilities for self-development and self-education. By "monitoring", the authors shall basically mean the systematic observation over the process under analysis to identify its conformance to expected results.

The monitoring framework usually includes three fundamental processes: research, evaluation, and forecasting. Research makes it possible to obtain information about the state and dynamics of learning mathematics in accordance with the selected parameters. Means of evaluation activity show the outcomes of mathematical training. They interconnect the research and forecasting components of monitoring. Forecasting enables one to set the trends for the development of monitoring objects, to identify constraints and quickly eliminate them. The interaction of these components ensures the functional integrity of learning outcomes monitoring in teaching mathematics which is manifested in the unity of information, evaluation, predictive and management functions.

It should be noted that the integration of monitoring into the ESD principles confirms the importance of the monitoring and evaluation of the quality of education in terms of its innovative character.

In this paper, the object of pedagogical monitoring is mathematical competence as a key element of professional competence of the graduate of the university of economics.

## 3. Research Questions

Over the last 20 years, the system of Russian higher education has undergone considerable changes. Three generations of educational standards have been developed and introduced. The Federal State Educational Standards of the first generation (1994) and the second generation (2000) contained requirements for the structure and content of education of an appropriate level and they also included a list of disciplines with an indication of their timing budgets. Thus, they limited the capabilities in the design and implementation of educational programs, restricted academic freedom of students in the choice of an individual educational path.

In the context of the Bologna process framework, FSES (2011) were introduced. They focus on competencies of graduates. The standards do not contain requirements for the minimum content of educational programs and they do not define the scope of academic disciplines, with the exception of some

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basic ones. The updated version of standards expands the rights of educational institutions in determining the content of their programs (Aleyevskaya, Ashirbagina, & Meshcheryakova, 2016).

### 3.1. Mathematical competence as a result of the multilevel system of mathematical training of students at universities of economics

Taking into account the fact that competencies are the basis of the content of the curriculum, let us underline that the key terms of current educational standards ("competence" and "competency") are still being widely discussed because of differing interpretations.

This problem is studied by Russian scientists (I. A. Zimnyaya, E. F. Zeer, Yu. G. Tatur, A. V. Khutorskoy and others) and foreign researchers (e.g. Glynn, Taasoobshirazi, & Brickman, 2009; McClelland, 1973; Raven, 1988). The information analysis showed that there are different points of view on the nature of these terms.

In this paper, the authors will differentiate "competence" from "competency". Competency is an ability reflecting the standards of behavior. Competence is mastery of a particular set of competencies, in other words, the combination of interrelated knowledge, skills, experience, including personal attitude to work. One can see the close correlation of these terms: competency is a predefined requirement for training based on employers' demand and public needs which is set forth by law; competence is an established personality trait.

It should be noted that competence is not just the sum of the individual competencies; it is the result of their synergy (Naumkin, Kuprjashkin, Grosheva, Shekshaeva, & Panjushkina, 2014). The complex nature of the concept "competence", reflecting a synergistic effect of developing competencies and personal traits of an individual, is shown as an integrative personal quality (N. V. Kuzmina, A. K. Markova, L. A. Petrovskaya, etc.).

Let us consider the concept “mathematical competence” of the student of a university of economics.

The results of the analysis of different approaches to the interpretation of the concept “mathematical competence” gave us an opportunity to detail it. Let us define “mathematical competence” as an integrative dynamic characteristic of an individual expressing readiness to use mathematical knowledge, skills, experience, and the ability to their increment and application in new situations to solve professional tasks in accordance with the level of higher education for sustainable development.

The proposed definition demonstrates its activity-related basis and commitment to continuous mathematical education, creative self-development, which in its turn is determined by motivational needs of an individual and by core values (Otis, Grouzet, & Pelletier, 2005; Vallerand, Pelletier, Blais, & Vallieres 1992).

### 3.2. The component structure and the content of mathematical competence

In psychology and pedagogical literature there are different approaches to the structuring of mathematical competence. Integrating data from different sources and applying the principles of ESD, the authors are going to identify the component structure of the mathematical competence of future bachelors and holders of a master's degree in Economics and to show its content in accordance with the particular characteristics of the competence (See table 01).

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**Table 01.** The structure of the mathematical competence of the student of a university of economics

| № | Structural components | Characteristics of components | Details of components |
|---|---|---|---|
| 1 | **Axiological** | Motivation and value attitude to learning mathematics | Motivated attitude to learning mathematics caused by value attitude to mathematics as a part of experimental sciences and an element of culture, awareness of the importance for the future professional activities, the opportunities that are given by the mathematical model approach for description and prediction of real processes and phenomena in the fast-paced world |
| 2 | **Cognitive** | Fundamental and applied mathematical knowledge, thinking skills | The availability of fundamental and applied mathematical knowledge; knowledge of key methods of cognition: analysis, synthesis, systematization, generalization, abstracting, classification, the mathematical model approach |
| 3 | **Praxiological** | Skills and practical experience | The possession of knowledge, skills, and practical experience in using mathematical knowledge and the mathematical model approach to solve professional tasks; development of mathematical self-education; the ability to increment the mathematical knowledge, skills, experience and their creative application in new situations for sustainable development |
| 4 | **Reflexive** | Reflexive and evaluating qualities | Skills of reflection, the ability to analyze the results of mathematical activities, self-assessment, self-correction in the context of the significance of the achievement motives of educational and professional goals |

In contrast to previously performed studies of the concept "mathematical competence", the authors included a creative component that expresses the commitment of mathematical training to development of skills of creative solution of true-life and professional tasks for sustainable development. Creative abilities that the graduates will be able to use in the market economy conditions emphasize the importance of the level of thinking and the skills of constructing mathematical models for research and forecasting real processes (Loshchilova, Lizunkov, & Zavyalova, 2015). Ursul (2013) states that simulation is one of the rapidly developing forms in the investigation of the global future which is introduced into the learning process.

## 4. Purpose of the Study

To identify the level of mathematical competence, one should deal with detecting assessment criteria and indicators of its formation.

### 4.1. Mathematical competence as an object of diagnostic assessment

Summing up the experience of researchers, let us determine the criteria of formation of mathematical competence based on its structural components. In accordance with the proposed criteria, the authors will identify the levels of formation of mathematical competence in the context of innovative learning.

It is obvious that the requirement of mathematical competence measurability as a means of control is a matter of some difficulty. It is related to the fact that mathematical competence is of integrative nature

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and it comprises a dynamic set of core values, mathematical knowledge, skills and soft competencies of the subject of the learning process.

Let us emphasize that the complexity of diagnostic procedures is associated with the multilevel system of mathematical training and the contribution of various disciplines to mathematical competence formation.

Taking into consideration the above-mentioned, let us identify the following levels of formation of mathematical competence: substantive level (domain area “Mathematics”); interdisciplinary level (within the subject area “Mathematics” and general professional disciplines); professional level (in the framework of professional disciplines, undergraduate training, graduation thesis, master's thesis).

These levels allow us to estimate the increment of mathematical competence from the perspective of unity of bachelor’s and master’s degree programs. The formation of mathematical competence at the previous level is a prerequisite for the formation of mathematical competence at the next level.

Let us detail the criteria of formation of mathematical competence by means of indicators for each level.

**Table 02.** The criteria and indicators of formation of mathematical competence

| № | Criteria | Indicators (according to levels of mathematical training) | |
|---|---|---|---|
| 1 | Axiological | Substantive level. The availability of social attitudes to the study of mathematics. | |
| | | Interdisciplinary level. The interest and values related to the study of mathematics | |
| | | Professional level. Desire for the study of mathematics due to professional interests | |
| 2 | Cognitive | I know and understand | Substantive level<br>Fundamental concepts of mathematics.<br>Theoretical fundamentals of mathematics |
| | | | Interdisciplinary level<br>Economic interpretation of mathematical concepts.<br>Interdisciplinary foundations of mathematics. |
| | | | Professional level<br>The possibility of applying fundamental and applied mathematical knowledge, skills and mathematical model approach to solution of future professional tasks. |
| 3 | Praxiological | I can | Substantive level<br>Solution of the model training problems of the domain area "Mathematics". |
| | | | Interdisciplinary level<br>Use of theoretical knowledge for the solution of profession-oriented mathematical problems of economic content. |
| | | | Professional level<br>Critical evaluation and interpretation of the experience of mathematical activities to solve the tasks from the sphere of future professional activity. |
| | | I am ready for | Substantive level<br>Independent use of mathematical knowledge, skills and experience. |

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Corresponding Author: Nataliya A. Burmistrova
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| | | | |
|---|---|---|---|
| | | | Interdisciplinary level<br>Use of the mathematical model approach to form creative skills in the context of handling profession-oriented mathematical problems of economic content.<br>The use of software tools for the study of mathematical models. |
| | | | Professional level<br>The increment of mathematical knowledge, skills and experience of creative activities to solve future professional tasks. |
| 4 | Reflexive | Substantive level<br>Skills of reflection. The ability to analyze the outcomes in the performance of educational tasks of the domain area "Mathematics". | |
| | | Interdisciplinary level<br>The ability to undertake self-assessment of mathematical knowledge and skills which are necessary for the solution of profession-oriented mathematical problems of economic content. | |
| | | Professional level<br>Self-correction of mathematical knowledge and skills on the basis of self-assessment.<br>The drive to increment mathematical knowledge and skills which are necessary for solution of professional tasks. | |

The analysis of the table 02 shows that the given criteria for the assessment of the level of mathematical competence of future bachelors and holders of a master's degree allow one to reveal the dynamics of axiological attitude to the study of mathematics, possession of profession-oriented fundamental and applied mathematical knowledge, skills, experience of creative activities, soft skills, enabling students to acquire mathematical knowledge and experience in their life activities.

### 4.2. Pedagogical measurement of mathematical competence

The necessity to assess learning outcomes of the multilevel system of mathematical training that is reported in the FSES of the third generation stipulates the development of a set of diagnostic tools. While developing a set of diagnostic tools, one should handle the mathematical competence as an integrative personal attribute and assess the dynamic of formation of separate components at each level.

The diagnostic tools should include various means of assessment corresponding to the content of the components of mathematical competence. Thus, one can monitor the learning outcomes of the multilevel system of mathematical training of bachelors and holders of a master's degree in Economics.

## 5. Research Methods

To detail the objects of a diagnostic assessment in a competency-based mode, the authors conducted the theoretical analysis of Russian and foreign researches within the studied problem, the international documents in the field of ESD and FSES of higher economic education. This enabled the authors to interpret the obtained results.

## 6. Findings

In connection with the new requirements for graduates of Russian universities under the conditions of using the FSES 3+, the problem of diagnostic testing and assessment of learning outcomes in the format of competences becomes important.

In this study, the authors propose to consider the mathematical competence including axiological, cognitive, praxiological and reflexive components as the object of pedagogical monitoring. According to the given structure, the authors identified the criteria and indicators of mathematical students' competence formation of economic universities, which ensures the monitoring of intellectual and personal development with a focus on the formation of abilities for self-education and self-improvement for sustainable development.

## 7. Conclusion

Finally, the authors came to the following conclusion. The readiness of graduates to be competent in their future professional activity is a result of professional education. The outcome of the mathematical training of bachelors and holders of a master's degree is not just a set of knowledge and skills but the ability of students to apply them. This ability is determined by the notion "mathematical competence".

The use of mathematical competence as the indicator of educational achievement has a huge methodological potential to transform the learning environment in line with the ESD principles which are aimed at formation of specialists of new generation who are creative and motivated and are able to live in the fast-paced world.

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