Specifics of Competence and Skills Assessment in the XXI Century

Nadezhda Efremova* and Anastasia Huseynova*

Don State Technical University, Gagarin sq., Rostov-on-Don, Russia

*Corresponding Author: Nadezhda Efremova and Anastasia Huseynova, Don State Technical University, Gagarin sq., Rostov-on-Don, Russia.

Abstract

The paper deals with the problems of the formation and assessment of competencies and skills of the XXI century as the results of the development of educational programs. It is noted that the assessment of non-cognitive learning outcomes differs significantly from the assessment of cognitive achievements, the difficulties in assessing competencies are indicated due to their multidimensional nature and deep latency. A number of recognized models of competencies and skills for successful professional activity are presented, innovative approaches to a comprehensive assessment of educational achievements are systematized. Particular attention is paid to the Evidence-Centered Design (ECD) methodology and design patterns of assessment tools with elements of evidence-based argumentation based on the planned activities of the subjects in the assessment situation. It is shown that ECD models lead to a reliable estimate.

Keywords: Learning Outcomes; Skills; Competency Models; Assessment Tools

Introduction

Changes in living conditions and social production have posed a difficult task for the education system to create and develop new technologies for teaching young people and assessing results. New business tasks in the professional sphere of activity have led to a modern approach to personnel training and a change in the paradigm of education. At the request of employers, the focus of the results of vocational training has shifted to competencies; competence-based forms of training are increasingly included in educational practice. It is expected that forecasting the required competencies will help balance the labor and education markets, narrow the gap between employers' demand for learning outcomes and their provision with the vocational education system. However, it should be noted that so far in domestic education this is more concerned with the terminological component of educational programs, in which the results of their mastering by graduates are recognized as competencies (universal, instrumental, professional, etc). But while the necessary methodology of competence-based training has not yet been formed, in the pedagogical environment there is still no clear understanding of the characteristics and structure of competencies, methods of their formation and assessment of achievement levels. Therefore, more often than not, checking the assimilation of the content of disciplines and individual topics is issued as an assessment of competencies. Sometimes some teachers even call this "measuring" competencies, which contradicts the very nature of competencies and the practice of their assessment.

At the same time, it should be noted that competencies are not something completely new for the domestic education system; to one degree or another, their inherent elements have always been in the field of view of teachers in the preparation of specialists (for example, VQK - professionally important qualities). The difference is that, until recently, they were not considered as the results of mastering educational programs in the form of competencies. This understanding of them appeared as a result of the development of the Bologna process

and the formation of a single pan-European educational space. The language of competences has become universal, equally understood in all countries and at all levels of education as a description of what graduates can do after completing their studies [1].

In recent years, many publications have appeared, noting the crisis in the traditional education system, and, accordingly, the system for assessing its quality. This is primarily due to key trends, "which determine the current situation and set the main parameters of the education of the future: massization, internationalization, turbulence of the world economy and the formation of a new technological order in industry, a digital revolution" [2, p. 4]. It is believed that new educational projects based on new technological foundations will create better educational practices in the future. It is believed that a set of important competencies will help a person adapt in a constantly changing world and large flows of information, navigate and learn throughout life, and be successful in work.

The task of modern education is the formation of not only knowledge, skills and abilities (ZUN) introduced by Ya. A. Comenius 300 years ago, but competencies as a special type of neoplasm and an independent learning outcome. Therefore, today all over the world there is a search for effective models of results, methods and means of teaching, formation and assessment of competencies and skills of the XXI century. At the same time, their formation is not a substitute for mastering the content of academic disciplines, but is viewed as an important addition that ensures the individual's ability to effectively apply knowledge and act in the modern world. The difficulties are associated with the fact that as a result of the formation of competencies have a very complex component composition (clusters, profiles, levels, sublevels), are formed on an interdisciplinary basis, are deeply latent in nature and are very difficult to manifest and lend themselves to formation and assessment.

Purpose of the Study

The purpose of this article is to show the variety of new technologies for the formation of competencies and skills of the XXI century, the problem of developing strategies for their assessment that can best meet the needs of teachers and students.

Methodology and Results

Models of competencies

Patrick Griffin (2015), professor at the University of Melbourne, leader of an international research project to assess and teach skills and competencies of the 21st century, believes that the key determinants of literacy in the industrial era were reading, writing and arithmetic, other fundamental knowledge, which will always remain important and mandatory. But in the modern world, this is no longer enough to be a successful specialist. He notes that while we still have teachers of geography, history, physics, chemistry, but no teachers of critical thinking, interaction or curiosity. Today, the emphasis is shifting towards the formation of critical thinking skills, a creative approach to business, broad professional competencies and skills of the 21st century, such as solving non-standard tasks and problems, teamwork and the ability to interact and communicate [3,4].

Many researchers believe that in the modern unpredictable world, not only different kinds of knowledge will be required, but an increasing demand goes to human qualities, to the so-called "quality of human capital". In addition to subject competencies, a lot of attention has recently been paid to a set of supra-subject (transferable) competencies and meta-competencies. Supra-subject allows an individual to communicate in a group and work creatively using large amounts of information. Meta-competencies provide systemic and algorithmic thinking, reflection, the ability of self-development, self-regulation and self-esteem. In various countries of the world, active work is underway to form effective models of skills necessary for a person in the 21st century. Developing a new model of competencies, international organizations and individual countries are striving to answer key questions about what modern education should become and what competencies graduates should have for active and successful work in the future, how to form and evaluate learning outcomes in terms of competencies.

One of the most effective is the "20 facets" model for a successful manager, developed by a group of researchers based on the results of a survey of 40 leading Russian and Western companies and 141 interviews with top managers and successful middle managers in Russia [5]. It identifies 5 main clusters of competencies. Cluster of management competencies: planning and organization, people management, development of subordinates, leadership. Motivation: initiative, quality orientation, result orientation, self-development. Decision making: problem analysis, information gathering, business and systems thinking. Personal qualities: resistance to stress, adaptability, responsibility, positive thinking. Interpersonal Communication: Empathy and understanding, teamwork, persuasive communication, relationship building.

The model of competencies and skills of the 21st century was developed by the Higher School of Economics on the initiative of the World Bank and was named 4K [6]. The most important competencies include: critical thinking (analysis, conclusions and argumentation), creativity (curiosity, imagination), communication and cooperation (interaction, assessment of the situation, teamwork, dialogue). This model is widely used in the general education system to assess individual progress in the development of schoolchildren. There are three blocks of results: fundamental knowledge, competencies and character traits [7]. Each block describes the required learning activities, which allows you to move on to the development of appropriate educational programs and assessment tools.

The set of competencies and skills that will be in demand in any human activity include: concentration and management of attention, digital and mathematical literacy, creativity and creativity, ecological thinking, cross-cultural, analytical thinking, communication, flexibility, integrity and teamwork, abilities to self-study and self-esteem. There are many other models in which the elements of competencies and skills discussed above are repeated to one degree or another.

The specifics of competencies and the difficulties of their assessment

Note that while globally generally accepted models of competencies by levels of education have not yet been formed, and, accordingly, the techniques, methods and technologies of an integral educational process in the format of competence-based learning have not yet been developed. The difficulty stems from the fact that competencies are not a simple sum of knowledge, skills and abilities. Due to the principle of emergence, the properties of a system cannot be reduced to a simple sum of the properties of its individual parts; as the components or subsets are combined, the system acquires new properties that are absent at the previous level. It is the interaction of the elements that generates new properties of the system that are not inherent in its individual elements. The same happens in the hierarchy of learning outcomes, the levels of preparedness of students consistently increase, with each higher level cumulating into itself the properties of a lower one, while acquiring new qualities. Emergent properties of competencies arise as a result of students' activities when they apply knowledge, skills and abilities to solve problematic tasks. At the same time, the properties of ZUN are not "fused", but are integrated, causing the emergence of competencies as unique personal learning outcomes. In contrast to ZUN, competencies are deeply latent characteristics of a personality, are formed on an interdisciplinary basis and are manifested only in a situation of specially organized educational activity.

However, not enough attention is paid to their formation and assessment in the educational process, primarily because most teachers themselves do not understand the essence of competencies, although they use this term quite successfully. It is pertinent to note here the well-known expression of Michael Barber (2011), professor and expert in international education research, that the quality of the education system cannot be higher than the quality of the teachers working in it [8].

Various mechanisms of their formation in the process of formal and non-formal education can be distinguished. These include: cognitive learning associated with finding, understanding and using information; knowledge acquisition and behavioral learning; involvement in collective activities; participation in the solution of projects, etc. Cognitive learning creates a knowledge base and forms the thinking patterns that are the basis for behavioral learning. Cognitive and behavioral learning is followed by the development of the ability to act,

which actually ensures the interaction between the results of cognitive and behavioral learning in the form of the manifestation of competencies. Thus, the formation of competencies is based on knowledge, experience and behavioral component. At the same time, a nonlinear causal relationship is observed between the results of cognitive and behavioral learning, and the generation of a new result - competencies based on their interaction. One of their key advantages is that they, as learning outcomes, do not depend on the ways and means of their acquisition [9]. As the development of educational programs and under the influence of a number of external and internal factors, as well as motivational readiness for systematic learning, there are constant updates and adaptations in the development of students. This applies equally to all levels of the education system.

It is clear that without knowledge, skills and abilities competencies are not formed, but, on the other hand, without competencies these learning outcomes do not manifest themselves and cannot be effectively used. All of the above leads to the idea that since the approach to competencies is changing, it is not a trivial task to form, identify and assess the levels of competencies, which is still far from being solved. It should also be borne in mind that competencies are not formed and do not manifest themselves independently of each other, they form certain clusters based on the principles of the same type, the combination of which and their manifestation is individual for each student. The complex structure of competencies requires a comprehensive assessment, and therefore it is very difficult to develop interactive, multidimensional, reliable problem problems based on the use of technology and reasoning in their fullest forms to identify difficult learning outcomes. It is impossible to identify and assess competencies using traditional means of control: surveys, testing or an exam; this requires new technologies and assessment methods.

Note that, on the whole, teaching technologies are currently much better developed than the possibilities for a reliable assessment of learning outcomes. Yet today there is a significant shift in the assessment of competencies, which has a significant impact on teachers and students around the world. Evaluation of learning outcomes is an important part of a coherent curriculum and overall teaching and learning strategy, part of a feedback loop, one of the most important elements of curriculum design and alignment. It should reveal the latent characteristics of students: knowledge and skills, practical and intellectual skills, competencies and skills, and provide feedback. The results of the assessment have a very strong effect on the affective sphere of students, sometimes impressions from it last a lifetime, and mistakes in this process can determine a career. By receiving focused, relevant and guiding feedback, learners understand what their strengths and weaknesses are and where they need to focus their efforts in their own learning. Thanks to feedback, teachers can better assess the strengths and weaknesses of not only students, but also the quality of their educational activities, their qualimetric skills.

Self-assessment skills in self-regulatory learning really play an important role, teaching these skills can significantly increase the amount of knowledge and provide the ability to choose and solve their own learning problems, build their educational trajectories [10]. For this, it is important to provide conditions, one of which is an authentic and reliable assessment of achievements at each significant stage of learning.

Methods for assessing competencies

To date, there are many types of assessment in pedagogical theory and practice. The term "assessment" refers to a wide variety of methods or tools used by educators to document the academic preparedness of students and their learning progress. But for the most part, all of them are aimed at assessing cognitive learning outcomes and to a small extent are able to assess non-cognitive competencies and skills of the 21st century. Cognitive achievement tests do not provide information on competencies, but they are necessary to identify the basic fitness of the subjects. Psychometric tests can only identify certain profiles and levels of competencies (teamwork, emotional behavior, etc.). The technique of leveling raw (primary) scores by ordering ranks using expert judgment and a scale of hidden features shows results similar to other measures to maintain the assessment standards [11,12]. But non-cognitive results are not detected by these methods, they require new approaches.

One of the innovative ways of assessing competencies is the conceptual model of the assessment tool, which has received recognition in foreign practice, developed in the logic of the Evidence-Centered Design (ECD) method proposed by Robert Mislevi (2003). ECD allows you to solve two problems: what evidence of achievement (competence or knowledge) of the student can be directly observed during the assignment and how to structure the situation and set the planned activities so that these evidences will allow you to see and evaluate the learning outcome [13-15]. This methodology is relevant for the assessment of complex, multicomponent constructs and the development of evaluative tools based on the principles of reasoned evidence. It is based on three premises:

1. The assessment is based on the use of important knowledge in the subject area and an understanding of how this knowledge is identified and found;

2. The chain of reasoning is based on the principles of evidence-based substantiation from what the subjects do to conclusions about what they know, can or should do;

3. The purpose of the assessment should be the driving force behind obtaining design solutions that reflect assumptions and con-straints, resources and conditions for the use of knowledge, skills and abilities.

A prerequisite for the design of such an assessment of competencies is a clearly defined structure of the assessment construct, re-flecting the levels of competencies and the planned activities of the subjects in the assessment situation, as well as with the use of what educational achievements these competencies can be displayed by the subjects [16,17]. The construct model can include such aspects of assessment as and how well the subjects are able to use a computer or software and tools, how great is the need for special technologies for presenting an assessment tool to students with disabilities, etc. This helps to develop target tasks and set the expected behavior of the subjects.

The ECD specification defines six models: the learner model; job model; job model; model of evidence; assembly model (conceptual assessment framework - KRO) for the coordination of all elements of the assessment tool; the assessment delivery model shows how all the elements of the assignment will work together to conduct an authentic assessment process (Figure 1).
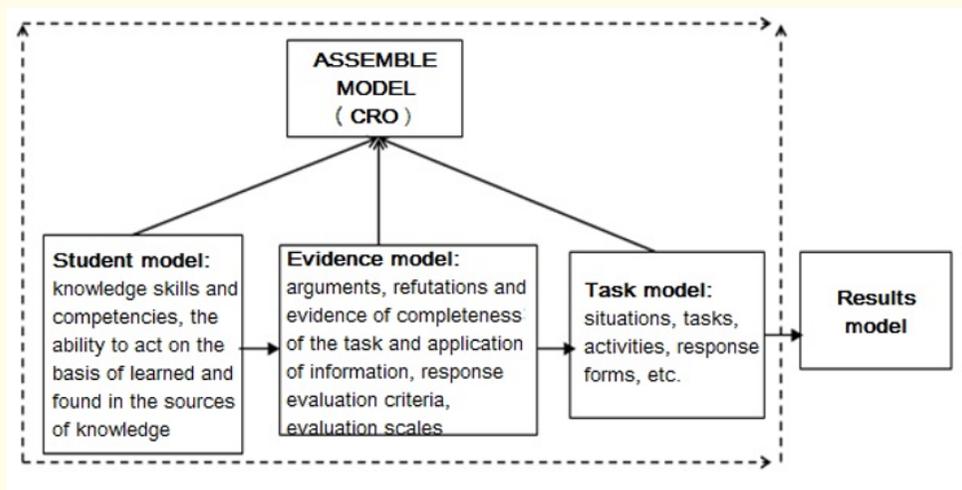

Figure 1: *Outline of evidence-based assessment design.*

The learner's model, based on the construct of the verified attributes, defines the structure of the verified characteristics. A construct-based task model describes what is to be identified, how to identify, and how to reconcile observations, evidence, and evidence of observed activity with the results of the assessment. An ECD assignment provides a multidimensional assessment, its reliability, evidence and reasoning through the use of a set of complex tasks, subordinate to the same logic and goals of the construct. It can include various cases and problematic tasks in different formats of their presentation to the subjects (blank, computer, etc.). This approach contributes to the creation of evaluative tools that define the planned activity, providing the subjects with the opportunity to show what and how they can do, using the knowledge obtained or found in sources [18,19]. The model of evidence contains a system of indicators of task completion as evidence of achievement, a grading scale and rules for drawing conclusions from the actions demonstrated by the subject using basic knowledge and abilities. The assembly according to the conceptual assessment framework provides the role, place and sequence of procedures, instructions, reporting forms, etc.

This method makes it possible to provide a connection between the stages of the development of the assessment construct, the planned tasks, the types and conditions of the subjects' activity in the assessment situation, and the forms of presentation of the result. The development of such tools from teachers requires a certain amount of preparation and time spent on the creation of so-called patterns (templates) of the evaluation tool for their repeated use in similar situations [20]. The main difficulty is the design of the assessment design so that the ECD algorithm provides all design decisions related to the specification of the task, elements of the tasks included in the task, the administration of the assessment process, presenting the task to the subjects and arguing the degree of its completion. This allows teachers of patterns (reusable design patterns) to develop robust assessments. In ECD, Assessment Toolkits can help developers, researchers, and educators prepare materials to assess the planned aspects of learners' thinking and actions. Each template may contain considerations regarding the application or search for knowledge, the ways of the subjects' activity in the situation of assessment, collection and presentation of results [21,22].

Epistemic games are another effective, innovative and reliable means of assessing so-called 21st century skills [23,24]. Epistemic game, otherwise called interactive epistemology, formalizes assumptions about the knowledge of the subjects and the rationality of their behavior in solving complex problems, predicts the behavior of participants and, consequently, the outcome of the game intended to give experience of professional practice within the content of the studied discipline or module of disciplines. It develops the ability to think, act and interact with others, to productively solve complex problems in real or quasi-real learning situations. In addition, epistemic games are effective for learning in the digital age, where individual and collaborative work is combined. They ensure the development of expertise skills, since decisions are made in real life and work conditions. Numerous decisions during the performance of subject-oriented tasks that the subjects need to make during the game ensure the accumulation of qualitative and quantitative data on the competences and skills of the participants. Joint problem solving in competence learning is becoming one of the leading educational technologies in the 21st century, providing a combination of cognitive and metacognitive processes. This technology allows both teaching and assessing the formation of a number of competencies: the use of general knowledge, communication, coordination, the manifestation of leadership and team functions.

The next method for assessing competencies is simulation exercises, which represent situations from real production activities. Their solution makes it possible to identify the corresponding behavior of the subject in a problem situation. In simulation exercises, role play provides a lot of information about the behavior of the participants. It can describe a real situation that is presented to the subject and the observer. The observer can ask leading questions to identify the level of competence and behavior of the subject. A good way can be a video recording of a role-playing or epistemological game, later you can watch and analyze its stages of execution with the subjects in order to understand the types of behavior of specific participants.

In educational practice, the formation of competencies is determined on the basis of multidimensional assessments using level scales. The scores for multivariate assessments are summarized and displayed on a level scale (Figure 2). Unlike the assessment of knowledge, competencies can also be assessed with negative values when the subject's behavior is unacceptable.
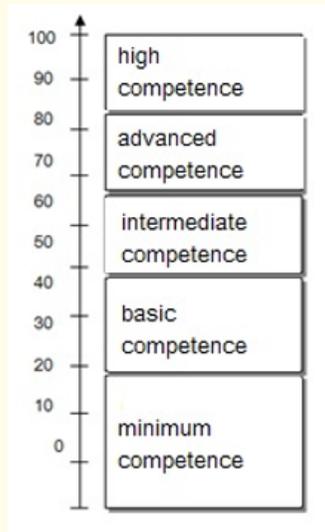
Figure 2: An example of a level scale for assessing competencies.

An important stage in the organization of a particular assessment is the definition of criteria that may be unique for a specific purpose of assessing learning outcomes. Once the criteria have been established, the next important step is to select appropriate assessment tools. Finally, it is important to provide for a discussion of the results.

After the assessment methodology has been decided, it is necessary to determine how it will be used to collect data, how the processes of scaling, interpretation and use of the results obtained will be ensured to improve the quality of learning.

Discussion

With a change in approaches to learning outcomes, the features of a professional teacher of the 21st century also change, learning technologies and requirements for assessing its results change. Teachers need to master new skills, an understanding of new functions in educational activities, the formation of loyalty to change, since the degree of complexity and uncertainty is constantly increasing in the world and in the education system. Another approach should be developed to assess the competencies of students, the development of new pedagogical tools for their reliable assessment. In addition, digital technologies are changing the way of learning, and accordingly, assessing the quality of youth training in the digital age becomes even more difficult and important. The landscape of virtual educational environments and related tools for digital modeling of the educational process is changing. There are specially designated environments for various purposes, such as "learning games" or "educational simulations" [25,26]. This will become especially noticeable over the next decade. Therefore, new technological and reliable methods of teaching and assessment are becoming more and more in demand, they should open up new opportunities for introducing the principles of self-study and authentic assessment. In such conditions, the role of independent external assessment of educational achievements will increase, and increased transparency and a better understanding of learning outcomes will ensure clearer management of the activities of students and trainers.

Conclusion

Basic knowledge in cross-cutting technological areas of education and assessment of educational achievements is today considered as the most important elements of the formation of critical thinking, and the development of competencies and skills of the 21st century is a

long-term educational trend that determines the staffing capabilities of countries in the future. The value of the competencies and skills of the XXI century is that they allow a person to better navigate in a rapidly changing world, disciplines and technologies, to understand large flows of information, to achieve success in educational and industrial activities.

Bibliography

1. Gonzalez H., *et al*. "Setting up educational structures in Europe. The contribution of universities to the Bologna process" (2020).

2. Konanchuk D., *et al*. "The era of "Greenfield" in education". Educational Development Center of the Moscow School of Management SKOLKOVO (SEDeC) (2013): 52.

3. Griffin P., *et al*. "Assessment and Teaching of 21-st Century Skills". Springer (2015): 362.

4. Griffin P. "Assessment for Teaching". Cambridge University Press (2014): 21.

5. Profile of a successful manager in Russia «20 Facets».

6. 4K: measurement of critical thinking, creativity, communication and cooperation.

7. Dobryakova M., *et al*. "Skills of the XXI century in the Russian school: the view of teachers and parents". HSE (2018): 72.

8. Barber M. "Ordered to achieve a result. How the implementation of reforms in the public services of Great Britain was ensured". HSE (2011): 393.

9. Winterton J., *et al*. "Typology of knowledge, skills and competences: clarification of the concept and prototype". Luxembourg: Office for Official Publications of the European Communities (2006): 140.

10. Kostons D., *et al*. "Training self-assessment and task-selection skills: A cognitive approach to improving self-regulated learning". *Learning and Instruction* 22.2 (2012): 121-132.

11. Bramley T., *et al*. "Maintaining performance standards: aligning raw score scales on different tests via a latent trait created by rank-ordering examinees' work". Third International Rasch Measurement conference, University of Western Australia, Perth (2008).

12. Bramley T., *et al*. "Evaluating the rank-ordering method for standard maintaining". *Research Papers in Education* 25.3 (2010): 293-317.

13. Mislevy R., *et al*. "Assessing Model-Based Reasoning using Evidence-Centered Design: A Suite of Research-Based Design Patterns". Springer-Verlag GmbH (2017): 123.

14. Mislevy RJ. "Evidence-centered design for simulation-based assessment". *Military Medicine* 178.10 (2013): 107-114.

15. Mislevy R., *et al*. "Bayesian psychometric modeling from an evidence-centered design perspective". Handbook of statistics (2007): 839-865.

16. Efremova N. "Designing assessment tools on the model of evidence-based argumentation". *Pedagogical Measurements* 3 (2018): 8-15.

17. Uglanova I., *et al*. "Evidence-Centered Design methodology for measuring complex psychological constructs". *Modern Foreign Psychology* 7.3 (2018): 18-27.

18. Efremova N. "Specificity and Problems of Forming and Evaluation of Competences". Current Problems of Science and Education, № 6 (2017).

19. Efremova N. "Competencies in education: formation and evaluation". National Education (2012): 416.

20. Mislevy R., *et al*. "Assessing Model-Based Reasoning using Evidence-Centered Design: A Suite of Research-Based Design Patterns". Springer-Verlag GmbH (2017): 130.

21. Efremova N. "Peculiarities of evaluating the competencies of students". *International Journal of Experimental Education* 9 (2017): 45-49.

22. Efremova N. "Patterns of Designing Evaluation of Students Competencies". *American Journal of Education* 4.2 (2018): 124, 1048-1065.

23. Rupp A., *et al*. "Evidence-centered Design of Epistemic Games: Measurement Principles for Complex Learning Environments". *Journal of Technology, Learning, and Assessment* 8.4 (2010): 49.

24. Oates T. "Evaluation of Assessment". The Cambridge Approach to Assessment (2017): 20.

25. Davies S. "Effective Assessment in a Digital Age. A guide to technology-enhanced assessment and feedback" (2010): 64.

26. Assessment principles and practices - Quality Assessments in a digital age. International Baccalaureate Organization (2018): 268.