

Methods and Technologies for Training Future Teachers of Robotics

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Abstract

Currently, schools have introduced a subject aimed at the formation of technical and engineering knowledge of students - educational robotics. This is because the modern digital society needs trained personnel with knowledge in the field of artificial intelligence, physics, electronics, programming, and design. For such demanded personnel to appear on the labor market, their training must begin at school, developing children's interest in engineering and technical professions, as well as the corresponding skills and abilities. Thus, the organization of the technical training of schoolchildren is an urgent task, which can be solved only if there are competent teachers in educational organizations, including in the field of educational robotics.

The purpose of the study is to identify technologies and determine the organizational and methodological conditions for teaching students of pedagogical universities the basics of educational robotics, the formation of their special competence that allows them to teach robotics at different levels of basic general education. The article discusses the methods and technologies of training future teachers of educational robotics based on the content model proposed by the authors, in which the components of the teacher's professional competence are highlighted, the target and methodological components of training are presented, the organizational conditions for the formation of teachers' competence for the successful implementation of professional activities in the field of educational robotics in the educational environment of a higher educational institution are determined.

Keywords ¹

educational robotics, engineering, and technical education, digital technologies, teacher competence, competency formation model.

1. Introduction

Currently, technical and engineering areas of training are becoming increasingly relevant in our country. This is due to the development of information and digital technologies, which have long been an integral and mandatory component of production and public life. For the young generation to be interested in the state and willing to develop in the technical direction, it is necessary to lay an appropriate basis for their training at the initial stage of education, i.e. at school. One of the directions of the development of technical and engineering competencies of students is educational robotics, which is considered an innovative direction and is widely introduced into school teaching practice [1, 2]. Unfortunately, teachers working in general education organizations have little or no training in this area. [3]. The analysis of the modern system of higher education in the field of teacher training has revealed a contradiction between the increasing requirements for the professional competence of a teacher, the variety of conceptual approaches in this area, and the insufficient development of the system of teacher training, the lack of developed technologies and methods of teacher training in the field of educational robotics.

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2. Purpose and Objectives of the Research

In connection with the above, the development of a model for the formation of teacher competence in the field of educational robotics is an urgent direction, it determines the goal and objectives of the research, which are to identify technologies and determine the organizational and methodological conditions for teaching students of pedagogical universities the basics of educational robotics, forming the special competence that allows them to teach robotics at different levels of general education based.

3. The Main Part

3.1. Theoretical Analysis

The professional competence of the future teacher of educational robotics must be considered through integrative personal qualities, which consist of special knowledge, motives, a set of the most important pedagogical skills and abilities that allow the teacher to carry out pedagogical activities in the field of educational robotics, and which must be formed during the training of students of pedagogical directions of the university [4, 5].

As a theoretical and methodological basis for the development of a model for the formation of professional competence of an educational robotics teacher, we used:

- competence-based, andrological, variable and subject-activity approaches;
- works that allow us to reveal the regularities of the formation of professional competence, including the competencies of a teacher, as well as to determine the essence and main components of the competence of a teacher of educational robotics (N. V. Kuzmina, E. I. Rogov, T. G. Brazhe, R. D. Hamilton, T. K. Hamilton, J. Raven, I. K. Drakina and E. V. Shmakova, A.V. Khutorskoy, etc.) [6 - 9]; studies considering the theory and methodology of teaching children and adults (A. I. Kukueva, S. I. Zmeeva, and others); as well as specific and methodological features of teaching educational robotics (d. A. Alimisis, A. P. Alexandrova, D. Kuposova, Yu. A. Skurikhina) [10 - 12].

3.2. The Content Model of the Formation of the Competence of the Teacher of Educational Robotics

The content model of the formation of the competence of the teacher of educational robotics is a pedagogical system, reflects the structure, properties, and relationships between the elements that make up it, allows you to identify the essential aspects of the professional competencies of the future teacher and consists of interrelated components presented in Figure 1.

Target component: consists of a system of goals and objectives. This component is a system-forming one, within the framework of this component, the development and content of all other components of the model are determined. The goal will be the formation of pedagogical competence of students of the pedagogical direction, future teachers of educational robotics. To achieve this goal, it is necessary to implement the following tasks:

- to form motives of self-development of students and make attitudes towards achieving goals;
- expand students ' knowledge in the field of robotics, computer science, programming, physics, and other related fields of knowledge necessary for teaching children educational robotics;
- to form professional skills in future teachers, such as research, design, organizational, reflective, communicative, constructive, technological, predictive, and others.

The methodological component is a combination of methodological approaches that underlie the formation of pedagogical competence, as well as the principles that regulate the process of forming a teacher's professional competence. The following approaches are used:

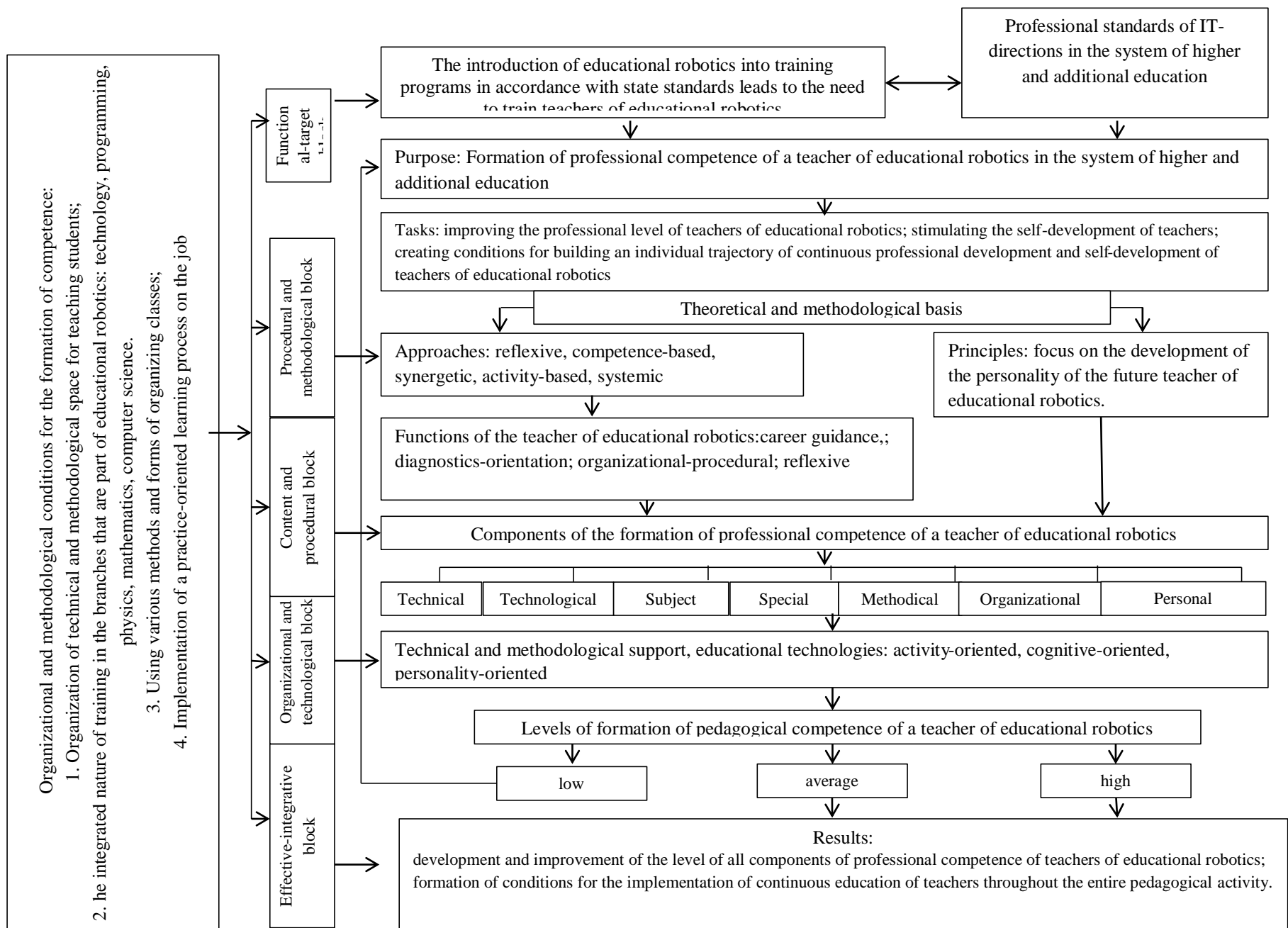


Figure 1: The content model of the formation of the competence of the teacher of educational robotics

1. A systematic approach, within the framework of which the components of the professional competence of a teacher of educational robotics are studied, the main structural and functional elements of the future model are identified, and connections between the components of the system are thought out and established. The center of the studied subject area is educational robotics, which can be considered as the integration of mathematics, technology, physics, computer science. The structural components of the concept are linked together by a leading idea, the basis of which is as follows: "the process of forming the professional competence of a future teacher of educational robotics should: occupy a special place in the education system; be a priority area of theory and methodology in the system of secondary and higher education; meet the modern needs of society and the state in the need to form a competitive teacher " [13].

2. An activity-based approach, within the framework of which the teacher's professional competence is considered as a guarantor of the implementation of a high-quality educational process in the field of educational robotics that meets the modern educational standard. This approach provides the basis for researching the formation of teachers' competence in the field under study, as a process of qualitative transformation of the personal and professional qualities of an educational robotics teacher. A competent teacher of educational robotics should have the ability to self-education, self-development, and the ability to quickly respond to ongoing changes in the professional sphere.

3. Synergistic approach. This approach is complementary to the activity approach. The synergetic approach is considered as a process of personality-oriented interaction between the student and the teacher, as a result of which the teacher engages the student in organizing his intellectual activity and developing his creative potential through self-organization in the process of teaching educational robotics.

4. Competence approach. It examines the personal pedagogical aspect: the formation of a successful, professional, active life position of the teacher. The main achievements of the competence-based approach in the field of educational robotics include the following formed personal and professional qualities of a teacher [13]:

- orientation of the teacher to a deep knowledge and understanding of the basics of educational robotics and related educational areas;
- readiness for independent comprehension and assessment of one's pedagogical activity in the field of educational robotics;
- the ability to broadcast in the media, scientific and pedagogical journals, competitions, and grants of personal achievements in the field of educational robotics;
- implementation of creative research activities in the development of optimal, most effective ways to form the intellectual cognitive activity of students in the field of educational robotics.
- Having analyzed the structure of the methodological component of the model of formation of professional competence of a teacher of educational robotics, we can conclude that the teacher should be characterized by high efficiency and effectiveness of the educational process in this area, which allows optimizing the educational process and increasing the competitiveness of the teacher in the labor market [14].

The study highlights the main interrelated blocks that make up the model of the formation of professional competencies of future teachers of educational robotics:

Functional-target block, the main element of which is the individual trajectory of the development of professional competence of a teacher in the field of educational robotics.

The functional-target block is the main element of the model. This block defines the goals, objectives, and basic principles of the formation of professional competence of a teacher of educational robotics.

The priority tasks of the implementation of the presented model are:

- improving the professional level of teachers of educational robotics;
- stimulating the self-development of teachers;
- creating conditions for building an individual trajectory of continuous professional development and self-development of teachers of educational robotics.

Procedural and methodological block: includes specific features of the implementation of methodological approaches, principles, conditions, and functions in practice.

This block is related to the main functions of teachers:

- diagnostics-orientation, which allows the teacher to analyze the contingent of students, identify existing educational needs, determine the zones of immediate development;

- organizational and procedural function: forms the teacher's ability to organize the interaction with a team of students, with parents of students and colleagues, as well as the ability to develop and implement educational programs that fully reflect the current needs of the market;

- a teacher needs a career guidance function to help students in self-determination, socialization, self-actualization, and adaptation to modern working conditions;

- the reflexive ability of the teacher allows you to find suitable ways to solve emerging problems.

A *content block* consisting of a set of professional and practice-oriented content of educational and methodological complexes of disciplines, courses developed for the formation of professional and personal competencies of future teachers, which provide methodological support and professional and personal growth of an educational robotics teacher.

In particular, the content of the academic discipline "Theory and methodology of teaching educational robotics" has been developed for the training of future teachers, the tasks of which are:

- familiarization of students with the basics of modern robotics;

- formation of general and technological skills in the design and construction of robotic systems;

- formation of algorithmic thinking and development of programming skills of self-managed robotic systems;

- development of students' professional skills of working with schoolchildren in the framework of educational robotics.

The developed program is designed for theoretical and practical training of students in the field of educational robotics and is designed for 108 hours.

Educational and methodological complexes of disciplines are presented with methodological materials that characterize the content of educational activities of teacher training, provide detailed methodological substantiation of the process of implementing educational activities, and also includes a set of approved practical works, diagnostic techniques, and materials for the formation of professional competence of a teacher of educational robotics [15, 16]. We have identified the following components of the professional competence of a teacher of educational robotics: technical, technological, subject, special, methodological, organizational, personal [17-18].

The organizational and technological block contains technical and methodological support, modern educational technologies.

The technical and methodological support is represented by robotic kits with a description of the methodology for their application [19].

An analysis was made of the robotic kits available in schools: these are mainly LEGO® Education robotic kits that can be used in grades 5-9 (Table 1).

The following educational technologies can be used:

- activity-oriented, these technologies include technological maps, activity games, and game modeling;

- publishing technologies: teacher's portfolio, articles, recommendations, methodological developments, author's educational programs;

- cognitively oriented technologies, including seminars, discussions, training, reflections, dialogues, and other methods;

- personality-oriented technologies: developmental training, interactive games.

An effective block, including monitoring the quality of mastering vocational educational programs and the formation of professional competencies of a future teacher of educational robotics. The productive-integrative block allows you to describe the expected results of the implementation of the constructed model and analyze the results achieved.

If the developed model is used to train and improve the qualifications of acting teachers, then a praxeological block can be added, the elements of which are the experience accumulated by the teacher and the ability to show the mastered competencies.

The developed model made it possible to identify the organizational and methodological conditions for the formation of the competence of the teacher of educational robotics [4]:

1. Organization of technical and methodological spaces for teaching students.




2. The integrated nature of teaching in the fields of educational robotics: technology, programming, physics, mathematics, computer science.

3. Using various methods and forms of organizing classes.

4. Implementation of practice-oriented education, including on-the-job for existing teachers.

Table 1

LEGO® Education Robotics Sets that can be used to teach robotics in grades 5-9

Set LEGO® BricQ Motion Start (for students of grades 3-4)	LEGO® Education BricQ Motion Prime (for students of grades 5-7)	LEGO® Education SPIKE™ Prime (for students of grades 5-9)
		
<p>The set immerses primary school students in the study of physical processes occurring in the world around them in the context of a healthy lifestyle. The kit includes a set of spare parts and printed assembly instructions. Special graduated elements allow you to visualize mathematical actions, making classes meaningful, creative and fun.</p>	<p>It immerses students in the study of physical concepts in the context of sports and helps to form a deeper understanding of such concepts as strength, movement, and interaction of objects. The set includes a booklet with assembly instructions and ideas for inspiration, with which children can learn natural sciences in practice.</p>	<p>The robotic constructor is ideal for teaching the modules "Robotics" and "Automated Systems". 523 LEGO® elements. Combines bright LEGO details. The teacher will be able to use either Scratch programming or Python programming to solve educational problems. The constructor is designed to create a new model at each lesson that solves the problem of the real world.</p>

The results of the implementation of the developed model include:

- development and improvement of the level of all components of the professional competence of future teachers of educational robotics;
- formation of conditions for the implementation of continuous education of teachers throughout the entire pedagogical activity.

4. Conclusion

In the course of the study, the following results were obtained and conclusions were made:

1. The training of teachers in the field of educational robotics is a priority direction of the educational policy of the Russian Federation since currently much attention is paid in the field of education to the training of specialists in technical areas, which, in turn, is associated with the digitalization of the economy and society.

2. The model of teacher competence formation in the field of educational robotics contains 5 interrelated blocks: functional-target, procedural-methodological, substantive, organizational-technological, and effective blocks, which together ensure the achievement of the planned results - the development and improvement of the level of all components of the professional competence of future teachers; the formation of conditions for professional activity in the field of educational robotics.

3. The introduction of the developed course "Theory and methodology of teaching educational robotics" into the educational program for training future teachers, allowed us to identify a positive impact on the formation and development of professional competence of a teacher.

In conclusion, we note that the formation and improvement of professional competencies of a teacher of educational robotics should be carried out systematically: it is necessary to introduce courses on robotics and methods of teaching it into educational programs related to the training of pedagogical personnel, open specialized educational programs for training bachelors and masters, organize advanced training courses for teachers and school teachers in the field of robotics.

5. References

- [1] M.G. Ershov, Application of elements of educational robotics as a means of realizing the polytechnic orientation of teaching physics: the dissertation ... candidate of pedagogical sciences: 13.00.02 [Place of defense: Ural State Pedagogical University] .- Yekaterinburg, 2016.- 240 p.
- [2] D. Alimisis, Robotics in Education & Education in Robotics: Shifting Focus from Technology to Pedagogy. In Proceedings of the 3rd International Conference on Robotics in Education, Prague, Czech Republic, 13–15 September 2012; pp. 7–14.
- [3] G.A. Echmaeva, Training of teaching staff in the field of educational robotics // Modern problems of science and education. 2013. No. 2. URL: <http://science-education.ru/ru/article/view?id=9099> (date of access: 23.08.2021).
- [4] O. Pankratova, E. Konopko, N. Ledovskaya, T. Shabalda, Building professional competence for teachers in the field of educational robotics. Proceedings of SLET-2020 – International Scientific Conference Innovative Approaches to the Application of Digital Technologies in Education and Research, Stavropol, Russia, 12-13 November 2020. pp. 164-171 <http://ceur-ws.org/Vol-2861>
- [5] N.V. Kuzmina, L.E. Pautova, E.N. Zharinova, Akmeological bases shaping the professional competence of a teacher. Izv. Sarat. University New. ser. Ser. Acmeology of education. Developmental psychology. 2020. No. 1 (33). URL: <https://cyberleninka.ru/article/n/akmeologicheskie-osnovy-formirovaniya-professionalnoy-kompetentnosti-prepodavatelya> (date accessed: 28.08.2021)
- [6] A.V. Khutorskoy, Methodological grounds for the application of the competence-based approach to the design of education. Higher education in Russia. 2017. No. 12. URL: <https://cyberleninka.ru/article/n/metodologicheskie-osnovaniya-primeneniya-kompetentnostnogo-podhod-k-proektirovaniyu-obrazovaniya> (date of access: 28.08.2021).
- [7] N.A. Ionkina, Features of domestic and foreign experience in training teachers for teaching robotics. Bulletin of the Peoples' Friendship University of Russia. Series "Informatization of Education". 2018.Vol. 15.No. 1.P. 114-121.
- [8] O. A. Mudrakova, K. D. Yudina, Competence of a modern computer science teacher as the basis for the formation of key competencies of students. Pedagogical Journal, 2019. V. 9. No. 3A. PP. 143-150.
- [9] D. Alimisis, Educational robotics: Open questions and new challenges. Themes in Science & Technology Education. 2013. № 6(1). PP. 63–71.
- [10] A.P. Aleksandrov, Modern robotics: position and prospects // Modern trends in the development of science and technology. 2015. No. 8-2. PP. 9–12.
- [11] Yu. A. Skurikhina, Methodological principles of studying robotics in the framework of the lesson and extracurricular activities. Concept. 2018. No. 4. URL: <https://cyberleninka.ru/article/n/metodicheskie-printsipy-izucheniya-robototekhniki-v-ramkakh-urochnoy-i-vneurochnoy-deyatelnosti> (date of access: 28.08.2021).
- [12] A. V. Morev, Formation of components of technical culture in the classroom on robotics in the additional education of children. Concept. 2019. No. 6. URL: <https://cyberleninka.ru/article/n/formirovanie-komponentov-tehnicheskoi-kultury-na-zanyatiyah-po-robototekhnike-v-dopolnitelnom-obrazovanii-detei> (date of access: 08/31/2021).
- [13] Ekaterina A. Konopko, Olga P. Pankratova, Djebir A. Abdullaev, Alikhan M. Ediev, Viktoriya N. Taran, Digital Education Toolkit and an Overview of Distance Learning Resources. In the V International Scientific and Practical Conference "Distance Learning Technologies" (DLT 2020).Yalta, Crimea, September 22-25, 2020. PP. 374-382. <http://ceur-ws.org/Vol-2914/paper35.pdf>
- [14] V.N. Taran, Quality Criteria for Professional Training of Personnel In IT Industry, In Proceedings of 2018 17th Russian Scientific and Practical Conference on Planning and Teaching Engineering Staff for the Industrial and Economic Complex of the Region, PTES 2018 17. 2018. C. 47-50. DOI: 10.1109/PTES.2018.8604267
- [15] V.G. Yafaeva, Conceptual-integrative model of the formation of professional competence of teachers of preschool educational institutions in the field of the intellectual development of children // Pedagogy and psychology of education. 2012. No. 2. URL: <https://cyberleninka.ru/article/n/kontseptualno-integrativnaya-model-formirovaniya-professionalnoy-kompetentnosti-pedagogov-doshkolnyh-obrazovatelnyh-uchrezhdeniy-v> (date accessed: 23.08.
- [16] J. Abdullaev, E. Konopko, E. Nersesyan, O. Pankratova, Training of Teachers for Professional Activity in the Digital Environment of the Educational Space. Proceedings of SLET-2019 -

International Scientific Conference Innovative Approaches to the Application of Digital Technologies in Education and Research, Stavropol - Dombay, Russia, 20-23 May 2019, pp. 205-212. DOI: http://ceur-ws.org/Vol-2494/paper_18.pdf.

- [17] O.P. Pankratova, E.A. Konopko, Remote training of teachers for IT navigation in inclusive education. CEUR Workshop Proceedings Selected Papers of the IV All-Russian scientific and practical conference with international participation "Distance Learning Technologies" (DLT), Yalta, Crimea". 2020. 2834, pp. 493-498.
- [18] O.P. Pankratova, E.A. Konopko, A.N. Chekunov, Training of pedagogical staff for training digital curators (Consultants in the field of digital development competencies of the population). CEUR Workshop Proceedings Selected Papers of the IV All-Russian scientific and practical conference with international participation "Distance Learning Technologies" (DLT), Yalta, Crimea". 2021. 2914, pp. 420-427
- [19] S. N. Fortygina, The program of training future teachers in the field of educational robotics. Scientific notes of the PF Lesgaft University, 2017. No. 10 (152), pp. 285-287.