

Building Professional Competence for Teachers in the Field of Educational Robotics

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Abstract

The article is devoted to the existing problems arising when forming the readiness of teachers for professional activity in the field of educational robotics. The need for system preparation of the pedagogical personnel satisfying to requests of modern society and capable at the different educational levels to train in educational robotics the younger generation of the country is established, thereby increasing the level of engineering education. The teacher of this direction shall possess professional competence, knowledge, and skills from different scientific areas: information science and information technologies, physics, microelectronics, and artificial intelligence. Theoretical justification of the entity, and also the identification of the main components and methods of forming of professional competence of the teacher of educational robotics is the research objective. Within research, it is established that subject, methodical, technical, special, organizational, and personal components, are the main for successful professional activity of the teacher of educational robotics. Professional competence of the teacher of educational robotics shall form and be improved systemically within the specialized directions of preparation and professional development of pedagogical personnel. In the article experience of the Institute for Information Technology and telecommunications of the North Caucasian federal university in the training of students in educational robotics, and also preparation of pedagogical personnel and professional development of the acting teachers in the field is considered. The perspective direction of research - is studying organizational and methodical conditions of forming of competence of the teacher and development of technologies of training of teachers in the field of educational robotics.

Keywords ¹

educational robotics, teacher of educational robotics, professional competence of the teacher, components of professional competence, methods, and approaches of training of teachers

1. Introduction

We are allowed to assume that another technical revolution took place in our world. Hi-tech products and innovative technologies became an integral part of modern society, and modern science and equipment gained unknown revolutionary development. At this juncture, there was a need for highly qualified engineering personnel who will be able to manage this equipment and to create new. Unfortunately, both in our country and in the world it is observed not only a shortage of engineers but also their weak preparation that in the short term can become one of the factors of growth inhibition of the economy of the countries. Thus, the need for an increase in the level of engineering education, complication, and gain of technical training of engineering personnel ripened. In this regard in education training in skills of designing and modeling engineering devices at the early stages of

SLET-2020: International Scientific Conference on Innovative Approaches to the Application of Digital Technologies in Education, November 12-13, 2020, Stavropol, Russia

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CEUR Workshop Proceedings (CEUR-WS.org)

training, began to take the important place - at school. For the accomplishment of objectives, the STEM education introduction was offered (S - science, T - technology, E - engineering, and M - mathematics). STEM education is interdisciplinary education, which implies the full training comprising studying natural sciences in total with technology, engineering, physics, mathematics, and robotics. Such an integrated interdisciplinary approach will allow training the highly skilled engineers who are in demand in modern society [1].

One of the elements of STEM education is educational robotics, which is considered now how the priority, integrative direction of modern science, which includes physics, microelectronics, information technologies, and artificial intelligence. Scientists of the whole world agree in opinion that educational robotics is the most effective remedy of development of engineering education [2 Robotics allow to acquaint in the form of the game the child with the laws of physics and electronics, to master programming elements that will promote, further, increase of interest of the younger generation the technical directions of science [3].

The widespread introduction of robotics in the educational process demands the existence of the corresponding qualification of the research and educational personnel. However, there are practically no competent teachers owning the necessary knowledge base in this area. As a rule, it is the teachers of information science or technologies who do not have special preparation in the field of robotics. Therefore the researches aimed at the development of special competences of teachers, which will allow them to create at pupils technical and engineering knowledge within classes in robotics, is the actual task.

2. Purpose and objectives of the research

The teacher training to robotics shall possess a wide range of knowledge and skills in the field of mathematics, technology, physics, information science, information technologies, to understand programming. So far, such preparation of pedagogical personnel performs in the form of additional education: in the form of professional development, master classes, conferences, and different seminars [4, 5]. These types of training of teachers in educational robotics, as a rule, allow to gain only general idea, and, mainly, about competitive robotics, but not about the theory and the technique of teaching discipline "robotics" [6]. Thus, in the course of the analysis, the following contradictions came to light:

- between the increasing requirements to the professional competence of the teacher, a variety of conceptual approaches in this area, and the insufficient readiness of system of preparation of pedagogical personnel in the field of educational robotics;
- between the need of forming of professional competence and lack of scientific justification of entity and components of professional competence of the teacher of educational robotics.

So-called contradictions are allowed to formulate the research objective, which consists of theoretical justification of the entity, and also in the identification of the main components and methods of forming of professional competence of the teacher of educational robotics.

3. Literature review

For the solution of the goal, understanding the directions of further actions for the gain of pedagogical education in the field of educational robotics, first of all, it is necessary to study the existing experience and features of preparation of pedagogical personnel in this area.

Because educational robotics is the new direction in education, yet there is not a lot of researches in this area [1-7]. Questions of robotics are reflected in works of the following domestic and foreign authors: D. Alimisis, M. G. Ershov, G. A. Echmayeva, N. A. Ionkina, D. A. Ovsyanitski, S. N. Fortygina, and more. However, in the majority of works, robotic technologies in detail are considered, and features and problems arising in the course of training of teachers of educational robotics remain a little studied. Papers where authors state the vision of the problem of preparation of pedagogical personnel in this area are of interest to our research.

So, for example, D. Alimisis in the paper notes that as fundamental questions in training in robotics educational theories, training methods, philosophy of training and curricula, but not as many put in the forefront, robotic technologies [5] shall act.

In the interview, the famous robotics coach D. Ovsyanitsky, answered the question of what shall be the teacher of educational robotics: "I consider that the teacher who goes in with children for robotics shall know not only one subject, for example, physics or information science, he shall know everything that is any way connected with the robot. Let's discuss, measuring equipment for the correct work with sensors, electrical equipment correctly to manage motors and competently to charge accumulators, et cetera." [1].

N. A. Ionkina, in the paper: "Feature of domestic and foreign experience of training of teachers to the training of robotics", notes that training of teachers is an important and integral link in the development of educational robotics. The author considers that training of teachers of this area shall become part of the state program as technical creativity and involvement of youth in it is that beginning, which allows the country to receive professional engineers and inventors. [7]

Problems of forming of professional competences of teachers were considered in researches by many domestic and foreign scientists: T. G. Brazhe, R. D. Hamilton, I. K. Drakina, N. V. Kuzmina, J. Raven, E. I. Rogov, A. V. Hutorskoy, however also methods and technologies of forming of these competencies are not enough works in which the entity and components of professional competence of the teacher of educational robotics would reveal and.

4. Methodology

The considered existing experience in the area of training for educational robotics allowed to make to us to select the following directions in the training of teachers:

1. Preparation of pedagogical personnel shall be performed systemically, to be based on satisfaction of requests of modern society in the highly skilled teachers capable to perform robotic formation of youth at all levels of training.
2. The teacher in the field of robotics shall integrate knowledge from different data domains: mathematics, technologies, physics, information sciences; have basic knowledge on some disciplines of technical colleges, in particular, according to the theory of automatic control, programming; and at the same time it is good to understand the theory and the technique of training.
3. Professional competence of the teacher in the field of educational robotics shall include the system of theoretical knowledge, and also practical skills which form at him in the course of preparation and allow the teacher to find independently the solution of tasks in the data domain "robotics", and also to organize work of pupils, connected with designing, programming, modeling, development in pupils of skills of project and research activity.
4. In educational programs of the pedagogical directions of higher education institution, it is necessary to implement courses on robotics and the technique of teaching robotics, and also to open specialized educational programs of training of bachelors and masters, to carry out system professional development of the acting teachers and teachers of schools in the field of robotics.

In research, we select the following components of professional competence of the teacher of educational robotics: subject, methodical, technical, special, organizational, personal.

The subject component is the system of knowledge which defines the theoretical readiness of the teacher of educational robotics. This component emphasizes specifics of training of the teacher in the field of educational robotics. A teacher of educational robotics must know:

- about the current state and perspectives of development of educational robotics and the place taken by it and the role in the education system;
- from the course of physics, information science, technology, microelectronics and to understand possibilities of embedding of maintenance of the subject "robotics" in the maintenance of these subject matters;
- about opportunities for use of means of robotics and the necessary educational equipment when picking the office for carrying out classes in educational robotics [8].

Mastering the teacher this knowledge allows us to achieve optimum results of pedagogical activity according to the demands made by educational standards.

The methodical component is the system of skills that make the basis of the practical readiness of the teacher for the implementation of professional activity. A teacher of educational robotics must be able to:

- carry out the analysis of the purposes and the maintenance of the subjects including components of educational robotics. Carry information science, physics, technology to them. Have not only the idea of consolidation opportunities with the maintenance of the called subjects of sections of robotics, but also to own practical skills of implementation of robotics in these objects;
- in practice to perform integration of opportunities of educational robotics with the training courses which are its part, to select the most suitable modules of robotics for embedding in the subject course;
- develop educational and methodical materials in the field of educational robotics;
- reveal the most effective remedies of information technologies that are necessary for the maintenance of types of educational activity and allow them to achieve the planned results of studying educational robotics and methodically competently to apply these means in the educational process.

The main result of forming of methodical preparation in the field of educational robotics is the readiness of the teacher to perform the activity on "training of school students in fundamentals of robotics, education and the development utilizing the subject of training, readiness for the organization of research activity which is trained in the field of educational robotics" [9].

The technical component - the teacher of educational robotics shall be ready to the mastering of new technical means in the field of robotics and implementation of activity in constantly improved technical space, for this purpose it is necessary for it:

- own skills of use of the robotic equipment and specialized news programs;
- own knowledge of the main units of management used in robotic systems and understand their device;
- own the main assembly techniques of robotic systems;
- own skills of algorithmic programming and knowledge of visual programming environments of robots;
- have and put into practice skills of programming and designing of robots;
- use the special equipment means of information technologies for the implementation of the educational process of discipline educational robotics.
- The technical component of professional competence allows us to become the teacher more technical and competent, mobile, and prepared for the implementation of different innovations in the field of robotics in the educational process.

The special component is the readiness of the teacher of educational robotics to independent implementation of the contents of the subject, ability to solve all problems arising in the course of professional activity connected with teaching educational robotics capability to carry out the reflection of the activity, to estimate the received educational results, if necessary to acquire new knowledge and skills in the field of robotics and to improve skills.

Organizational component - the ability of the teacher to organize teaching and educational process according to requirements of the existing educational and professional standards, namely:

- it is qualitative and productive to organize the professional activity;
- interest trained and motivate to vigorous cognitive activity;
- maintain the relations in children's collective and stimulate the knowledge which is trained to acquisition;
- organize and direct trained to joint activity and self-knowledge;
- organize project and research activities trained in the field of robotics.

The personal component is the component which comprises professionally - personal qualities of the teacher to which it is possible to carry:

- level of proficiency in the teacher in acceptances of continuous self-realization and personal self-expression, self-development, aspiration to permanent improvement of quality of the work, the capability to self-motivation;
- mastering of methods of activity for the satisfaction of own interests and implementation of opportunities;

- readiness for permanent professional growth and professional development;
- capability to self-preservation, the ability it is correct to organize work without overloads and fatigue;
- capability of the finding of non-standard solutions of any professional tasks;
- ownership of means of opposition to professional deformations of the personality;
- readiness for overcoming of professional difficulties.

5. Results

At NCFU, some experience in the organization of laboratory robotics, training in robotics of school and university students, and preparation of pedagogical personnel in the field of educational robotics is saved.

Since 2014 based on Institute for Information Technology and telecommunications, the educational center "Virtual Worlds" has been functioning. The center is suited with modern equipment, namely: android ROBOTIS DIOLOID Premium Kit robots, sets of the designer of Arduino Uno Starter Kit, and designer of Bioloid Premium Kit, 3D printer. The use of high-tech equipment allows organizing training of school and university students for an increase in their technical literacy.

Within the educational center, depending on the training level, the following additional programs are developed for pupils of elementary, middle, and senior grades. There are some of them for instance: "NCFU IT school", "School of programming", "School of robotics", "School of programming", "School of computer graphics". Each program has the individual modules allowing listeners to receive certain technical skills [10]. So, for example, the NCFU IT school program includes the following modules: Fundamentals of robotics, Mobile applications, Bases of Photoshop, Fundamentals of microelectronics, Information protection, Virtual reality, 3D - modeling, 3D - the seal, Entertaining cryptography.

Training within educational programs of the center promotes an increase in the level of ICT culture of the school and university students, development of technical education, and allows to create optimal conditions for further professionalizing of trained.

In addition to additional programs in the field of robotics, information science and information technologies for school and university students based on the center educational programs are realized, and seminars for the professional development of teachers of the educational organizations are held. These programs of professional development include training of teachers on such modules as Methods of teaching fundamentals of robotics on different education levels; Training in fundamentals of microelectronics, 3D - to modeling, and 3D - seals. For 4 years of work in the educational center, training in different additional programs took place more than 900 school students and 100 teachers.

In the Institute for Information Technology and telecommunications of the North Caucasian federal university system training of teachers and other specialists in the field of educational robotics is conducted.

So, for example, in the direction of preparation 44.03.01 "Pedagogical education", the Information Science and Information Technologies in Education profile, the discipline of "Fundamentals of robotics" is entered into the curriculum. Within this discipline students, future teachers of information science, get acquainted with robotics history, study the device of robots and the characteristic of anthropomorphous robots, master programming essentials of movements of robots utilizing RoboBasic language programming aids in the AR-Basic Studio coding environment, perform programming of different operations of the anthropomorphous AR-101M robot. Furthermore, within this course, there is the studying of fundamentals of extreme robotics, and also an acquaintance of students to questions of application of robotics in the industrial industries. But the most important is that within discipline students of the pedagogical direction of preparation, study the technique of carrying out classes in robotics with school students and after successful mastering of the course is ready to implementation of educational robotics in the educational process of the general education organizations. Thus, this course allows bachelors of the pedagogical direction to seize the competences of the field of educational robotics allowing them to organize training activity of robotics at schools [11].

In addition to the training course of "Fundamentals of robotics", in Institute for Information Technology and telecommunications the Software of Robotic Complexes profile in the direction of preparation 09.04.02 "Information systems and technologies" is implemented. The program of the

magistracy began to be implemented in 2015 at the department of information systems and technologies. During training in profile, students master methods of systems analysis, mathematical modeling, methods and analysis algorithms, and data processing for their application for development and operation of robotic systems and hi-tech management systems. The program of the magistracy includes the following training courses connected with robotics: "Educational robotics", "Programming of robotic systems", "Design of mobile robots, industrial robotics". For the period training the master purchases the subject and specialized competencies⁶ allowing it to perform not only information maintenance of robotic and hi-tech management systems, but also pedagogical activity in the field of educational robotics, to teach educational robotics, both at schools and in higher educational institutions.

As a result of long-term researches conclusions are drawn that forming and improvement of professional competences of the teacher of educational robotics shall it is performed systemically [12]:

First, in the educational programs connected with the preparation of pedagogical personnel, especially teachers of information science, mathematics, physics, the technology it is necessary to implement courses on robotics and the technique of its teaching.

Secondly, to open specialized educational programs of training of bachelors and masters. For example, such as "Information science and educational robotics", "Information science and additional education (in the field of robotics and designing);

Thirdly, to carry out system professional development of the acting teachers and teachers of schools in the field of robotics. Now contents are developed and the large number of the advanced training courses organized for the training of teachers in the field of information and communication technologies [13, 14] is carried out. However, it is not enough courses in the professional competences of the teacher of educational robotics connected with forming. Besides, on these courses, it is rarely a teacher who receives professional competences in the field of robotics necessary in this case.

6. Discussion

The carried-out analysis of the problem of training on educational robotics allowed us to formulate some outputs:

1. Forming of the content of preparation of pedagogical personnel in the field of educational robotics shall be based on the requests of modern society connected with the need of development and gain of engineering education for the country, taking into account increase of attention to the educational and developing robotics potential, proceeding from equipment the robotic equipment of the educational organizations now and taking into account the further improvement of this equipment in the future.
2. Implementation of robotics in the educational process demands the appropriate level of training of the teachers possessing not only strong technical knowledge in this area but also knowledge of methodical bases of teaching robotics and pupils, ready for implementation of robotic education.
3. In higher education institutions, training for educational robotics shall be performed systemically, on all education levels, as by the introduction of the corresponding courses to the existing educational programs, and by the opening of the new educational programs connected with the robotic directions of training of specialists.

7. Conclusion

Thus, professional competence of the teacher of educational robotics consists in the unity of theoretical and practical preparation for the implementation of the pedagogical activity, indicates the level of professionalism of the teacher in the field of robotics, and includes the following main components: subject, methodical, technical, specified, organizational and personal. Modules of the professional competence of the teacher need to be considered not separately from each other, and the whole as they have integrative and complete character. The structure of the professional competence of the teacher reveals through his skills and abilities, and their formation is the main criterion of pedagogical skill.

In conclusion, we will note: studying organizational and methodical conditions of forming of competence of the teacher in the field of educational robotics and development of technologies of preparation of pedagogical personnel in this area is the perspective direction of research.

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