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Educational Robotics as a Factor in The Development of Polytechnic Education

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***Abstract*— With wide implementation of information technologies in education, there is a transition to a new paradigm. The traditional forms, methods, means and content of education do not fit into the new paradigm and so need theoretical reconsideration. The methodological basis for the new para-digm has to be the postnonclassical methodology relying on synergetic vision of the world and soft modeling ideas. The article draws attention to the main directions of the development of Polytechnic education in the information society. Project activities, technical contests and engi-neering creativity should come to the fore in the educational process. Modern requirements for Polytechnic education involve the training of professionals capable of designing, producing complex engineering objects ready for creative work in a team. The article also discusses the prospects for the development of educational robotics based on the designers of programmable robots. The article presents the themes of the course "Educational Robotics". The authors dwell in detail on the issue of different-level research work of students in the study of robotics and methods of organization of classes with different models of robots. The results of the experi-enced teaching of the course "Educational robotics" show that in the study of constructioning in this course there are gradual development of the possibilities of designing robots, their pro-gramming to perform various tasks; formulation of the study for a deeper understanding of the principles of their work; transition to a creative level in the design of their own models of robots.**

***Keywords*— research method, programming, LEGO construction, creative design, modeling, research tasks, activity approach, models of robots**

I. INTRODUCTION

Interest in educational robotics has recently increased in the society. A whole series of fundamental works [1], [2], [3], [4] is devoted to this direction. Mod-ern requirements for polytechnic education presuppose the training of professionals who are able to design, produce and apply complex engineering facilities ready for creative work in the team. Features of the use of robotics in engineering education were considered in a number of articles [5], [6], [7], etc. To implement the concept of Polytechnic education, increase the motivation of students to receive engineering specialties a good help is the opening of engineering classes in schools. The engineer-ing class should help the student to form the necessary competencies for the future profession of engineer. The key competences of the graduate of "engineering class" should be metasubject competence: the ability to organize cooperation and joint activities with the teacher and peers; work individually and in a team; formulate, argue and defend their opinions, develop leadership qualities and etc. In the infor-mation society competence of specialists not long time can remain constant, they should be improved.

To work in engineering classes that are just beginning to appear in Russian schools, qualified teachers are required. The development of physical and mathe-matical education is an important link in the training of future engineers who meet the requirements of the digital economy. We must not forget about the quality of training teachers of mathematics, physics, computer science, robotics, owning mod-ern information technology. These teachers will work in engineering classes.

The main difference between engineering classes and ordinary ones is the technology and content of education. The methodological basis of the modern edu-cational paradigm should be the post-non-classical methodology based on the syn-ergetic vision of the world and the ideas of soft modeling [8], [9]. Project activity, technical competitions and engineering creativity should come to the fore in the educational process.

Educational robotics is a modern learning technology that allows students to engage in project activities since primary school. Classes in robotics develop stu-dents ' skills in areas such as modeling and design, programming, artificial intelli-gence. Classes in robotics significantly improve students ' knowledge of natural Sci-ences, develop cognitive abilities and technical skills, contribute to the development of algorithmic and logical thinking, the ability to analyze and summarize infor-mation [10], [11], [12], [13], [14].

As part of the study of the discipline "Educational robotics" students get ac-quainted with the basics of design and programming of robots based on the LEGO MINDSTORMS version of Education Edition (i.e. educational version). Classes in robotics teach to apply the theory in practice, to solve problems with non-standard methods, develop creative and logical thinking.

The methodical basis of the course "educational robotics" is the activity ap-proach and the organization of the most productive creative work of students. The objectives of the course – to give an initial knowledge of the modeling of robotic devices; to teach the basic techniques of Assembly and

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programming of robotic means; to form General scientific and technological skills of design and engineering.

The main topics in the course "educational robotics" can be the following: Programming movements on different trajectories. Working with sensors. Joint work of several robots. The main types of competition. Development of creative projects.

In robotics classes, students are engaged in constructionism, which encour-ages them to work equally their heads and hands. While designing programmable robot models, students combine the qualities of scientists and designers, teachers and engineers, i.e. the most diverse specialists. Due to the fact that the main type of work in the design is the experience statement, then, of course, such work is closely related to the research. At the same time, the design process allows to expand the scope of research activities due to the large number of available parts and sensors.

The research method in training has been used since the beginning of the XX century. It is based on a logical process based on independent observation of the real facts, on the basis of which the relevant conclusions are drawn. Most often, educational research consists of four phases: observation and formulation of ques-tions; the nomination of the hypothesis; a study of hypothetical decisions, and choice of one of them as the most likely; the check of the hypothesis and its final confirmation.

All these stages easily form the basis of construction. If there is a ready-made model - a robot, then it is not difficult to build an observation of its work. On the basis of this work, a new question is posed about the possible functioning of the model, a hypothesis is advanced. Further, by reasoning and inference, there are solu-tions, then they are tested in practice.

When designing with the LEGO MINDSTORMS Education EV3, we offer several types of research that can be divided into three levels of complexity.

The first level of complexity is: "what will happen if you change the model." The tasks of this level involve the study of the finished constructed working model, about which a number of questions are raised. Such research is proposed to be car-ried out even on the most simple LEGO WeDo robots that do not have sensors and great features. Such works are studied in the initial course of construction in elemen-tary school. These include such models as "Dancing birds", "Smart spinner", "Mon-key drummer", etc. An example of the task of changing the model is the question: "what will happen if one of the pulleys is replaced by a pulley with a smaller diame-ter?"

Research tasks of the second level of complexity can be defined as: "what should be changed to get the result." This level involves the study of higher complexi-ty, requiring the construction changes to achieve a specific result.

The third level of complexity – "Build your model" – not only involves the solution of the research problem, but also brings the activity to a creative level. Tasks of this nature are complicated by the fact that they require combining the research process with the modeling process. Most often it is difficult to reach this level without passing the previous two. Among the most interesting kinds of tasks in this level are the tasks for the simulation of various robot competitions or projects containing several similar-themed designs.

Within the course "educational robotics" based on LEGO MINDSTORMS Education EV3 designer, tasks of all three levels of complexity can be offered for the development of students ' research skills. Tasks like "what will happen if you change the model" are quite simple and are based on a specific model, based on the process of its Assembly. Therefore, in this article we will consider examples of re-search problems of the second and third levels of complexity based on the basic LEGO MINDSTORMS Education EV3 and ITS models.

The base model SPIK3R – a six-armed robot is able to turn around and grab objects with its claws; it also has a function of the movement of the tail. For this model, at the second level of complexity it is interesting to consider the problem of studying the possibility of capturing the object and moving it to a given place. For example, grab the ball and throw it so that it hit the target. At the third level of diffi-culty based on SPIK3R can offer simulation of the game of football or hockey. For example, the project "Football field" can contain such structures as "forward", "goalkeeper", "defender".

Another basic model of R3PTAR is a robot that can glide across the floor and quickly attack objects with fangs. The tasks of the second level of complexity here can be aimed at tracking a moving object. These tasks include the search (de-tection) of a moving object, tracking a moving object and the possibility of hitting a moving object. The task of the third level of complexity for this design can be to create a security system containing, for example, a guard dog.

The basic model GRIPP3R is a robot designed to lift gravities; this model is equipped with a mechanism to capture objects. At the second level of complexity for this model, we can offer a task to study the possibility of holding the heavy load at a given angle after capture. The tasks of the third level of complexity here can be attributed to the project "Construction work", containing the design of "bulldozer" and "crane" with various additional functions.

Of course, the range of research tasks of any level of complexity is not lim-ited to the proposed options and depends on the imagination of the developer. So, without relying on specific basic models, you can create a project "Smart home". Here you can offer to design a lot of small models, connected together. For example, an automatic door of the house (will open only when someone comes to it); Elevator for several floors (with the ability to select the floor, for example, based on the color sensor); automatic light switch (if someone is in the room); garage with automatic door, etc.

The results of the experienced teaching of the course "Educational robotics" show that in the study of constructioning in this course there are:

- gradual development of the possibilities of designing robots, their programming to perform various tasks;

- formulation of the study for a deeper understanding of the principles of their work;
- transition to a creative level in the design of their own models of robots.

The value of the course "Educational robotics" will only increase over time. Robots are increasingly part of our lives, they help in production, for military pur-poses, in medicine and other areas. They very quickly master new activities, acquire artificial intelligence, are increasingly introduced into education.

Number equations consecutively. Equation numbers,

References

[1] Bishop O. Handbook of robot developers. SPb. MK-Press, KORONA-VEK, (2010)

[2] Dahin A. N. Pedagogy and robotics. Pedagogy, № 6, pp. 65-69 (2015)

[3] Robotics SKOLKOVO. URL: https://sk.ru/foundation/itc/robotics/

[4] Yurevich E. I. fundamentals of robotics. SPb.: BHV-Petersburg (2007)

[5] Kinzyabulatova R. F. introduction of robotics in educational space. Innovative technologies in education: materials of IV International scientific and practical video conference, pp. 182-183 (2017)

[6] Labutin V. B. development of engineering and information culture in the framework of the updated content of the subject "Technology" URL: http://metodist.lbz.ru/authors/techologia/3/obr-rob.pdf.

[7] Tolstova N. A. Bondarenko D. A., K. Y. Ganshin. Educational robotics as a component of engineering education. Science. Innovations. Technologies. No. 3, pp. 171-177 (2013)

[8] Testov V. A., Golubev O. B. Education in the information society: transition to a new paradigm: monograph. - Vologda: VoGU (2016)

[9] Golubev O. B., Testov V. A. Network information technologies as a basis of new education paradigm. Procedia-Social and Behavioral Sciences, Volume 214, pp. 128-134, 5 December (2015).

[10] Golubev O. B., Morozova I. V. possibilities of educational robotics for the development of research skills of students. Informatics at school. № 7 (120), pp. 26-28 (2016).

[11] Aleksanov D. I. introduction of robotics in educational organizations at different levels of education. Technology. Service. Vol.1. No.1(6), pp. 99-104 (2015).

[12] Bartosz D. S., Izmestyev N. With. Kukhtina E. S. Educational robotics as a means of development of algorithmic thinking. Prospects and challenges of the information society proceedings of the IV all-Russian scientific and practical conference with international participation in the IV International scientific and educational forum "Man, family and society: research and development prospects". Krasnoyarsk State Pedagogical University. V. P. Astafieva, pp. 105-109 (2015).

[13] Gnusina M. N. The role of educational robotics in the educational process. Issues of education and science: theoretical and methodological aspects: collection of scientific papers on the materials of the International scientific-practical conference, pp. 21-22 (2014).

[14] Licencia E. S. Educational robotics and the formation of the occupational and generic competences in the framework of the technical creativity of youth. Educational robotics: state, problems, prospects: collection of articles all-Russian scientific-practical conference; Novosibirsk State Pedagogical University, pp. 83-88 (2016).