LEARNING THE FUNDAMENTALS OF ROBOTICS IN THE SCHOOL PHYSICS COURSE

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Abstrakt: *The article describes the successes achieved in the new and rapidly developing field of robotics science and technology, as well as the issues of introducing robotics knowledge into the physical and mathematical sciences program of general education schools. The hierarchical structure of the cybernetic model of the robot is revealed. The study topics of the physics course were determined for the study of robot systems.*

Key words: *robotics, technical culture, physics, educational robotics.*

The change of the modern technological environment and the renewal of the technical activity of the society should be reflected in the content of school education. It is necessary to pay the main attention to the formation of knowledge, skills, skills and abilities that allow the successful integration of the young generation into modern socio-technical systems, the effective support and development of the scientific and technical potential of society. Improving the content of technical education should be carried out in the directions of technical innovation. One such field is robotics.

Robotics is the applied science of creating and using robots and other robotic tools for various purposes. On the basis of the science of cybernetics and mechanics, a new science robotics appeared and, in turn, led to the development of a new direction in science: for cybernetics - intelligent control required for robots, for mechanics - multi-component manipulator-like devices. mechanisms. A robot is a universal automatic machine that functions autonomously and is designed to perform human physical motor and mental functions. It has the ability to adapt and learn in the process of active interaction with the environment. Robots are characterized by:

1) autonomy - is the ability to independently perform actions or production operations, which is carried out by a software algorithm or by perceiving purpose-oriented commands and changes in the external environment;

2) universality - provides the ability to perform many different actions or production operations and allows easy transition from one type of action to another;

3) automaticity - the ability to perform sufficiently complex and complete actions or production cycles without the direct participation of a human operator;

4) anthropomorphism - in the broadest sense - presenting the robot with human capabilities and uniqueness: physical (with power), functional (motor) and intellectual

(mental); In the narrow sense, a robot does not have to have an external resemblance to a person, but it can be used for special purposes.

5) flexibility is the ability to adapt goal-oriented actions to changes under the influence of external conditions and in the process of learning in interaction with the external environment. In this case, the robot's ability to adapt and learn is realized as a result of its impact on one or another means of feedback: sensing, seeing, hearing, smelling, remembering, etc. These five characteristics define the robot's abilities and capabilities as a sufficiently complete technical system. In this case, the first three are considered indispensable features of any robot, and the next two - the fourth and fifth - belong to relatively modern robots in one way or another.

Robotics has been in the global education system for over 15 years. In the last 6-7 years, the activity of schoolchildren in robotics in our country has increased significantly. The content, methodical and technical aspects of the organization of training in robotics S. Ya. Vyazov, O. Yu. Considered in the works of Kalyagina, K. A. Slezin, V. N. Khalamov and others [1; 2; 3; 5; 7; 8] considered in the works.

Today, it is very common to look at educational robotics as a means of forming the engineering mindset of schoolchildren, encouraging them to choose an engineering profession, and developing their interest in technical creativity. This point of view is not objectionable, but in practice, in our opinion, the trends of scientific and technical development, in particular, the global changes taking place in the modern technological environment, are not fully taken into account. This is, first of all, the rapid development of robotics and the mass introduction of robotic systems into various spheres of social practice (industry, military production, science and culture, service and everyday life). Robots are "part of the new industrial revolution." Its main features are the robotization of production and the widespread introduction of robots into the social sphere. Robotics determines the effectiveness of the development of any industry. This is our "real future", in which specialized infrastructure is being formed. The result of its emergence will be global socio-cultural changes [6].

Currently, some schools have started practical work in the form of robotics clubs, meetings with industry representatives, quizzes, and various events.

It is known that robotics is an interdisciplinary field of knowledge. Therefore, the approaches to introducing robotics as a subject of learning in the school education system are incomplete and unclear. Various pedagogical and organizational solutions can be proposed. In the development of models for the introduction of robotics into the educational program of general secondary schools, in our opinion, the following are the main factors that should be taken into account: 1) the rapid development of robotics as a field of scientific and technical knowledge ; the mass nature of the introduction of robot systems in the modern technological environment, the variety of types of robots and the wide range of their application areas; 2) the need to understand the basics of robotics in the modern technological environment as a condition for human adaptation and integration; 3) the importance of studying the

issues of robotics methodology as a condition for understanding the general trends and social consequences of its development; 4) the relationship of robotics as an object of study to sciences; 5) the necessity of harmonizing educational programs in subjects as a condition for students' qualitative mastery of the theory and practice of creating and using robotics systems; 6) the need for practical training of students in modeling and construction of simple robots; 7) the need for a differentiated approach to teaching, identifying talented students, supporting them within the framework of individual development programs; 8) connecting the content of science education with activities outside the classroom, contests and competitions dedicated to robotics; creating creative teams of students.

The expediency of learning about robotics during the school physics course is based on conducting questionnaire surveys with teachers and students of grades 9-11 in general secondary schools, as well as in advanced training courses for physics teachers. confirmed. During the analysis of questionnaires, the following results were obtained: 94% of teachers believe that it is relevant to convey the concepts and knowledge of the basics of robotics in the school physics course to students, and this has a positive effect on increasing students' interest in physics. However, it was also noted that the teachers do not have the appropriate educational materials and methods related to robotics; 83% of students have heard about robotics, 65% of them have certain ideas about it; 62% of students believe that learning the basics of robotics at school will help them to choose a future profession; 91% of schoolchildren are interested in modern technologies, development and prospects.

Shuning uchun ham maktabda fizika fanini o‘qitishda o‘quv robototexnikasini qo‘llashning umumiy konsepsiyasini ishlab chiqish muhim ahamiyatga ega. Uni ishlab chiqishni fizikani o‘qitishda robotexnikadan foydalanish maqsadlarini tushunishdan boshlanishi kerak. Bunga quyidagilar kiradi:

1) demonstrating the capabilities of robotics as a direction of technical innovation and a means of changing the modern technological environment;

2) to show the role of physics as a science in creating robotics;

3) improving the quality of teaching: expanding and deepening knowledge of the subject; systematization of knowledge, understanding of the relationship between academic subjects (physics, mathematics, informatics, chemistry, biology, etc.); development of ideas about modern physical experiment as a way of knowing, skills formation and robotic experiment installation skills; improvement of technical training of students using educational robotics: expansion and deepening of knowledge in the field of applied physics; formation of practical skills in the field of technical modeling and construction (in the preparation of robotic physical experiments, design and creation of technical objects as a practical application of physics);

4) development of motivation to study physics and its technical application;

5) to strengthen the professional orientation of students to engineering specialties.

The main components of the robotics curriculum should be:

1) information about the history of the development of robotics and its prospects, the place and role of robotic systems in the modern technological environment; 2) basics of the philosophy and methodology of robotics (general, special): the concept of "robot", the specific characteristics of a robot as an object; types of robots; laws of robotics, cybernetic model of the robot, basic approaches to the design of robotic systems, including computer and full-scale modeling; 3) modern solutions and technologies in the field of design and programming of robots: physical manipulations and manifestation of features such as "sensation", "smell", "vision", "hearing", "Speech", "memory", "nervous system" ", it is possible to perform tasks such as modeling of artificial "intelligence" signs [12].

The question arises as to which part of this program and at what level should be studied in physics classes. To answer this question, consider a cybernetic model of a robot (Figure 1).

From the point of view of control theory, a robot includes three main systems: control, execution, and data collection. Each of them is implemented using its own element base. An important part of the phenomena and laws that ensure the operation of this base is studied in the school physics course. This allows us to successfully describe the technical application of physics in the example of creating and using various robotic systems.managementfeedback

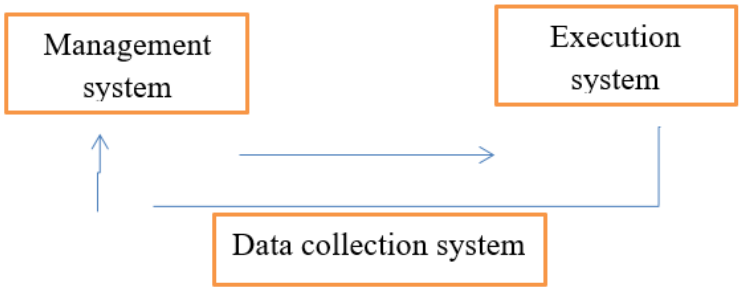

Figure 1. A cybernetic model of a robot

In order to analyze the possibilities of learning the basics of robotics in the content of the school physics course, we use the ideas about the structure of the elementary base of robotics (Fig. 1). In our research, we have analyzed the main components and principles of operation of the devices that make each system work. As a result, tables showing the main physical phenomena and laws were created, on the basis of which the principle of operation of these devices was revealed and assigned to the relevant topics of the physics course. Parts of these tables are presented below (see Tables 1 and 2).

Table 1

Studying executive robot devices in a school physics course

Groups	Robot elements	Physical phenomenon, law, technical object	Physics course topic	Class
1	2	3	4	5
Drives	Electric motor	DC motor	Electromagnetic	8

			phenomenon	
		Alternating current electric motor	Electromagnetic phenomenon	8,11
	Hydraulic drive unit	Pascal's law, hydraulic press, manometer	Electromagnetic phenomenon	8
	Pneumatic drive unit	Pascal's law,	Generate, transmit and use electricity	8
Intermediate transmissions	Gear transmission	Change the angular velocity of the rotation	Kinematic movement in a circle. Motion of solid bodies	7
	Friction transmission	Static friction	Mechanical power. Frictional force	7
	Levers, blocks	The Golden Rule of Mechanics	Simple mechanisms	6
	bearing, ball joint, etc.	Sliding and rolling friction.	Forces in mechanics. Frictional force	7
	Heavy machinery	Straight and curved motion	Fundamentals of kinematics	6, 7
Working bodies	Tracks of manipulators, handles, holders, wheels	Motion along a straight and curved trajectory.	Kinematics. Dynamics. Statics.	7, 9, 10.

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Studying feedback devices in a school physics course

Robot element	Physical phenomenon, law	Physics course topic	Class
1	2	3	4
Magnetic field sensor	Score effect	Fundamentals of electrodynamics	11
Distance sensor	Propagation and reflection of ultrasound	Mechanical vibrations and waves	9, 10
Light sensor	Photoresistor	Electricity in different environments	11

There are undeniable problems in the practical introduction of students to the basics of robotics, such as the lack of robotics laboratories in schools, the absence of enterprises operating in this field or institutions conducting scientific research, and the inability to organize students' visits to such places. In order to solve this problem, it is possible to offer the idea of remote communication through modern telecommunications while introducing students to real equipment in research laboratories and scientific centers. It helps students to see the reality of many robotics terms and concepts and gain confidence in understanding and mastering new knowledge. However, in the current conditions, the insufficient technical capabilities of many schools may not allow the full implementation of this idea. In the school physics course, students can get practical introduction to the basics of robotics in a number of possible ways.

In the school physics course, the following approaches are proposed for organizing the study of the basics of robotics.

1. "Invariant" teaching model. In this case, learning the basics of robotics in the school physics course is mandatory for students. Additional information on the basics of robotics is included in the physics course of general secondary schools.

2. "Variative" teaching model. In this model, fundamentals of robotics is offered as an additional elective course. This model can be seriously considered in the current situation, where the Ministry of Preschool and School Education is promoting the idea of introducing elective subjects for general secondary schools in the future. Students interested in robotics will be able to participate in these additional courses (most likely in grades 10 and 11).

3. Model "In the framework of the academic subject". In this model, learning the basics of robotics is mandatory for students. Relevant educational materials, concepts and knowledge related to the basics of robotics are integrated into the educational content based on the physics topics of the 6th-11th grade.

The components of the methodology of using robotics elements as a means of developing and educating students in physics classes will consist of the following.

Educational tasks of robotics. The didactic potential of robotics in organizing training is very high. As a result of working with robotics, students will acquire modern technical knowledge and skills, in which technical and technological competences necessary for life activities related to the operation process of various objects are formed.

The creation, operation process and appearance of an innovative construction through the use of virtual tools in the educational process are understandable to children and schoolchildren of almost any age today. Here, the school student evaluates his ideas, technical creativity and suitability of the created robots, creates additional conditions for their verification. The task of teachers is to use the elements of robotics in the students' activities, to identify and apply the components of science, to show the importance of related fields of scientific knowledge.

Robotics is a new expressive tool. It has a positive effect on the complete assimilation and perception of the educational material by the students and helps to conduct the educational process effectively [9]. Physical experience, explaining the structure and operation of devices with the help of demonstration tools, the use of robotic devices in the educational process is not only interesting for schoolchildren, but also guides them to choose technical professions. They help to improve the quality of the educational process. For example, experiments using robotic devices can lead to the manifestation of quantitative changes.

Robotics is an effective means of individual organization of education, in which it is important to take into account the level of interest and readiness of students [11]. The use of various educational kits in robotics training ensures the development of technical creative competencies of students, assimilation of educational materials

related to science. An important factor in this regard is the selection and organization of competitions in robotics.

Developmental and educational tasks of robotics. The ability to put forward one's own idea and independently determine the robot's construction and various tasks is an important condition for satisfying the child's psychological needs: it is understood in the choice, in obtaining the result "here and now", in independent self-application, in the achievements [10]. In this case, it is possible to discuss the options of the robot construction, to analyze the advantages and disadvantages of these options, to determine the best of them, to create a moving robot model, to defend the prepared project, and to apply the results of the design in the educational process of physics. teaching methods, participation in robotics contests or competitions with one's own project.

The following educational materials and tools related to robotics can be used to explain the practical application of the examples in the teaching materials on the subject of "Power Sources" in physics of secondary schools of general secondary education. In robotics, a special board is used to connect circuits. The plate is used together with welding equipment in performing various design works. The special board is made of plastic. Special grooves are opened on the board, in which many electronic components or jumper legs are inserted, fasteners of various elements are held. The slots are connected to each other by conductive material running under the board. In electronic networks, when connecting devices to the circuit, 5 V (+) red and black (-) color conductors are used so that students do not get distracted. The rest of the wires can be any color (Figure 2).

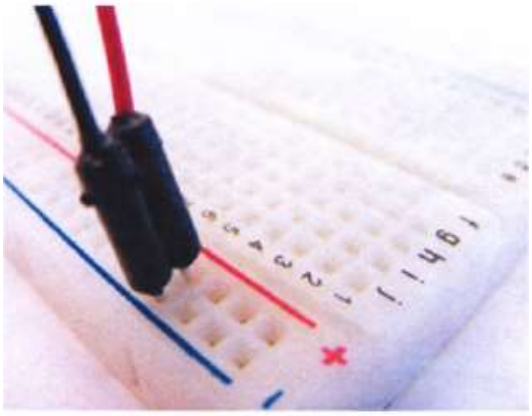

Figure 2: Connecting the plate to the conductor

Grooves allow you to connect two or more pairs of leg components, and also prevent short circuits or various defects that may occur in the circuit components. On the top and bottom of the board there are a series of holes marked with blue and lines, which are used to supply power to the components installed in the main part of the board. They are called voltage sources. Positive and negative sources are connected horizontally to the board. Red lines are the positive source, blue lines are the negative source. Connecting various components to the maketd is done using wires. The connecting wires are single-core insulated, the ends have a special connecting piece. It

is convenient to connect and disconnect them on the board. When the connecting cable is inserted into the board, it is held by a spring clamp and ensures that the connection is made. To connect the circuit, it is possible to connect the components by placing them in the adjacent slot (Fig. 3) [10].

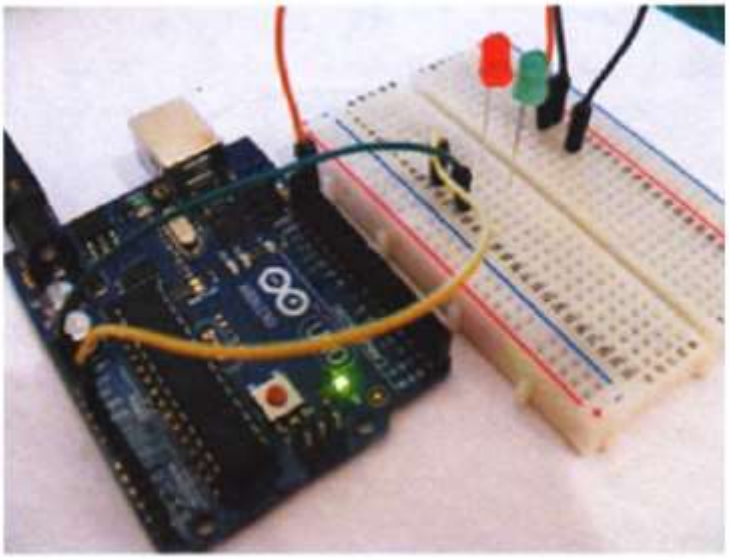

Figure 3: Chain connection diagram on the plate model

In conclusion, it can be noted that the use of educational materials and teaching tools related to robotics in the development of students' interest in physics shows the practical application of physics. Students will understand information about the structure and operation of various devices based on the science of physics. Also, giving them such tasks in the performance of various homework and assignments will help them develop competencies in designing and constructing various devices.

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