NOVATEUR PUBLICATIONS
JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN No: 2581 - 4230
VOLUME 8, ISSUE 11, Nov. -2022

USE OF ROBOTIC TECHNIQUES IN TEACHING PHYSICS

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This article covers the organization of a physics lesson using modern methods. In this, the intelligence of the student increases by performing laboratory work with the help of robotics.
Key words: robotics, competence, education, LEGO, micromodule, experience.

Currently, there is high competition in the field of science and technology between developed countries. The results of such competition determine not only the level of the country's defense capabilities and its place on the world scale but also many political, economic, and social processes taking place in society. Currently, in developed countries such as Germany, England, France, Russia, Korea, and Japan (LegoMindstorms, LegoWeDo, Huna, Arduino, Matrix), schoolchildren of different ages are engaged in teaching robotics, using robotics elements in leading higher educational institutions. In educational institutions of developed countries, issues of the development of students' technical creative competencies are being discussed, and scientific centers are being established. Creating the necessary conditions for the development of technical creative competencies of schoolchildren in Uzbekistan, strengthening the material and technical base of educational institutions, providing didactic and methodological support, and developing normative and legal documents in progress, "By 2030, increasing the share of modern circles such as robotics, information technology and programming in additional educational institutions by 20 percent", in this regard, expanding didactic and didactic knowledge is one of the priority tasks of the educational system [1]. Methodical possibilities of competencies, technical creativity in practical group classes, robotics elements in extracurricular activities, and the development of teaching methods based on them serve to increase students' technical creativity competencies [2]. The relevance of the development of robotics in the field of education is related to the need to train engineering and technical personnel for industries. In this regard, the field of education faces the task of introducing robotics into various levels of the educational process.

The "Mechatronics and Robotics" program of the educational institutions of the Republic of Uzbekistan for 2020-2022" is intended to train personnel in the field of undergraduate education. This system is aimed at developing advanced technologies, equipping educational institutions with new equipment, improving the qualifications of pedagogues, widely involving children in scientific and technical creativity, early career guidance, and the effective realization of their potential by talented young people serves to issue.

To organize the activities of schoolchildren in the field of educational robotics, a number of constructors are offered on the market today, which allow the student to quickly assemble the structure, connect sensors and electric motors, create a program, and start the robot model. It should be noted that almost all educational kits for assembling robots are designed and manufactured abroad.

The most popular constructor for organizing robotics classes in many educational institutions is the LEGO constructor. These constructors have been produced since 1998 and are widely distributed in many countries of the world. High-quality LEGO bricks are combined with sufficient strength, safety, and ease of assembly that does not require special tools. The programming systems of constructors are adapted to the appropriate age of children. There is methodological and didactic support for various collections in the form of step-by-step instructions, recommendations for the teacher, lesson development, and training courses. There are a number of companies that produce equipment

compatible with LEGO sets (HiTechnic, Mindsensor, Vernier), which allows students to significantly expand the capabilities of the basic designer. For example, Vernier's collaboration between Software and Technology and LEGO Corporation has led to the introduction of adapters and software that allow the use of Vernier sensors. With the computerized NXT device controlling the MINDSTORMS constructor, data logging and graphing functionality were added in the second version of the MINDSTORMS program [3].

Using new technologies in the educational process, LEGO produces a number of special sets for physics and technology. The following thematic collections are known:

- "Technology and Physics",
- "Renewable energy sources",
- "Energy, work, power",
- "Entertainment Industry",
- "Pneumatics".

Each kit comes with a corresponding instruction manual for using the constructor in the educational process.

Text and object-oriented programming languages adapted for technical systems are used to create programs that "bring" constructor models to life.

The most popular national software products for programming LEGO robots (USA). This company is one of the world leaders in the development and production of data collection systems and software management technology for managing technical facilities and technological processes, as well as hardware and software for automated testing systems. The company has more than 40 representative offices in different countries of the world.

One of the possible options for changing the forms of organization of the modern educational process is the integration of educational robotics into various components of the educational process.

I wrote the following in these components:

1) forms of lesson work (implementation of educational projects, preparation of demonstration experiments, experimental devices for laboratory work, and school physics workshop work);

2) forms of extracurricular activities (students' creative design work, participation in competitions and scientific-practical conferences, including forms of their remote and network implementation);

3) work in the additional education system (virtual and circle work).

These components correspond well to the basic principles of organizing the activities of schoolchildren in working with robotic systems. Designing, modeling, and programming robots together with the use of ICT technologies, as a rule, is characterized by a high level of creativity, independence, competition, and group communication. Students will develop the skills necessary for the modern student. Among them are subject, meta-subject, ICT competencies, and communicative competencies.

Despite the positive impact of the use of robotics in the classroom, the experience of many science teachers shows that educational robotics still dominates in circle and circle work. This is due to the insufficient development of the methodology of using robotics in the educational process, the lack of study guides for students, and methodological recommendations for teachers. At the same time, there are a number of methodological manuals created by foreign authors on the use of robotics tools in project work on physics, chemistry, and biology, and it can be noted that they can be used in the activities of science teachers.

When developing a methodology for the use of educational robotics in the teaching of academic subjects, particularly physics, it is necessary to, first of all, formulate the goals of its use.

The methodology of using educational robotics in teaching physics can be divided into five parts.
demonstration of the capabilities of robotics as one of the main directions of scientific and technical development ;
to show the role of physics in the design and application of modern technology ;
3) Improving the quality of educational activities:
• Deepening and expanding knowledge in science,
• Development of experimental abilities and skills,
• Improving knowledge in the field of applied physics,
• Formation of skills and competencies in the field of modeling and design;
4) Development of children's motivation to study the subject, including cognitive interest;
5) Strengthening preliminary and profile training, directing them to engineering-technical profile professions.
The analysis and generalization of experience from this methodology allow us to determine the following directions for using robots in teaching physics:
1. The robot as an object of study. Study the physical principles of operation of sensors, motors, and other systems of the designer.
2. As a measuring tool in traditional experience. Sensors of the main designer and additional types of sensors (Vernier, HiTechnic, etc.) are used in a physical experiment as a measuring system with processing and recording of its results in various forms.
3. The robot as a means of setting up a physical experiment (robotic experiment) is a comprehensive use of engines, warning systems, sensors, and robotic constructors in demonstration and laboratory experiments.
4. The robot as an educational modeling and design tool. The use of educational robotics in the design, research and design work of students:
• Using existing robots with other systems,
• Create a new robot
• Modernization of the robot (development and design of other robot systems in new conditions, including new sensors and expanding the possibilities of its use).
The following positive aspects of the use of robotics elements in the lessons, including in the hands-on physics experiment, as well as in physics laboratory exercises, can be distinguished:
1. Processing of the results of measurement of physical quantities can be programmed and performed in automatic mode when the program is executed.
2. Accidental measurement errors related to the use of are excluded: human reaction speed, measurement by eye, perception of events by ear, etc.
3. Continuous monitoring of the value of the physical quantity during the experiment with an adjustable frequency of taking sensor readings from one measurement to several tens of times per second at certain time intervals and for the entire duration of the experiment.
4. Experimental data will be displayed on the screen during the entire experiment in the form of numerical values, numerical scales with indicators, tables of values, and graphs of functions.
5. The graph obtained as a result of the experiment, as well as the tools for its study, provide additional opportunities for analyzing the laws of physical processes:
• Output digital data for any point of the graph;
• Extract values of different intervals of value change in a certain time interval;
• To determine the average value of the amount in a certain period of time;

• Zoom in on the graph;
• Display several graphs obtained during several similar experiments on the coordinate plane.

In addition to these advantages, it is possible to show the disadvantages of using robotic systems in the school experience.

First, a robotic experimental device requires pre-assembly and programming, which takes a lot of time. To minimize time costs, the following is recommended:

• Create in advance step-by-step instructions for assembling the installation;
• Creating a bank of programs prepared for use on different devices;
• Replacement of some components of the installation design with non-separable analogs;
• Preassembly of the installation by schoolchildren before the lesson (as part of an individual or group creative task).

Secondly, there is an instrumental error in system sensors and the need to take them into account.

There may be different levels of complexity of educational tasks in laboratory work using robotics. This level is determined by:

1) The level of participation in the assembly and installation of the experiment:

• work on the completed installation;
• self-assembly and adjustment of the installation, software adjustment of sensors, development of a program for processing results;

2) The level of didactic support of schoolchildren's academic work:

• implementation of the project according to the instructions;
• implementation of the project according to the instructions using structural assembly schemes;
• implement a project according to instructions with instructions for programming a robot.

Let's take a look at a lab using several methods with some suggestions for using robotics in physics classes during the learning process.

Method 1. Lab setup using Arduino micromodule to determine free-fall acceleration.

The first method to determine the acceleration of free fall uses a special program written on an Arduino micro module. For him, the teacher should have the skills of programming from the elements of robotics and a micro module. For this, a simple program can use writing methods (MBLOCK) [3]. Can use Sensors installed at the top and bottom of the tripod, an Arduino microprocessor module, and a distance sensor that detects the movement of the ball.

When the ball is thrown from the set point of the tripod, the first light sensor is triggered. This will send a signal to the Arduino module to start the stopwatch. A stopwatch will start. When the ball passes the second light sensor, the second sensor is activated. When a signal from the second sensor is received, the stopwatch stops and the result of measuring the time interval is shown on the module display or in a special program compiled for Arduino on a computer. The distance measurement result is also displayed on the module display. The program for this installation is obtained by the teacher from the program bank (originally written by the teacher) or the program is prepared by the students before the lesson. Data processing (time and movement of the ball) can be done in the traditional way in the implementation of scorebooks, or a software option can be used to process the measurement results. To do this, you need to add a calculation block in the program. There are various options for enabling software processing of results:

• Students write the formula independently. The teacher shows you where to enter the formula in the program and helps you save and run the program. In this case, the teacher must run the original version of the program for each group of students;
• To write in the program after the class discussion.
All groups work with a program that includes a block for processing the results.
This work suggests options for using other sensors. Various combinations of light, sound, and tactile sensors can be used:
1) When replacing the bottom light sensor with a button sensor, the button sensor must be installed on the base in such a way that when the ball is hit, it presses the button of the sensor. The reader will need to change the sensor type in the program. Students can do this in class;
2) When the bottom light sensor is replaced by a sound sensor, as soon as the ball hits the designated barrier, the sound sensor is triggered and the stopwatch stops. In this case, the reader will have to change the sensor type in the program;
3) When replacing the high light sensor with a button sensor, in the program you need to configure the launch of the ball and the stopwatch at the same time;
4) When the high light sensor is replaced by the sound sensor, you need to set the ball and stopwatch to start at the same time in the program. For example, you need to start the sound sensor by clapping your hands so that the electric grip will start. Then the signal received by the module through the sensor activates the handle. In this case, it is necessary to change the sensor settings in the program;
5) Both light sensors can be replaced with sound and touch sensors in any combination of up and down positions.
Method 2. Setting up a laboratory device using an NXT block and a distance sensor to determine the acceleration of free fall.
The proposed laboratory device for determining free-fall acceleration has a simple design, including an NXT unit and a distance sensor. The standard NXT-G plotting function is used to determine descent time and distance traveled. It should be noted that this work does not require programming. All the necessary information is obtained from the graph. The distance sensor is mounted on a tripod and positioned in such a way that it is convenient to measure the distance from the sensor to the falling object. It is convenient to use a small tablet of A4-A5 size for the base.

CONCLUSIONS

By carrying out various options for assembling and adjusting laboratory equipment, students get acquainted with the principle of modularity of modern technology, algorithms for assembling and disassembling technical structures, and their repair, and get an idea of some technological processes.
The possibilities of using robot constructors in the educational process are quite wide, and their implementation requires methodological and technical training from the teacher. By connecting the tasks of school education with the prospects of automation and robotization of modern production, effectively developing the technical thinking of schoolchildren, the efforts of educational institutions, industrial enterprises, higher educational institutions, and educational institutions coordination are necessary.

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