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OPEN SOURCES-BASED COURSE «ROBOTICS» FOR INCLUSIVE SCHOOLS IN BELARUS

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The paper describes the experience of developing courses of robotics based on budget models of training robots and the integration of courses in the educational process of the university and inclusive school.

Keywords: robotics, training of schoolchildren, inclusive education

Introduction

Information technology in the last decade has become an integral part of the learning process and has become almost an everyday element of educational activity in schools and universities. A new stage in the development of information technologies in education is, in our view, the development of training courses related to robotics and other programmable mechanisms. Those who today are trained in IT specialties already have to use more and more often, to program, and to create someone. As a result, many training courses were supplemented by a serious block connected with the interdisciplinary direction of mechatronics. First of all, they are electronics, mechanics, telemechanics, physics, computer science and programming. These disciplines have very close integration with each other in the framework of this interdisciplinary interaction.

The article describes the main problems in developing a training course on robotics and approaches to their solution.

The main approach used in the study is an action research as an interactive method of collecting information that's used to explore topics of teaching, curriculum development and student behavior in the classroom [6] The action researchmethods used include observing individuals and groups, using audio and video tape recording, using structured and semi-structured interviews, taking field notes, using analytic, distributing surveys or questionnaires. The preparation phase of the study also included such method as systematization, formalization and modeling. As a result, open educational resources which can be used as a source of an educational program code were analyzed and classified. The base of educational codes taking into account age and specific features of children was created. It has allowed to demonstrate possibilities of robots prior to programming activities by children. Formalization has allowed the description of substantial characteristics of object of research and the processes happening in it on the basis of creation of a generalized sign model (for example, by means of mathematical or logical symbols). The use of

modeling methods led to the development of several models of a course taking into account specific features of children, their age, knowledge about creation of algorithms. division of lessons into 2 parts: working with electronic constructions and working with a programming environment.

The development of this direction is promising in the educational and scientific sphere. Development and improvement of robotic systems is one of the fastest growing research areas, investments in which, according to the report of the analytical agency Strategies, are estimated at 10.6 billion US dollars by 2020 [1]. Serious scientific research is being conducted in the field of development of robotic assistants and the complication of algorithms for their functioning based on artificial intelligence.

According to the analytical agency Technavio [2], the market of robots used for educational purposes will grow by more than 20% from 2016 to 2020. At the same time, 47% of investments are made in the USA in the direction of development of educational complexes for primary and secondary (K-12) schools. Other major investors in this market are South Korea, Japan and China.

The report published by the agency «Global market of training robots in 2016-2020» identifies 3 main types of training robots that are being intensively developed by both manufacturers and users of devices (universities, schools):

- reconfigurable robots - systems that can be expanded or changed for the solution of specific educational tasks, including the tasks of the «Internet of Things»";
- wheeled robots;
- robots-humanoids - robots, whose systems mimic the movement and actions of man (including robots manipulators).

In the market survey prepared by Technavio [2], the largest market share of the development of robotic systems for education is:

Fischertechnik is one of the most popular solutions that allows you to create not only educational projects, but also prototypes of real complex devices. Sets are created from simple to advanced level, which are used to demonstrate the operation of complex mechanisms and modeling of production processes. The cost of a basic set of wheeled robots is 550-600 Euro.

Lego - the first robotic kit was introduced in 1998, which was upgraded in 2006 and 2013. Today this set is the most popular solution for educational robotics, these kits are equipped with mugs of robotics in many countries, Lego Mindstorms is in the leading positions and in the Russian sections of robotics. The cost of a basic set of wheeled robots is 450-500 Euro.

Modular Robotics is an American manufacturer of educational kits for robotics. The set is rather unusual, there are no wires. The parts have special connections, which are fastened together by ball-magnets. The basic programming language is the Scratch environment. The cost of a basic set of wheeled robots is 600-800 Euro.

Tetrix Robotics - a system that was conceived as compatible with Lego, but can be used as a stand-alone product. The designer consists of metal parts. The cost of a basic set of wheeled robots is 600-800 Euro.

Along with these sets, in the East European market a significant share is occupied by systems based on Chinese developments and analogues of Arduino

microcontrollers. First of all, this is due to their low cost: the basic model of the wheel robot can cost 20 Euro, while including sensors that are available in the extended versions of the «brand» designers: there are several dozens of types, more than 300 versions [5]. Presence of solutions for programming based on Scratch (S4A), extensions for visual programming AdruBlocks allows you to easily integrate these educational kits into the learning process. The volume of this market is difficult to estimate, but if you evaluate the statistics of orders for such devices in popular online stores, you can conclude that tens of thousands of purchased devices.

In addition to equipment, important components of training courses are the training code and materials of practical exercises, experiments and laboratory work. Typically, all developers provide a minimum set, based on which you can conduct training. In addition, there are many network communities, video materials, open Internet resources, where you can get advice and access to educational and methodological developments. However, the construction of a logically structured course on them is the task of the teacher, taking into account the trainees' characteristics (age, knowledge in the field of electronics, learning objectives, etc.).

The experience of using robots in training courses

When developing the elective course «Robotics» was tasked to minimize the budget for the purchase of educational hardware and software. This task without the use of exclusively virtual simulators (for example, ceebot.com) was possible to solve using the platform Arduino. Solutions for more demanding computing power training tasks are completed with educational microcontrollers on Intel Galileo and Intel Edisson platforms.

For the training of students, two main types of robots were selected:

1. Robots-manipulators - universal training robots, having 5 degrees of freedom. Robots can be equipped with three types of microcontrollers: Arduino Uno, Intel Galileo, Intel Edisson. They are used to teach programming for various levels, up to the professional knowledge of the C++ language. Depending on the version, the training robots can be equipped with various sensors, a video camera, an automatic pattern recognition system and color processing.

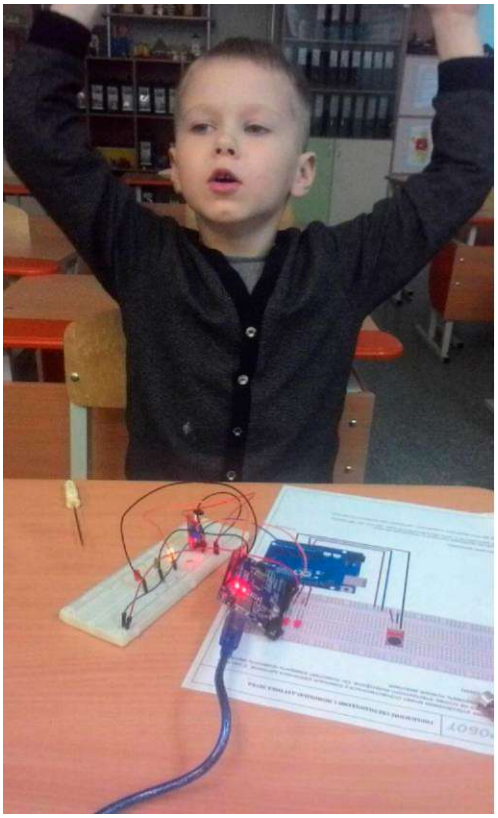
2. Mobile robots - training robots, based on the educational dual-core microcomputer Intel Edison. Using this microcomputer and programming skills, you can expand the capabilities of your robot: connect the robot to the Internet, manage the robot remotely, establish a video stream and make this robot model part of the Internet of things. Such opportunities for microcontrollers such as Arduino Uno are not available. In addition, training mobile robots MPobot can be equipped with a manipulator, capture, a video camera with an automatic pattern recognition system.

To train students in IT areas («business informatics», «applied informatics»), training modules are being developed that are integrated into the working programs of disciplines within the general interdisciplinary direction of robotics.

Due to the fact that the project is innovative, many tasks of the educational process are solved in the cooperation of the teacher and students:

- improvement of models of robots
- rationalization of robot design
- the introduction of new and more modern platforms as they arise

development and improvement of educational program code and algorithms creating practical assignments



In the process of implementing the project, it turned out that a number of tasks of the educational process do not fit into the working programs of the academic disciplines. Such tasks were included in the work program of student circles.

Thus, the significant role of independent work of students in the development and improvement of the course of robotics has turned it into an independent student start-up. The students became authors of many elements of the course, model simulators, elements of practical training.

In 2016 the Belarus School of Education started a pilot project at the Minsk School No. 111, specializing in inclusive education, with a proposal to implement a course of robotics for pupils of 1-4 forms.

In primary school, engineers, technologists and other specialists are not trained; accordingly, robotics in an elementary school is a conditional discipline that can be based on the use of elements of technology or robotics, but which is basically based on activities that develop general educational skills.

In group classes, students develop the ability to ask questions and answer them, to comprehend various phenomena in the surrounding life, to conduct experiments on their own and to analyze the results of research. Students study the proposed material and evaluate their own ideas that arise during the design process. It is important that the learner's vocabulary is supplemented by various technical

terms that he uses to describe the parts and processes used.

In the process of studying, students learn basic methods and techniques of programming, rules for compiling algorithms, and methods for solving problems using a computer. It is very important to organize classes primarily on active teaching methods.

Students who want to engage in robotics can have different levels of development, personal culture, different health, a combination of personal qualities and character traits, as well as a different level of preparedness for learning to work on a computer. This should be taken into account in the course of conducting classes and, above all, creating conditions favorable for the successful activity of each student.

For the development of training modules, a group of students who already had experience working with robots on the. Based on the experience of teaching the course, the modules were divided into 2 groups:

1. Theory and practice of designing electronic devices (Arduino, Intel).

As a basis for practical exercises, a set of electronic components MPobot (various educational electronic components for creating circuits: resistors, photo-resistors, light-emitting diodes, thermistors, buttons, potentiometer, piezo-dynamics, wires, solderless prototyping board, etc.) are used as practical training. Workshops are developed for two platforms: Arduino Uno and Intel Edisson. Workshops for junior students include a series of experiments on electrical engineering, the creation and management of simple electronic devices, sensors, servos, relays, etc.

2. Theory and practice of programming microcontrollers (Arduino, Intel).

Conducting practical lessons on programming in junior school is quite a difficult task due to the lack of similar subjects in the school curriculum. At the initial level, these are implemented in the Scratch environment to develop basic competencies in compiling computer algorithms. As you gain the necessary skills, practical tasks are performed in the Scratch for Arduino (S4A) environment and the ArduBlock visual programming environment.

Conclusions

The thematic structuring of the course, the division of its modules into two groups, the predominance of practice-oriented classes made it possible to achieve results when working in inclusive groups of children:

- provide informatization of primary education;
- to form the information environment of an elementary school with intersubject connections for the formation of a holistic perception of learning for children;
- develop modeling thinking in children;
- on the basis of methods of group work, to teach children on the basis of cooperation, exchange of experience in groups.

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