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PROCEEDINGS

DEVELOPING TECHNICAL SKILLS OF PUPILS IN PRIMARY AND SECONDARY SCHOOLS

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Abstract

The paper is aimed at the development of technical skills of pupils in primary and secondary schools. Technical courses are usually not popular among pupils. Therefore, within the scope of the "Windows of Science Wide Open" project, we prepared a number of activities, which should encourage pupils' interest in the technical courses and help develop their technical skills. During the academic year we held several workshops for primary and secondary school pupils. The workshops contained activities such as the programming of robotic kits, the use of electric microscope in education, the use of measuring systems and a computer for the measuring of quantities around us, or the use of modern technology when creating an audiovisual project. Approximately 150 primary and secondary school pupils participated in the workshops.

Keywords

Robotic kit, EdLab measuring system, electric microscope, audiovisual technology, ICT.

1 Introduction

In the majority of cases, primary and secondary school pupils do not find instruction of technical courses attractive. Pupils and students lack the motivation and dedication to learn algorithmization, programming, physics and chemistry. (Nagyová, 2014) Only avid and enthusiastic pupils find these courses attractive. As a result, the technically-oriented secondary schools and universities have fewer applicants than the humanities-oriented schools. The aim of the "Windows of Science Wide Open" project is to make the technical courses more attractive to pupils and spark their interest in further study of those.

The "Windows of Science Wide Open" project is financed from the "Education for Competitiveness" Operational Program. The University of Ostrava is both the applicant and recipient of the project. The Faculty of Science and the Pedagogical Faculty of the University of Ostrava participate in the project.

Within the scope of one of the key activities, the "Windows of Science Wide Open" project aims to introduce primary and secondary school pupils to the technical courses, spark their interest in them and thus deny the established notion that they are difficult to learn. In so doing, the project uses ICT and technical devices in the teaching of courses such as informatics, physics, chemistry or biology. Within the scope of the project, pupils visited a specialized laboratory at the Pedagogical Faculty of the University of Ostrava where they participated in a number of activities aimed at the use of ICT for the programming of robotic kits, the measuring of physical and chemical quantities, the examination of microscopic preparations or the creation of an audiovisual project.

2 Technical Resources

The LEGO Mindstorms robotic kits and the EdLab measuring system are the key elements of the activities for pupils.

Nowadays, the robotic kits (LEGO Mindstorms) are used more frequently in schools. A number of researches were conducted, which focused on the use of robots as an educational support. The study comes to a conclusion that robots help pupils develop their logical and creative thinking, the ability to solve problems and to learn programming, mathematics and science. (Scaradozzi et al., 2015) For instance, a study documenting that a robotic kit competition helps increase pupils' interest in ICT in their university studies was conducted at the Department of Computer Science at Qatar University. (Qidway et al., 2013)

Primary and secondary schools can use virtual laboratories to conduct various physical and chemical experiments. (Bílek et al., 2010) Some of the currently used measuring systems – EdLab, Vernier, Pasco – can be used for illustrative and real experiments. (Oujezdský et al., 2015) These measuring systems have measuring sensors, a measuring interface and a computer which is used for visualization, archiving and analysis of data. As a result, the computer-supported experiments are becoming more attractive for pupils. (Koníček, 2014)

3 Activities for Pupils

The courses "A Day with a Robot" and "Measurement around Us", which were realized during the course of the project, were attended by primary and secondary school pupils. From October 2014 to February 2015, 5 courses were held for the 5th, 6th and 7th grade primary school pupils and 2 courses for the secondary school pupils (the pupils from Secondary Grammar School of Prof. Otto Wichterle). During the courses, the following activities were prepared for pupils:

- Robotic kits Lego Mindstorms EV3,
- EdLab measuring system for the measuring of various quantities around us,
- Electric microscopes with preparations,
- Audiovisual technology for the creation of an audiovisual project.

3.1 Robotic Kits

Different activities for working with the LEGO Mindstorms EV3 robotic kit were prepared for both groups of pupils (i.e. from primary and secondary schools). The LEGO robotic kits enable the construction of various types of robots. The robot is controlled via a programmable cube, which operates the robot's drive motors (wheels, tracks, robotic hand) and subtracts and processes the values measured by the robot's sensors such as distance, luminosity, direction, etc.

Within the scope of "A Day with a Robot" the primary school pupils spent three hours with the robot. They were divided into groups of four to five pupils; each group worked with one robotic kit. Following the introduction and concise guidance, the pupils constructed the first robot according to the instructional manual in which the basic programs for the robotic cube are listed. After the pupils constructed one part of the robot, they tested the possibilities of a given program and then, according to further instructions, modified and expanded the basic program. The pupils were not limited in their work and some of them found the work

interesting. Those created complicated program constructions, built mazes and tried to guide the robot through them. Other pupils were interested in the construction process. Those added new parts (wings, scraper shovels, etc.) to the basic version of the robot.

After a short break, the pupils had the opportunity to create simple programs on a computer. Creating programs on a computer broadens the possibilities as the robot's actions are more precise and smoother. The pupils in groups could record a shout which the robot would produce while moving. They could also draw a logo which would be displayed on the robotic cube.

"A Day with a Robot" proved to be extremely demanding for the pupils. The instruction was divided into 90-minute blocks (which was unusual for the pupils as they were used to the 45-minute classes). However, it needs to be said that they succeeded and were often so drawn into the activities that they would not mind working even longer. On the other hand, in each group there were 3-5 pupils who did not find the work interesting.

The secondary school pupils participated in "A Day with a Robot" within the scope of their informatics class. As they had already been introduced to the basics of programming, the concept of working with the robots needed to be modified. Working in pairs on a computer, the pupils did not construct the robot, but only programmed it. They created the programs according to the assignments with each group solving tasks according to their interest. Some pupils worked with the light sensor and tried to control the robot via the colors on the mat. Others focused on the ultrasound sensor and tried to park the robot to its designated lot. The girls were interested in the possibility to write songs using notes and to adapt the robot's movement to the played melody. Each group created quality programs; the pupils drew on their prior knowledge of basic program structures (branching, repetition). At the end, the individual groups presented the work they had created.

Experience has shown that besides the educational value, "A Day with a Robot" also had informational and promotional values. Many pupils said that they would like to have a similar kit at home. While the LEGO robotic kits have existed for quite a while, their incorporation into the Czech education system is very slow.

Fig. 1: Construction of the robot

3.2 EdLab Measuring System

The EdLab measuring system is a special device that is used as an educational support in the natural history and technical courses in primary and secondary schools. It is used mainly in physics and chemistry classes where it helps conduct a number of experiments. The system consists of a measuring interface, which is connected to a computer through USB. Sensors for

the measuring of electric and non-electric quantities are connected to the interface. 6 analog and 2 digital sensors can be connected to the EdLab system.

Within the scope of the "Measurement around Us" day, a number of tasks with the EdLab system were prepared for the pupils. The pupils could measure quantities such as air temperature, humidity, static pressure, lighting in the room, noise in the room, but also the concentration of oxygen and carbon dioxide in the air. The EdLab measuring interface and several sensors were used for each task. The measured quantities were displayed on mobile computers.

The secondary school pupils were more inventive and creative. Not only were they interested in a particular task, but also in how the individual sensors worked. They tried to realize their own ideas such as the measuring of the telephone temperature by the infrared thermometer, depending on the CPU load. Another idea was to use the spirometer for the measuring of the volume of inhaled air of a smoker and nonsmoker.

Fig. 2: Measuring of noise by the sound level meter and the EdLab measuring interface

2.3 Electric Microscopes

For examining biological preparations the primary school pupils used electric microscopes equipped with a video camera that were connected to a computer. The pupils examined approximately 50 different biological preparations. The main advantage was that the preparations were displayed on a computer monitor so more pupils could see it. The pupils mastered the operation of both the microscopes and the software application for the displaying of the preparations. As a result, the microscopes and the biological preparations enabled them to visit the micro world. In one case, a biology teacher who accompanied the pupils was glad to join them in the process because their school did not have as many preparations.

Fig. 3: Examining a preparation by an electric microscope

3.4 Audiovisual Technology

The secondary school pupils expressed interest in modern audiovisual technology and wanted to create an audiovisual project. Using an HD video camera, a studio microphone and a green screen they made a video clip to a song which one of them sang. The entire project was realized according to a short script which was prepared by the pupils themselves. First they shot a dance performance (choreography by the pupils themselves) and then recorded the singing part using a prepared audio device. Using the chromatic key, they added the singer to the dance scene. The professional editing software application Adobe Premiere CS6 was used for the creation of the project. The pupils were creative and modern audiovisual technology enabled them to realize their ideas.

Conclusion

Within the scope of the "Windows of Science Wide Open" project the courses "A Day with a Robot" and "Measurement around Us" for the primary and secondary school pupils were realized. The aim of the courses was to motivate the pupils to use ICT in class and thus make the natural history and technical courses such as algorithmization, programming, physics or chemistry more attractive to them.

During the courses, more than 150 primary and secondary school pupils visited a specialized laboratory at the Pedagogical faculty of the University of Ostrava where they were engaged in a number of activities such as the programming of the LEGO Mindstorms EV3 robotic kits, the use of the EdLab measuring system for measuring quantities around us, the use of electric microscopes with a computer for examining biological preparations or the use of modern audiovisual technology for creating an audiovisual project.

The pupils were interested in working with ICT. Moreover, they enjoyed the programming of the robotic kit and even organized robot races. The secondary school pupils – who were more creative than the primary school pupils – invented their own measuring tasks and even created their own audiovisual project.

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