

Project of integration educational robotics into the training programme of future ICT teachers

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Abstract. The paper discusses the project of implementation educational robotics into the training of future ICT teachers at the Department of Information Technology and Education, Faculty of Education, Charles University in Prague. It also describes concept of teaching courses that are being developed in the framework of the respective project and consists from characteristic of the project during which students will be acquainted in detail with the possibilities of using educational robotics and constructivist approaches in their future educational practice at lower and higher secondary schools.

Keywords: educational robotics, robotics, education, constructivism, project

1 Introduction

The decline of the interest of pupils and students of schools in the Czech Republic in area of technical and natural sciences clearly evident from the carried out results of many recent surveys raises the need to adopt appropriate measures in order to increase again the attractiveness of these disciplines. An appropriate application of previously little-utilized pedagogical approaches in the form of additions or alternatives to the traditional concept of education, as well as the implementation of modern technologies, may be one of the ways how to attract the future graduates of secondary schools to study engineering, technology and natural sciences at the higher levels of education and training.

We can see a high potential particularly in technical tools which will develop thinking, imagination and creativity of pupils, without any links to just a single narrow thematic area in the tools with a considerable interdisciplinary overlap. Simultaneously, we feel the need to link the implementation of selected activities through a specific technological tool with an adequate educational concept.

In connection with the possibilities of the exploitation of the new tools in teaching at secondary schools, our interest focuses on the educational robotics and leads up into the sphere of constructivism, respectively constructionism.

2 Theoretical background of the project

The Jean Piaget's constructivist approach to learning differs from the traditional teaching concepts mainly in the way of a different understanding of the relationship between teacher and student activities and shifts the responsibility for acquiring knowledge closer to the person of a pupil or a student. So far, a predominantly unidirectionally oriented relationship between teacher and student will turn, with the application of constructivist conception, into a balanced partnership. The role of the educational process and also the rate of activities that they show does change. It is primarily the initiative of students that grows. Students themselves work their way to knowledge while the teachers are their guides, mentors and organizers of activities. Such a shift of paradigm and of the role of stakeholders is typical for a teaching, based on the constructivist theory. According to this theory, each student actively constructs their knowledge based on information and experience, which they gradually acquire during their life. This view further develops the theory of constructionism of Seymour Papert, who is identifying series of following practical activities, leading to a real product attractive for the pupils or students, as the most efficient way how to construct their knowledge.

For the educational exploitation of technologies, the theories of constructivism and constructionism are particularly beneficial. It is exactly this sphere, where the students very often focus on the practical implementation of various activities, resulting in a specific product, and where they shape their own knowledge. The condition for a successful running of the conceived constructivist teaching is a good organizational background of the teacher, based on the knowledge of all aspects of the concept. In preparing future teachers for implementing educational robotics in engineering and science subjects it is therefore understandable that we have decided to develop approaches particularly relevant to the concept of constructivism.

Robotics and constructivism are the fields of science which interest many experts from various specialized institutes at home and abroad. However, the project is not directed into these separate, specific areas. It observes a realm still relatively neglected – the educational robotics in the context of the constructivist approach – that is an area of robotics applied in education which linked to the constructivist theory [1].

3 Objectives of the project

The main objective of the project is to analyze the theoretical background, the relevant specifics of didactic and educational aspects of the exploitation of robotics as a means of promoting constructivist teaching methods in education at the Czech lower and higher secondary schools (it means schools for pupils from 12 to 16 years old and students from 16 to 19 years old), and to validate implementations of the educational robotics in the school practice.

Another project goal is the elaboration of the conceptual and methodological outputs of the project and of materials for upgrading the programme for preparation of students of pedagogy.

The project team seeks the way how to competently assess and appropriately substantiate, whether the educational robotics is an appropriate tool for promoting the education, and namely under which conditions and with which a methodical approach. The results should indicate whether the practical use of educational robotics in schools leads to an increase in the quality of educational contents and of the process, and whether it has an effect on the objectives of education. With regard to the acquired findings project team works on the modification of the curriculum of the future ICT teachers' training programme in a way that the students will have a chance to get adequately acquainted with the possibilities and educational aspects of robotics, in order to use it competently in teaching. At the same time researchers are developing a comprehensive set of methodological materials for the support of educational robotics applied in the school practice [2].



Fig. 1. Educational robotics courses for the future ICT teachers at Charles University in Prague.

4 Current progress of the project

With regard to the need of a comprehensive approach to address the issue, both theoretical and empirical methods are used to meet the objectives and tasks of the project. The theoretical methods are employed in the preparation of research in the first phase of the project. The analysis of the primary and secondary sources is used to anchor the subsequent empirical research in the pedagogical theory and enabling to draw up and to apply the project. Focus of the work is based on the empirical qualitative methods. It is primarily the action-oriented research, verifying the examined teaching strategies, based on the analysis of the experimental learning model and other micro-studies, associated with the observations and interviews with the research participants. In case that the project team will have appropriate quantity of the research material (in this moment we are still collecting feedback from pupils and students) these methods will be supplemented by proper quantitative approaches

– by exploratory investigations and by an analysis of the recorded text and voice pieces of communication with the project participants.

The theoretical investigations contain studies and analysis of the national and foreign professional texts related to the issues of educational robotics and constructivism. Particular interest is focused on the studies and analysis of materials of the related ratings, hence aimed at tracking the target problems in the secondary and tertiary education systems.

The empirical part of the project consists of the experimental learning courses of educational robotics based on the methodology of TERECoP project [3] at secondary schools and of the educational robotics courses for the future ICT teachers at Charles University in Prague, Faculty of Education, Department of Information Technology and Education.

Content of the first project year (March 2011 – March 2012) is: pilot educational robotics courses for the future ICT teachers at the faculty, the methodological and technical preparation of the experimental learning model at cooperating secondary schools and pupils' and students' work with robotics kits at cooperating schools under the methodical guidance of experienced instructors. After this stage multi-level analysis of all activities is planned.

For the experimental learning courses of educational robotics at secondary schools there was prepared the schedule described below (with assuming weekly from one to two 45 minutes informatics lessons per class in one from two last grades of the lower secondary school and one from two first grades of higher secondary school, it means 15 – 16 years old pupils and 16 – 17 years old students that are ICT experienced users but novices in programming).

- 1st month – an introduction to educational robotics, familiarization with robotics kits LEGO Mindstorms NXT Education, introductory motivational and demonstrational assignments
- 2nd month – creation of students' own robotics models with the use of the freeware graphical tool LEGO Digital Designer
- 3rd to 4th month – work with robotic kits, basics of algorithm development and programming with the software LEGO MINDSTORMS NXT Education Software
- 5th to 6th month – advanced activities with robotics kits with an interdisciplinary overlap into other engineering and natural science subjects
- 7th to 12th month – processing, analysis and evaluation of data obtained in the course of model practical teaching; to be carried outside of the schools

Taking into account the specifics of educational robotics and constructivist concepts, the attention of the project participants is focused on their own teaching activities and on all created materials (e.g. pre-conceptual questionnaires, background materials, training of students, outgoing materials, reflective questionnaires, standardized questionnaires of creativity, etc.).

In the second year of the project (from April 2012), the findings acquired during the first phase will be exploited as starting material for the application of educational robotics in the newly modified courses for the future teachers of ICT and science subjects.

The courses participants will meet in several multi-hour teaching blocks. Beyond these teaching blocks, students will be able to benefit from regular consultations conducted by the project participants. A part of the meetings will be devoted mainly to the theoretical problems (constructivism, constructionism and robotics); further meetings will be focused mainly on the practical activities. The aim of the courses will be the preparation of the future teachers to use the acquired pieces of knowledge and skills from the area of robotics in the constructivistically conceived teaching in their future educational practice.



Fig. 2. Experimental learning courses of educational robotics at lower secondary school.

Courses for future teachers will take place in the computer laboratory at Charles University in Prague, Faculty of Education, Department of Information Technology and Education. Students will have for their disposal personal computers with installed programs needed for their work (design SW LEGO Digital Designer and programming SW LEGO MINDSTORMS Education NXT Software 2.1) and kits LEGO MINDSTORMS Education NXT. In order to develop a team work course participants will work in pairs. Students will gain the access to the necessary supporting materials via LMS Moodle [4], or via free internet resources (such as the SW LEGO Digital Designer, sample programs etc.).

In the last third of the course for future teachers, students will work on their own individual projects from the area of the educational robotics, constructivism and constructionism. Their results will be presented at the end of the course, when also the evaluation will be carried out. The resulting outputs of students, in addition to other available sources (e.g. interviews with individual students, continuously processed sub-tasks, etc.), will represent one of the bases for the course evaluation.

During the course, the members of the team project consider to carry out a video recording of all important parts, to be later used as a means of a further methodological support. What could be also useful, are, e.g., records of working processes in the course of the construction of robots, records of robot behaviour, reports from various parts of the project preparation, instructional photos, videos, etc.

During the second stage of the project, methodological materials for the support of educational robotics will be systematically elaborated from the collected data and a proposal of adjustments to the programme of preparation of students of pedagogy will be drafted.

5 Conclusion

The authors of the project expect that the execution of the project will lead to the verification of the implementation feasibility and to the verification of the didactical potential of the educational robotics as a mean of the support of the constructivistically conceived teaching. This can be useful to the students of pedagogy in their future teaching practice. After a thorough familiarization with the didactical specifics and functional possibilities of the educational robotics, the methodological endowment of students will be enhanced and the range of teaching tools applicable in the pedagogical practice will be extended.

The proposed project is thematically related to the international project Comenius 2.1 TERECoP [5], previously solved at our Department, however being oriented only to general aspects of the educational robotics, without a direct link to the specific conditions of the transformation of our educational system, curriculum specifics of educational framework programs and conditions of actual learning at schools.

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