E-learning Support for the Course of Robotics

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Abstract: *The main theme of this article is an e-learning course built for teachers and future teachers to support a school robotics project. The course is based on LEGO MINDSTORMS NXT robots and supports the face to face 2-day teacher training course. Its second purpose is to prepare undergraduate students to be able to choose robotics as the topic of their bachelor thesis. The course is built in BlackBoard environment, and many different e-learning tools are used during the course. To serve different target groups it has modular build-up. Briefcase labs complement the otherwise 100% e-learning course. An additional remotely controlled robot with web interface will soon be available for learners.*

Key words: *Robotics, E-learning Course.*

INTRODUCTION

The problems encountered by the University of Tartu are common to many European countries and Universities. The number of students is diminishing thanks to the low birth rate and the demographic nadir is now reaching universities. The number of students drops in all universities. Especially difficult is the situation in technical universities and faculties of informatics and mathematics, as the popularity of mathematics, technology and natural sciences is low among school graduates. The unpopularity comes from schools, so the only possibility to raise the popularity has to be done in secondary schools, and really even earlier - at elementary and lower secondary level.

Active learning methods, where students can see the results of their activity, have been seen as a magic wand for many educational problems. One tool, which can be used as an active learning tool for many subjects, is LEGO MINDSTORMS robots [8]. They have been widely used in higher education: to teach introductory programming [2], embedded systems [1, 5], advanced software development [3]. Those tools are powerful enough to use even for tasks which recently needed a lot of memory and processing power, such as real time face recognition [4].

Robots were introduced into schools in Estonia from 2007, when the Estonian School Robotics program [6] started. Based on the new LEGO MINDSTORMS NXT robotics set [8] and using the support of different foundations, authors have now trained about 100 basic school teachers to be able to run lessons with robots. They Robots can be used to support lessons of different subjects like science, informatics and technology. About 60 schools have already obtained sets of LEGO robots; many schools have started extracurricular activities. Robots are very popular among teenage students.

Project development problems have moved from the first round teacher training and obtaining robotic sets to phase two - new round of problems. The main phase two problems are: not only working teachers have to be retrained to use robots, but also future teachers have to be trained during their studies in colleges and universities to be able to use robots as active learning tools to support lessons of different subjects and to run hobby groups; otherwise in-service training will be an endless task. To start phase two authors prepared an e-learning course, which can serve both as a course for students, future teachers and as an in-service course for working teachers.

CREATION OF COURSE MATERIALS

The majority of learning materials for this course were created in an untraditional way. As school robotics project development team members were very busy with writing funding proposals, preparing and running teacher training courses, developing the robot-theatre and visiting schools with the latter to propagate robotics, organizing national Robo-Miku contest for basic school students (13-16 years old), etc., there was no human

resource left for building an e-learning course. We all know that compared to a face-to-face course, slides cannot be the main material for real e-learning course. This type of course needs real multimedia materials [6].

To create full text materials, video clips and other multimedia materials, we chose a different solution. We suggested about 10 different robotics themes as topics for bachelor theses for 3rd year informatics students, and prepared a comparatively rigid structural form for their thesis format. In the study year 2008/2009 seven different bachelor works on robotics were defended and nine followed in the study year 2009/2010. From the material created by students under the supervision of the authors of this article, the e-learning course was created.

E-LEARNING COURSE

The course is built up to serve interests of the two very different target groups: undergraduate students and in-service teachers. Those two groups have different aims and interests. Teachers need robots to add interesting and motivating lessons to their subject (science, informatics, technology, etc.). Those teachers may not be advanced computer users and need continuous support during their studies. They expect quick responses and adequate help when problems arise. They need comprehensive background materials and ready-made work sheets for their pupils to be used during their own lessons.

Undergraduate students are future computer professionals, they are independent learners, they have programming experience and are professional level computer users. Why would such students want to learn about robots in a form of an optional subject? Some students are looking for an interesting subject to collect credit points and many plan to choose their bachelor thesis themes in the field of robotics. Graduate students, future teachers want to add robots to their pedagogical arsenal, and this course prepares them to be able to work with LEGO MINDSTORM NXT robots, their programming languages and sensors.

MODULAR BUILD-UP OF THE COURSE

As the course covers many different subjects, the course is built up in a modular way. The first basic module is compulsory to everybody who have not had any experience with robots. The basic module explains the development of school robotics program in Estonia and gives basic knowledge about LEGO MINDSTORMS NXT robots. This module is theoretical; it contains many different multimedia units, but has no exercise part. After the basic module everybody can choose modules according to their interests and goals in the course. To pass the course with 3 ECP (European Credit Points) one needs to pass at least three modules.

The course is a 100% e-learning course with no face to face gatherings. The course is built in the BlackBoard learning environment (Fig.1). We use almost all features available in this environment: multimedia materials, tests, discussion groups, etc.

As teachers and students will never meet each other during this course, we use many tools for communication and additional structures to support learning:

- Forums - to solve learning problems, discussing interesting matters, exchanging experience. Peers are welcome to answer questions of other students. Based on questions in the forum, we dynamically form the FAQ (Frequently asked questions) part of the course.
- Chat room - here teachers and students meet online by a scheduled timetable during the course. Students can receive fast feedback to their problems.
- List of terms - as robotics brings along many new terms, we compiled a list of all used terms with explanations for this course.

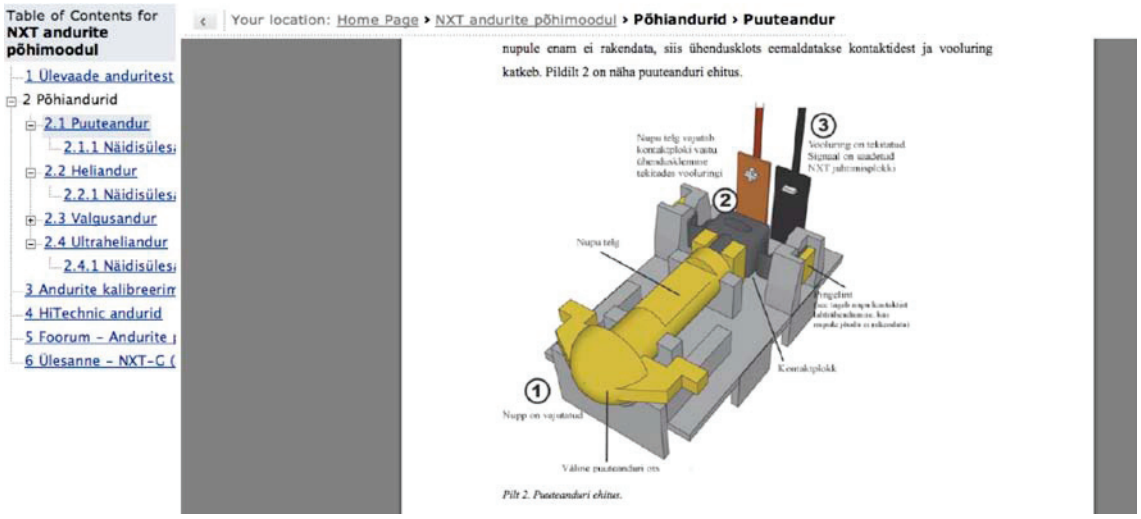

Fig.1. Example of the learning material in one module in the BlackBoard environment

OVERVIEW OF THE COURSE MODULES

Basic module is the largest and is compulsory for all newbies in the field of robotics. People who are familiar with robots (for example - have taken our two day introductory course for teachers) do not need to take it. This module coves 5 topics.

1. Introduction to LEGO MINDSTORMS NXT set, its history and its usage in Estonia. This part contains also explanations, how robots can be used in lessons of different subjects, the examples with videos of different simple tasks what programmed robots can do, etc.
2. How to build your first robot and how to compile your first program for the robot in NXT-G graphical programming environment.
3. Simple tasks with robots. In this part a first collection of tasks is presented that teachers can do with their pupils. The hungry robot, noise box, and the dancer are examples of methodical materials collected into this part. Teachers can find more than 10 different tasks for pupils.
4. Widening your understanding of robots in the world. List of useful literature and useful additional tools like LEGO Digital Designer (LDD), etc., are introduced in this part.
5. Selected video materials about robots. Many useful videos, which teachers can use in their lessons are collected and explained here.

To complete the module one has to take a test which covers all topics.

Having passed the basic module, the learner has to choose two electable modules according to one's needs and interests. The number of optional modules is growing, but just now authors have prepared next four modules.

- Sensor's base module - materials and exercises on LEGO basic set four sensors.
- NXT programming base module - programming NXT with different real programming languages like Java and Python.
- Mobile devices module - how to manipulate your robot using mobile phones.
- Robot Design module - using LDD to design a new robot.

Laboratory work with robots

The basic module does not contain actual work with robots. This module was meant to support our two day face to face teacher training course, where newbies build and program their first robot in small groups. However, all other modules demand a certain

amount of practical work with real NXT robots. Authors are not able to give real robot set to every student for a long period, because the sets are used by the robot theatre travelling to different schools. We are also not able to set up a robotics lab with permanent supervision for students to come and work with robots. As a solution in this situation we have set up briefcase labs.

Briefcase lab

The idea of briefcase labs was coined by professor V.Kukk, who teaches in the Tallinn University of Technology. He used this very simple idea for his electrical measurements course. The faculty has a set of briefcases for different laboratory works. In his setting every briefcase contains all needed equipment to set up an experiment. The results with calculations have to be uploaded in the website for the teacher to mark.

In our case, every briefcase will contain a robot and necessary sensors for a particular task. The results (in the form of a program and/or video) have to be uploaded to the course website. It gives some freedom to students: they can choose suitable days (for example, weekend) and are not constrained by lesson limits, which usually are too short for real practical work with robots. Of course, schedule with pre registration is needed for this kind of labs.

For teachers, lab tasks generate a lot of work. Usually the teacher in the classical lab setting has to check the experiment equipment setup, to test students' knowledge about background info and to mark the results. As robots are not dangerous equipment, we do not need the teacher check up. Results of the work are usually a program with testing data – the latter have to prove the workability of the program. In our case the workability is proven by video, where the robot performs as expected.

Fig.2. Robotics lab briefcase

In addition to the proving function, the same videos can be used by teachers in their school lessons to demonstrate how the robot has to perform during a certain task.

In addition to solving given tasks, every leaner has to create one new task as graduation work of the given course. The new task has to be complete: background information presented, task itself explained, ideas how to solve the task added, program to

solve tasks in a programming language compiled, problems the solver may encounter explained, and possible developments of the task for advanced students added. In this way, we will guarantee a permanent flow of new tasks, which can be uploaded for teachers to use in their school lessons.

NEW DIRECTIONS

An idea of remote-controlled robot is currently being developed. If one has no robot, but wants to program one, we shall provide a web based system for a remote controlled robot. The robot will move in our lab in a secure area. A person can prepare a program to govern this robot at school (or his/her home). Subsequently (s)he will have to reserve a "robot time" with our robot using a web-based reservation system, and upload his/her program to our server. In a given time (s)he will be granted a possibility to load remotely the program from the server to the robot using Bluetooth connection, and to start it. To be able to see what happens, video connection will be set up. During the devoted time the author of the program can make corrections in his/her program and run it repeatedly.

The described system is in a prototype stage just now and we hope to develop and test it during next study year. After that it can be used in combination with briefcase labs during our course.

Fig.3. Prototype remote-control robot with video and control panel for students. Interface shows the possibility to choose a program from uploaded programs (Vali program). Below the choice box are buttons to start and stop the program (the latter is very useful button for beginners, as many newbie's programs tend to work in infinite loop). In the lower part of the screenshot is an interface for uploading a program.

CONCLUSIONS AND FUTURE WORK

E-learning is useful not only for theoretical course cases, but can give serious support to a very practical course like the course of educational robotics. This course can serve as a preparatory course for undergraduate students who are interested to write their bachelor theses about robots in school education. At the same time, this course can serve as a support course for working teachers, who are trained to use robots in their subjects. In this course they can find a growing number of tasks for their students and take new modules about mobile robotics, LDD, etc.

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