Study (workpackage 3): A methodology for designing robotics-enhanced constructivist learning for secondary school students: the bus route

Introduction

In previous work package (wp1) we discussed, in detailed, significant theoretical principles that support educational robotics activities (constructivism, constructivist, project based learning). Important characteristics of these activities were mentioned and a general framework for organizing Robotic activities was introduced. The learning activities are organized in five stages.

Stage	**Description**
Engagement stage	Students may be provided with an open-ended problem and get involved in defining the project and the main issues involved
Exploration stage	Students get familiar with basic concepts and ideas (constructions or programming features) useful to tackle their problem. They make hypothesis and test their validity in real conditions in order to acquire essential experience.
Investigation stage	Students formulate the driving questions / problems, investigate alternative solutions
Creation stage	Students share and combine their artifacts, synthesize 'solutions' to the initial problem
Evaluation stage	Students share ideas & products at class level, evaluate final group proposals, synthesize the final product

In this work package we will describe activities based on this framework.

Activity

Title: The Bus Route

General Description:

The Bus Route is an introductory activity to control technology and robotics. Its structure enables the gradual familiarization of students with Lego Logo material (sensors, motors, lamps) and software. It is also an activity suitable for introducing issues like control, programming, models and robots.

Bus Route can be part of a broader area of study like for example My City, My Neighborhood or Public Transportation. This option is useful in case we have to fit control technology activities in the rest of the curriculum.

During this activity students will define ways that a bus operates in a city, they will construct an appropriate physical model and finally they will program it to perform the appropriate behavior.

Learning Objectives:

Learning objectives of the activity are presented in three categories:

<u>Learning outcomes:</u>

Students will be encouraged to:

Describe the basic characteristics of a robotic device.

Identify important issues related to public transportation.

Describe and explain common design structures (gears, axes and blocks).

Design and construct a robotic device.

Use appropriate programming features to program a robot (loops, if structures etc).

Skills outcomes:

Students will be encouraged to:

Identify practical or real situation problems.

Search for information related to their study.

Experiment with software and constructions to test hypothesis

Formulate arguments based on evidence.

Evaluate designs and proposed solutions.

Analyse and synthesize arguments and articrafts.

Attitude outcomes:

Students will be encouraged to:

Work collaboratively in carrying out tasks and attain a common goal.

Appreciate the use of science and technology in every day life.

Duration: The duration could be from 10 to 13 hours according to the background and experience of the students.

Age Group: This activity is suitable for students of the age of 12-15 years old.

Software/Resources: The appropriate software is RoboLab 2.9 or LEGO NXT Education

Preparatory stage: It is necessary that this activity be arranged in a computer laboratory with enough space for constructing the models. Material (blocks, joins, motors, sensors etc.) used in this activity must be organized in an easily accessible place (sorting trays, storage etc.). Space for safely storing constructions has to be provided.

As most of the tasks in this activity are performed by small groups of students, group formation is a critical issue. Groups can be formed by the teacher in advance or by the students according to specific criteria.

Description

Engagement stage I: Introduction to the project

Students will:

Discuss in groups and in class.

Make a questionnaire.

Public Transportation is a popular topic within many school subjects like science, language, technology etc. The teacher may use a video or a survey to introduce this topic. Questions or issues related to Public Transportation to address can be:

1) What kind of citizens' needs does public transportation serve?

2) Environmental problems and Public Transportation
3) What makes Public Transportation a preferable way to move in the city?

Students can make a questionnaire and a survey on their friends and family beliefs about the local bus service within their area. Finally they may describe the 'perfect bus' for their city (or neighborhood)

Engagement stage II: A bus robot

Students will:

Get familiar with the way robots work.

Appreciate the influence of robots in everyday living.

In this stage students will discuss and define what a robot is through different examples of robotic devices. They can describe the way that a robotic bus can operate in a neighborhood. They will discuss how issues that were processed in the previous stage can be incorporated into the constructions. Students will set a list of questions (defining sub-problems) that they need to answer in order to design, build and program a robotic bus.

Exploration stage I: Design and Construct a bus

Students will:

Be able to use simple mechanisms (gears, pulleys)

Construct a bus with a number of desirable features

In this stage students will experiment with simple constructions and describe those that can be used for their bus. Then they will get involved in constructing a small bus with motor, sensors and other LEGO building material (blocks, gears etc.)

Exploration stage II: Exploring basic programming features

Students will:

Study the function of motors, touch sensors and light sensors

Use software to program their model

Students will study sample programs which give different behaviors to their bus (for example moving on a line forward and backward.). They will also learn how to use control features of the programming environment. Finally they will be asked to use these features in specific tasks.

Exploration stage III: Exploring investigation features of the software

Students will:

Use appropriate features of the programming environment to collect and download data

Interpret graphics

Make calculations of speed

Through the data logging features of the programming environment students can collect data and study graphs. As a part of this exploration they can calculate the speed of their bus and they can compare with the models of other groups. They will be stimulated to identify factors that influence the speed of the bus.

Investigation stage: Investigating specific problems

Students will:

Make a hypothesis and test it

Formulate the driving questions/problems

Conduct an investigation on different parameters of the problem

Develop programs

Students reflect on the initial issues raised at the engagement stage and conclude to specific driving questions/problems. Each group of students selects one driving problem to investigate. They investigate this problem and they come up with an answer or alternative answers. Examples of the "driving problems" are:

Design a program that makes the bus turn left/right.

Design a program that parks the bus at a specific area.

Design a program that stops the bus according to different criteria.

Make a bus time table.

Investigate the effectiveness of various designs.

The outcome of each group is presented to the rest of the class or to a common information space. Students can keep diary.

Creation stage: Synthesis

Students will:

Program

Investigate and improve their programs

Each group of students is asked to develop a program that drives the bus through the bus route. In this stage students should combine programs that they have created by themselves or by other groups.

Evaluation stage

All solutions are presented to the rest of the class and evaluated according to the criteria that have been set by the class at the engagement stage.

Evaluation of the activity

A variety of materials can be used for evaluation purposes.

For Individuals

- Each student keeps a portfolio of worksheets and printouts.
- Tests
- Observation during each lesson

For small groups

- Electronic files of programs created.
- Presentations
- Models created

- Group diary (with specific guidelines)

For whole class

- Final product (physical model and behavior)