TEACHING MATHEMATICS WITH ROBOTICS – A STEM PROJECT

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Abstract. In an engineering school, mathematics applications are diverse and the ISEP (School of Engineering, Polytechnic of Porto) laboratories are the ideal setting to show just that. In this article we will present the project *Matemática, por onde andas?* (Mathematics, where are you?). This project is aimed at secondary school students and intends to show that mathematics is transversal to different areas. With the help of technology, mathematics is applied in engineering projects, and in this work we will present an application to robotics.

Key words: Robotics, STEM, technology.

INTRODUCTION

In September 2014, the *Matemática, por, onde andas?* (MPOA) project was born at ISEP. Each session lasts 2 hours and is directed to secondary school students. The MPOA project intends to bring an interdisciplinary approach building a more dynamic and interesting teaching and learning process. Considering the close relationship between mathematics and engineering, the MPOA project aims to show young students that mathematics is essential in technical fields such as engineering. Mathematics intervenes in all areas of engineering, therefore, engineering can be a mean to show the applicability of mathematics and to awaken in students the interest and motivation for its learning. The Accreditation Board for Engineering and Technology (ABET), in its EAC Criteria for 1999-2000, of 1998, highlights the importance and the use of various branches of mathematics in engineering.

The advantages of interdisciplinary studies are widely accepted by teachers and researchers. Some authors refer that interdisciplinary works use knowledge that comes from different curriculum areas that offer different perspectives on a particular problem, making the curriculum more compact and more consistent. Furthermore, interdisciplinary works provide the students with relevant, challenging and enjoyable learning experiences (Clark & Wallace, 2015; Chettiparamb, 2011; Schmidt, 2015; Păvăloiu, Petrescu & Dragomirescu, 2015).

THE *MATEMÁTICA, POR ONDE ANDAS?* PROJECT

MPOA project intends to bring an interdisciplinary approach building a more dynamic and interesting knowledge process. It is intended to show to the students that mathematics is essential and an important tool, in technical fields like engineering. Making use of appealing area, such as robotics, the students witness the applicability of mathematics in engineering projects (Caldeira et al, 2016).

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Project stages

Stage 1: Welcome students. Breaking the ice by a small talk to the students (so that they feel more comfortable) and an introduction to the theme (15 minutes).

Stage 2: Case Study: Mathematics in Robotics (25 minutes). In this stage, mathematical knowledge is crossed with engineering, remembering, and showing the mathematical concepts involved (such as geometry, linear velocity and angular velocity) in order to be able to control a robot (Figure 1).

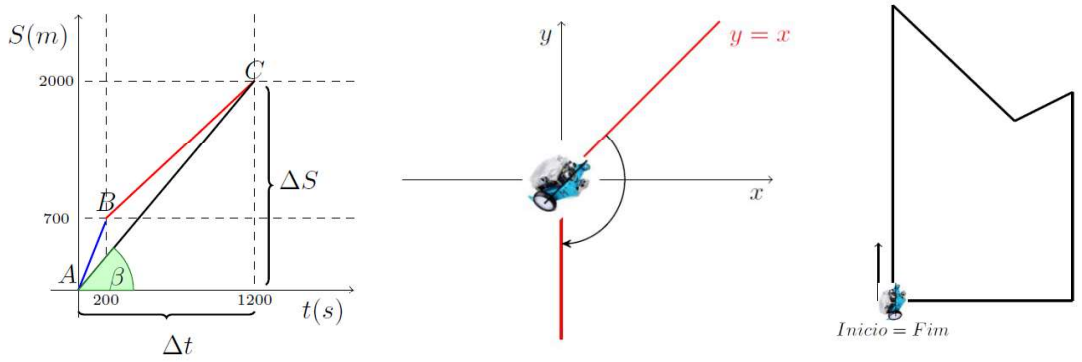

Figure 1: Some mathematical concepts involved to control a robot.

Stage 3: Introduction to block programming (20 minutes). To program a robot like the Mbot (https://www.makeblock.com/steam-kits/mbot), the mBlock graphical programming environment is used.

- Allows you to program robots and games.
- The mBlock interface is very friendly and intuitive.
- The programming language consists of the use of blocks, previously defined, which allows "giving orders" to the robot.

Stage 4: Activities in the robotics laboratory - programming and simulation of paths (60 minutes). Hands-on the robot, trip to the ISEP engineering laboratories. The robot is programmed to run a certain path and tested on the track. The students test their mathematical knowledge in engineering projects – applied knowledge.

Results

In the academic year 2021/2022, 14 teachers and 151 students participated in the MPOA project. A survey was carried out among teachers, to obtain their opinion on the project. The results are very satisfactory and motivating for the continuation of the project. We can see that most of the teachers are very satisfied in all points of the survey. The only exception is related to the impact on student motivation for learning, where 88% of the teachers answered that they were very satisfied, with 12% of the teachers that they were satisfied. The results are shown in Table 1. In addition, teachers were asked to mention the strengths and weaknesses of the project. It stands out as strong points mentioned: active participation of the students, the theme, the pedagogical strategy and the transversality of the contents. Only one weak point was mentioned: the duration of the session being short.

Inquiry questions	Satisfied	Very satisfied
Purpose and nature of the project		100%
Adequation of the MPOA to the school's educational project		100%
Activity structure		100%
Student satisfaction and engagement		100%
Impact on student motivation for learning	12%	88%
Overall appreciation of the project		100%

Table 1: Results from inquiry to teachers

The students reveal interest, motivation and curiosity when they were given the possibility of using mathematics in engineering projects. Through real problem situations, we emphasize the relevance of developing several skills and attitudes essential to achieve results, showing the importance of mathematics in engineering.

CONCLUSIONS

Making use of appealing areas, such as robotics, the students witness the applicability of mathematics in engineering projects. The perception of importance of mathematics in building a successful academic path is crucial for the teaching and learning process. The project "Mathematics, where are you?" Aims to motivate students early in this direction. The results obtained with specific sessions for audiences showed that are well received by students and meet the proposed objective. Through real problem situations we show the importance of Mathematics in Engineering. As future work, we intend to carry out a study to assess students' opinions about MPOA and what impact had on their math learning.

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Introduction

In September 2014, the "*Matemática, por, onde andas?*" (MPOA) project was born at ISEP.
MPOA is directed to secondary school students and consists of a partnership between mathematics and engineering.
This project intends to bring an interdisciplinary approach building a more dynamic and interesting teaching and learning process.
It is intended to show to the students that mathematics is essential and an important tool, in technical fields like engineering.

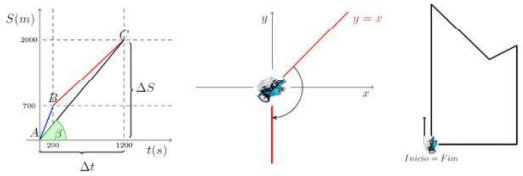


Figure 1: Some mathematical concepts involved in robotics

Objective

Dissemination of activities involving the application of mathematics in engineering.
Bring an interdisciplinary approach building a more dynamic and interesting knowledge process.
Show to the students that mathematics is essential and an important tool, in technical fields like engineering.
Making use of appealing area, such as robotics, the students witness the applicability of mathematics in engineering projects.

Project stages

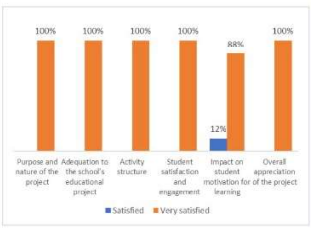
Stage 1: Welcome students. Breaking the ice by a small talk to the students (so that they feel more comfortable) and an introduction to the theme (15 minutes);
Stage 2: Case Study: Mathematics in Robotics (25 minutes);
Stage 3: Introduction to block programming (20 minutes);
Stage 4: Activities in the robotics laboratory – programming and simulation of paths (60 minutes).

Analysis

Engineering can be a mean to show the applicability of mathematics and to awaken in students the interest and motivation for its learning.
MPOA project allows Students have the opportunity to applicate mathematics concepts with robotics and test using a STEM coding robot.
The robot is programmed to run a certain path illustrated in Figure 1 and tested on the track.

Results

A survey was carried out among teachers, in the 2021/2022 school year, to obtain their opinion on the project.



In addition, teachers were asked to mention the strengths and weaknesses of the project. It stands out as strong points mentioned: active participation of the students, the theme, the pedagogical strategy and the transversality of the contents. Only one weak point was mentioned: the duration of the session being short.

Conclusions

The students reveal interest, motivation and curiosity when they were given the possibility of using mathematics in engineering projects.

Through real problem situations, the importance of developing several skills and attitudes essential to achieve results have been shown.

Through real problem situations, was shown the importance of mathematics in engineering.

Related Literature

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