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Fernão de Magalhães:
A STEAM activity to celebrate the 500th anniversary of Circum-Navigation around the globe

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Abstract. This paper presents a case study of a workshop that have used the celebration of 500 years of circum-navigation of the globe, by the portuguese navigator Fernão de Magalhães, as a *motif* to develop some hands-on activities integrating history and STEAM topics, including physics and geography. The participants were 7th grade students from Oeiras public schools. The results showed the interest and envolvement of the students with the activities and some of them demonstrated a strong desire in participating in future activities with robotics and programming.

Keywords. Educational robotics, Sciences education, STEAM, Education technologies.

1. Introdução

The celebration of the 500th anniversary of the first circumnavigation of the terrestrial globe by the Portuguese Fernão de Magalhães, has been celebrated in Portugal through various artistic and cultural events.

With the objective of drawing the attention of students and teachers to this important event in global history, as well as showing different possibilities of using digital resources in teaching and learning situations, the Clube de Ciências do Liceu de Oeiras, in partnership with the startup Inovlabs, developed the STEAM activity reported here.

The activity aimed to demonstrate to the school community other possibilities of using ICT in different subjects of the school curriculum.

Section 2 presents the motivation and relevance of this activity. Section 3 describes the pedagogical strategy adopted, as well as the details of the tasks developed. Section 4 presents the collected data and partial results. Section 5 refers to the conclusions and future work.

2. Motivation and relevance

The stimulation of creativity associated with scientific knowledge often depends on a solid knowledge base in the STEAM areas. Different authors argue that most jobs of the future will require a deep technological knowledge associated with the areas of Science, Mathematics and the principles of engineering and design [1, 3].

Therefore, it is important to arouse the interest of our students in these areas of knowledge as a way to prepare a future based on knowledge and sustainable for any nation.

On the other hand, the scientific literature has shown that students' interest and understanding of new concepts is more effective if we associate the new concepts with the knowledge and interests that are already part of their daily lives [2, 3].

Thus, based on the structuring ideas presented above, the InovLabs team, together with secondary school teachers at Liceu de Oeiras, developed the *Hands-on* activity “Fernão de Magalhães - 500 years of circumnavigation of the globe” for students from third cycle, involving history, programming and other information and communication technologies (ICT) [4].

3. Materials and methods

The work was developed as applied research aiming to produce knowledge that can be effectively applied in the real world and with the objective of contributing to the training and interest of students involved in the STEAM

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areas. The development of the activity followed approximately the cycle shown in Figure 1.

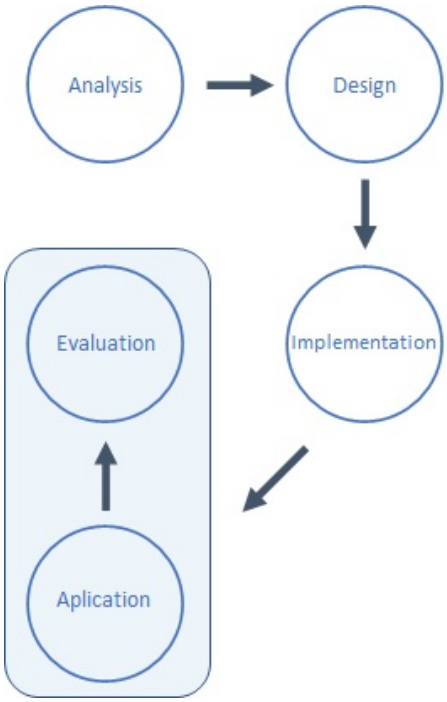

Figure 1: Stages of development of the workshop (area marked in green is the focus of this work)

3.1. Participants and the workshop

The workshop was developed to be applied during two consecutive classes, making a total of about 90 minutes. It was repeated 8 times, for 4 days.

The participating students belong to classes of 7th grade (aged 13 to 14) and, on average, were mixed groups of about 25 students and their accompanying teachers (1 to 2 teachers for each class).

3.2. Materials

For the application of the Workshop, two caravels were printed in 3D coupled to a flexible spring in order to simulate the oscillation of the waves. The objective was to simulate the possible movements of the vessel (on the X, Y and Z axes , known as *Roll* , *Pitch* and *Yaw* , respectively) when sailing on high seas (Figure 2).

In the vessel model, a micro:bit board was installed, used to record the rotation values around the X, Y and Z axes, and to plot the respective graphs to be explored over time.

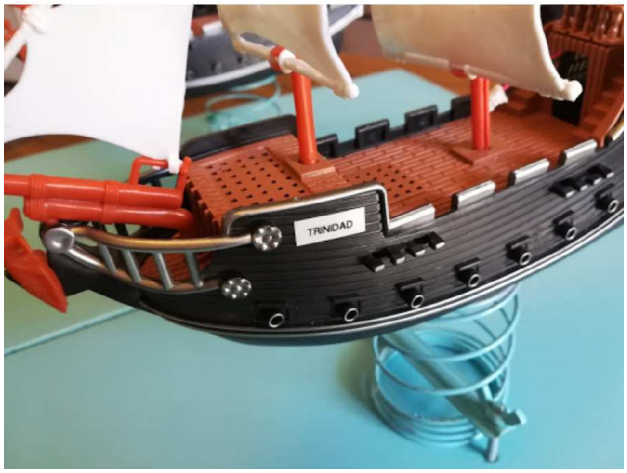

Figure 2: Model of the 3D printed caravel mounted on a spring and wooden plate (simulating the movement of the caravel in the sea).

During the tasks developed (*see* section 3.3.) The following software were used: *Google Earth* , to explore the maritime navigation route and the main places visited by the fleet; programming environmente for blocks of micro:bit (*editor makecode*); *MU Python IDE* (for acquiring the values of acceleration in the rotation axes); and MS Powerpoint®.

Each group of three students had a personal computer with internet access. As the activities were being presented, students were encouraged to explore information on the Internet and/or use the aforementioned applications to develop specific tasks.

3.3. Task performed

The four proposed activities were developed using a narrative as the "guiding thread", where students were led to reflect on the circumnavigation carried out in the year 1509, the technologies existing at the time, the challenges faced and, finally, how the event would be if the fleet of vessels had access to some technological devices existing today.

After a brief introduction of our team and the objectives of the workshop, the following four activities were presented:

- **Google Earth - T**he teaching team provided a

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set of geographic data (in .KML format) with the entire circumnavigation path, also georeferencing the main places visited. For each location and route, students were able to explore and complete information about the locations and were encouraged to investigate and enrich the information with new relevant complementary data.

- **Calculating the cardinal points -** During the second part the teacher inquired the students about the technologies employed at that time in order to guide the vessels. After that the students programmed in the MakeCode environment the intervals of angles corresponding to the main cardinal points (North, South, East and West). The code generated in the online application was subsequently downloaded to the micro:bit of each group of students, in order to be tested.

From the ideas and opinions presented by the students, a discussion started about the four main cardinal points and how we could find them (intervals) using angles and the Cartesian plane.

- **Programming and the micro:bit board -** Next, the micro:bit board was presented to the students and referenced that it had an internal compass. There was also talk about the possibility of the cards being able to communicate via bluetooth. The main programming commands of the board were presented and, in a supervised way, the students were led to create programs that could communication between the micro:bits and to implement the functioning of the compass (Figure 3).

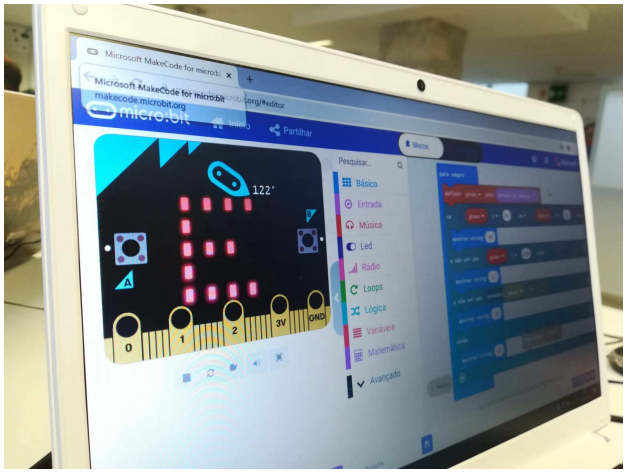

Figure 3. Micro:bit showing one of the cardinal points (East) from a program partially developed by the students.

- Using the micro: bit in the ship model - The last stage of the Workshop tried to couple the 3D model of the caravel, a micro:bit with a working compass program. Once the vessel was supported by a spring – and could move in the three coordinate axes XYZ (Figure 2) - students tried to move the model around these three axes to see the changes in the direction drawn in real time on a computer screen coupled (Figure 4).

The moment was taken to introduce students to some other important navigation movements (*Roll, Pitch and Yaw*), culminating in a final reflection on the possible consequences to the first circum-navigation of the globe, if *Fernão de Magalhães* had programmable boards at his disposal like the micro:bit.

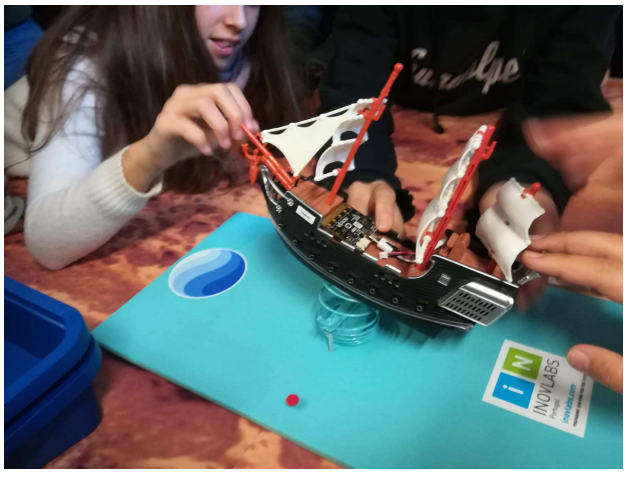

Figure 4. Students interacting with the model of the

fleet's ships, where the port (red) and starboard (green) sides were also marked.

4. Data acquisition, evaluation, and partial results

For the evaluation of the project carried out, some criteria were listed that sought to identify the participation and interest of the students (involvement in the activities, resourcefulness in the programming) and the feasibility of the proposed activity (Table 1).

The ability to work in a team was also developed during the workshop, since students were instructed to organize themselves to cooperate with each other. During the experiment, the teacher provoked the teams with questions such as:

- Which direction was chosen by the *Fernão de Magalhães* fleet?

- What interests (economic, political) existed behind the circumnavigation?

- How was done the orientation of the ships at that time?

- How can we represent the cardinal points in the programming of the micro: bit? - With the technology we have today, what can we say about a project of this scope?

Table 1: Main evaluation items and main questions

Topics taken into consideration	Guiding questions
Captivation	Did the students get involved in the proposed activities and ask questions?
Resourcefulness in programming	Were students able to understand the basic programming structures presented? Were they able to change the codes to achieve their objectives and challenges proposed by the teacher?
Viability	Is it possible to carry out an activity of this nature in a real classroom / laboratory situation?

It is worth mentioning that for the age group of those involved, all the evaluated criteria took into consideration elements related to STEM and the essential learning goals defined by DGE-Portugal [5].

5. Conclusions and future work

Different authors have been recognized that experiential, hands-on activities provide superior engagement for learning new subjects. The main reason seems to be the real-world meaning these activities provide instead of the otherwise abstract knowledge. Particularly educational robotics has been shown to provide an important support for these activities specially in STEAM areas.

The workshop described in this paper allowed us to demonstrate (to organizers and other teachers), the potential of working with students using an active educational approach, with the support of computational platforms and software.

It also showed us that interdisciplinarity is possible, involving content perceived by many as having little relation with the use of information and communication technologies and with disciplines in humanities.

This work, developed at the *Sebastião e Silva secondary school*, has allowed the creation of new partnerships and projects involving other research institutions and the expansion of didactic activities in the School Science laboratory.

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