Robotics and STEM education for 4-8 y.o. children in Spanish Pre and Primary schools

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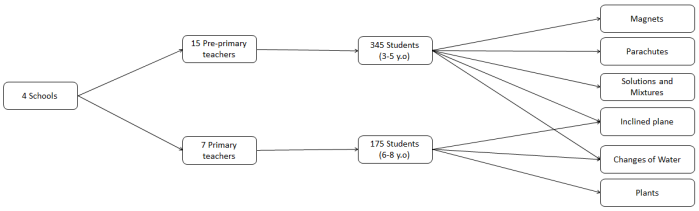
Abstract

botSTEM is an ERASMUS+ project aiming to raise the utilization of inquiry-based collaborative learning and robots-enhanced education. The project outputs are specifically aimed to provide in- and pre-service teachers in Childhood and Primary Education and children aged between 4 and 8, with research-based materials and best practices that use integrated Science, Technology, Engineering, Mathematics (STEM) and robot-based approaches, including code-learning, for enhancing scientific literacy in young children. Initial results from the project from a qualitative analysis of implemented activities during science teaching in preschools in Spain are presented here. Despite the possible obstacles that preschool teachers initially expressed, the preliminary analysis of the implementations indicates that the proposed STEM integrated framework, including inquiry teaching and engineering design methodologies, can be used with kids as young as 4 y.o.

Participants



Magnets in Pre-Primary schools

'Magnets' has been the project that Pre-Primary teachers have chosen the most. The versatility of this topic has been considered as an excellent starting point to take their first steps in the application of an integrated STEM approach at school. The toolkit designed by the project offers a concrete example that teachers have adapted and adjusted for the level of their students. Originally, this activity focuses on encouraging children to design and build a magnetic toy. To that end, students have to generate their own knowledge about magnetism following Scientific Methods and think critically and creatively, as engineers do, to design a prototype. In order to achieve these goals, children have to apply mathematical knowledge, related to series, classifications, counting and programming skills to program a simple robot, which helps them to consolidate the new information.

Research methodology

Case study. Analysis of the content of initial and final interviews with teachers; class activities recorded on video; and written material (planning of activities by teachers and worksheets for children).

Tentative results

Before and after the implementation, teachers were asked to discuss with colleagues, and give answers to the following questions:

1. What knowledge do we want the children to develop? **2. What do we do to help them develop that knowledge?** **3. At the end of the project, what have children learnt?**

These questions are related to variation theory (Marton and Booth, 1997) which explains that learning is always directed at something (phenomenon, object, skill, aspect of reality). This something is called the object of learning and 'learning' entails a qualitative change in the way of experiencing the object of learning – ways of acting originate from ways of experiencing (Marton and Tsui, 2004).

Intended objects of learning. STEM

Teachers planned objectives related to scientific concepts about magnets:

- Characteristics of magnetic objects
- Power of magnets
- Power of magnets through surfaces

Some of them also planned objectives linked to the history of magnets:

- The discovery of magnets (Magnes the shepherd)

But they did **not** propose objectives about:

- Methodologies: inquiry based learning or engineering design process
- Nature of Science

Intended objects of learning. Programming:

Teachers programmed objectives in order to:

- Consolidate the new knowledge acquired during the project.

They did **not** consider the possibility of analysing the robot as a programmable machine in current and future society.

Enacted objects of learning. STEM

In order to achieve the objectives planned, teachers put into practice the following steps and they reduced the level of complexity of the prior objectives:

- Play and experimental areas where children could discover different properties of magnets with the guidance of the teacher
- Definition of hypothesis related to magnetic objects, power and polarity of magnets
- Verification of the hypothesis through simple experiments
- Documentation of data
- Drawing conclusions

In spite of the fact that teachers did not consider as an object of learning the understanding of the methodologies used, they implemented a scientific method during the process (Engineering design methodology was not used, although all ended the project with the development of a magnetic toy). However, it was not addressed in a explicit or reflective way.

Enacted objects of learning. Programming:

Originally, these teachers did not have any knowledge about how to introduce robots in their classrooms. However, when they started the activity they felt more and more confident to introduce new ways to use them with students. During the implementation children not only used robots to consolidate the new knowledge acquired, they also worked on:

- Spatial orientation
- Sequence of movements
- Reducing impulsivity
- Working memory
- Counting
- Mathematical concepts such as multiplication

'There are children who really surprise you in their ability to observe and program. Children, who do not dazzle in other aspects, are amazing in this'

Lived objects of learning. STEM

Before the implementation children had the following prior conceptions about magnets:

What kind of things are attracted by magnets?

- ❖ **'Objects that weigh little are not attracted by magnets'**
- ❖ **'Cold things are attracted by magnets'**

Can magnets attract each other?

- ❖ **'Some little faces can be joined together but others can not stick together'.**
- ❖ **'The S with the S do not come together, they repel each other'.**
- ❖ **'They do not meet because there is air between them'**

Do magnets have different powers?

- ❖ **'Yes, big magnets take more clips and those which are small only take one or two'**

After the project children could redefine their preconceptions about magnets:

What kind of things are attracted by magnets?

- ❖ Not all metal objects are attracted by magnets.

(But they were not able to identify the ones that were attracted)

Can magnets attract each other?

- ❖ Magnets attract and repel each other
- ❖ Magnets can attract each other even if there is a surface between them.

Do magnets have different powers?

- ❖ The power of a magnet is not related to its size.

Lived objects of learning. Programming

Before the implementation not all the students had experience with robots. But most of children find them fun, for them it is only a game and teachers took advantage of it to develop and improve their competences and abilities. Above all, teachers note the improvement observed in their ability to sequence steps and spatial orientation. Occasionally, although children verbalise that robots are controlled by people, when they make a mistake and the robot do not go where they wanted, they point to the robot as being responsible for the error.

- ❖ **'If we make a mistake, nothing happens. You can do it again'**
- ❖ **'Robots have lots of buttons to go to lots of different places'**
- ❖ **'We tell them where they have to go'**

'This robot is crazy, where does it go?'

Conclusions

Science is a very motivating subject for young children and all of them want to keep learning about Science. Additionally, all teachers, without exception, agree that an integrated STEM approach is an exceptional way to teach Science because it encourages children to learn and it boosts their curiosity. However, after these first implementations, they are still reluctant to integrate this approach in their teaching practice. They perceive it like isolated projects, although they note that the students' competences improve significantly. For that reason, taking into account their experience, we have categorized them in three groups taking into account their willingness to implement this approach in their classrooms:

- ❖ Still reluctant due to children limitations
- ❖ Entirely favourable
- ❖ Still reluctant due to teachers limitations

It's worth stressing that although not necessarily consciously, they implemented, in practice, an integrated STEM approach, integrating the S, T and M parts along with robotics. The reason could be their holistic view of education and the fact that they usually work with projects.

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