roBOTics and STEM education for children and primary schools

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Robotics and STEM education for 4-8 y.o children and primary schools

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Abstract

Robotics and STEM education for children and primary schools is an ERASMUS+ project that aims to develop a new methodology for including STEM integrated activities into education curricula for childhood and primary schools. The project outputs are specifically aimed to provide in- and pre-service teachers in Childhood and Primary Education (4-8 y.o.), with research-based materials and best practices. STEM in early childhood education should be preferably holistic, child centered, project and problem based so there is potential in the integration of science, technology, engineering and mathematics in STEM experiences for them. In particular, inquiry teaching methodology and engineering design help intertwine the different fields in STEM through real world problems. Working with inquiry-based STEM activities provides children with opportunities to practice skills such as reasoning, reflection, questioning, modelling, justifying decisions and communicating. In addition we consider that computational thinking (by means of robotics) should be introduced at early childhood (scaffolding devices: robots, Scratch, BBC microbit, etc.) not only because of its prominence in actual technology, but also for its potential to teach logical thinking, problem solving and digital competence. Also, given that girls in general come out as much more negative towards technology and its development, botSTEM pursues to establish gender inclusive teaching and learning activities. Hence, these four aspects form the basis of our theoretical and didactical framework for the teaching activities:

- Integrated STEM.
- Inquiry teaching and engineering design methodologies.
- Scaffolded introduction to computational thinking through devices .
- Inclusive strategies.

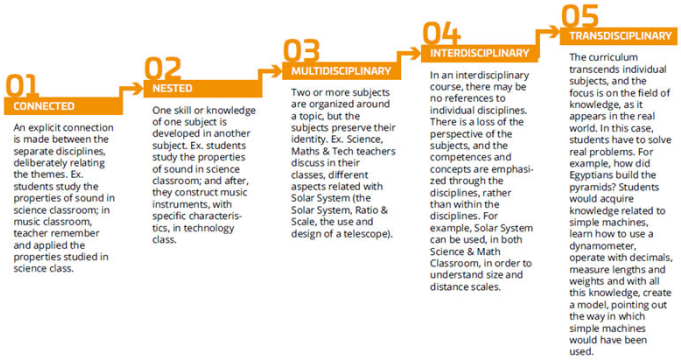
Intellectual Output

The first output of this project is a downloadable *Toolkit,* freely available at botstem.eu, including selected good practices for collaborative inquiry teaching and learning concerning robotics and STEM with methodological guidelines and new teaching activities using the guiding theoretical ideas of the project.

Integrative STEM

An important point in the STEM proposals is that these disciplines should be addressed in an integrated way. But what does that mean? How can integrative STEM be achieved?

The integration can be done in several ways. Gresnigt et al. (2014), after analyzing several integrated STEM projects in primary school, proposed five different kinds, of increasing degrees of integration. The theoretical framework developed in botSTEM makes use of the **transdisciplinary level of integration**.



Two methodologies

Integrated STEM proposals need to apply certain active, dynamic methodologies that fulfil the requirements of integrated approaches like **Inquiry Teaching** and **Engineering Design Process**. With these methodologies scientific objectives are conceived, not in terms of knowledge of a set of facts and theories, but as a progression towards the understanding of key ideas - 'big ideas' – important to the lives of students during and beyond the school.

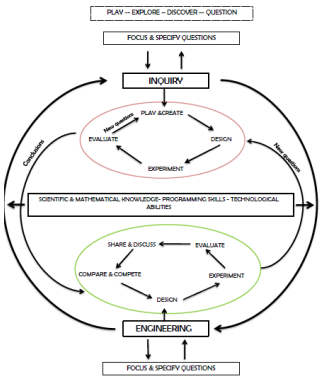


Figure 2 - Phases of inquiry teaching and engineering design for young children. Inspired in Chalufour & Worth (p.74, 2004) diagram.

Programming and Robotics

Robots are considered as transversal tools and are increasingly finding their way into classrooms around the world, not only for developing computational thinking, but also because it gives them extra motivation to focus on their studies. Moreover, educational robotics can also be presented as a tool for inclusiveness and a tool to prevent bullying.

Related to computational thinking, we propose a scaffolding use: beginning with simple robots, followed by the introduction to block-based coding (like Scratch that can be used for presentations, simple modelling, etc.) and ending with physical computing (like BBC Microbit that can be programmed to be used as different measurement devices).

Collaboration

Collaboration is an essential part of an integrative STEM approach to teaching and learning. It is a key part of the educational experiences we aim to cultivate, due to its potential effectiveness for learning and productivity. Integrative STEM approaches require collaboration between children and with teachers. Teachers need to establish a mutual understanding among themselves characterized by inter-subjectivity which includes both the child's perspective and the object of learning.

Inclusive Gender Approach

Several studies have shown that at a young age, girls generally show just as much interest in Science as boys with a sudden drop in this interest by the time they reach high school. In order to offer the same opportunities for boys and girls, it is necessary to change teaching strategies within the classroom and thus reduce this inequality gap. The integrated STEM approach is based on the contextualization of the curriculum in order to address real problems from different perspectives, which generate feelings of self-efficacy and confidence, especially in girls.

New activities

They are being implemented, refined and evaluated in preschools and schools in the partner countries. The overarching aim is to, through the 3-year-botSTEM project along with teachers in schools analyse and revise STEM integrated activities within our didactical framework. These activities are based on the solution of real world problems through Inquiry Teaching, Engineering Design and Robotics. Some of them are mainly focused on scientific problems such as *Magnets* and others are related to programming and robotics, *Domotic Garden*.

Tentative results

After the implementation of STEM activities in Spanish and Swedish schools, the tentative results are positive. Teachers highlight the high impact of these methodologies on children's motivation and learning and point out how children relate the scientific knowledge to their experiences. In addition, the integration of robots in learning processes, instead of being a new isolated subject, has been much appreciated. Robots are described like a motivational tool that help children focus their attention, develop spatial orientation and strengthen their confidence.

In September, new activities are going to be implemented again in Spain and Sweden, as well as in Italy and Cyprus. Additionally, teachers who are already involved in the project are participating in the development of more STEM integrated activities to be implemented in their schools. All the information collected is being analysing in order to improve STEM proposals and to enable teachers to use an integrated STEM approach in their schools.

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