Beyond barriers. Inclusion and innovation through the use of educational robotic environments

by *Daniela Di Donato* and *Paola Mattioli*

For inclusive teaching

In Italy, the definition of inclusive teaching is relatively recent. Studies and research on the classroom as an educational context capable of welcoming every child on a social and affective level (Cottini, 2004; 2017; Ianes, 2001) and the evolution of the legislation, which in 2012 introduced the category of Special Educational Needs, have generated an idea of inclusion focused on the enhancement of individual differences, rather than on the distinction of the difficulties of some.

In short, the processes must concern all children, regardless of their physical, intellectual, social, emotional and linguistic conditions (Morganti & Bocci, 2017).

At the international level, this approach is proven by the proposal of the Universal Design for Learning (Savia, 2016) and the Index for Inclusion (Booth & Ainscow, 2014). The dimension described by the Index's indicators for inclusion exalts the classroom as a group of people, each of whom has the right to develop his or her potential, in a climate that is participatory, encouraging and based on mutual respect.

Inclusion and Educational Robotics

The writer Isaac Asimov said that there is nothing more different from us than a robot and this is what makes human beings feel more similar to each

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other. Perhaps the universal value of the human-robot relationship is also in this extreme difference, it ignites curiosity and provokes reactions.

Educational robotics exploits robots as a tool to bring children and young people closer to new technologies, but also as a means to develop in them both disciplinary and transversal skills.

Robots, in an indirect or direct way, are part of our lives and in the field of educational robotics children and teachers work together in groups to creatively implement the programming of the available robots. They develop processes in which both the child and the robot have a role and interact.

Educational robotics was born in the late 1960s thanks to Seymour Papert, a professor at MIT, one of the first to realize how robotics could positively influence learning.

Pedagogist and computer scientist, he collaborated with Jean Piaget and immediately saw in computer programming the tool to teach from an early age how to reason and solve problems effectively.

With this goal he created LOGO in 1967, the first programming language dedicated to elementary school students, along with Wally Feurseig and Cynthia Solomon.

One of the most famous robots created by Papert and his team is precisely known as the LOGO turtle, a large programmable hemisphere with wheels to move, and markers on the bottom to draw.

Using the LOGO language, also created by Papert, children could make the hemisphere perform various operations, such as drawing geometric shapes. LOGO became popular in schools, but unfortunately was later abandoned.

What Papert had clearly described was the value of process and reflection on process as the main key to stimulating learning, rather than application of rules or repetition (Papert, 1984).

In the didactic experiences linked to educational robotics, children learn by doing and above all by experimenting with what is proposed to them, fully realizing constructivist teaching.

In the programming of the robot, the management of error becomes fundamental; it is no longer a reason for frustration, but the starting point for reflecting on new possible solutions.

If we were to identify the main educational functions of the robot in education, we could mention at least three:

1. the robot as mediator: as an object and subject of experience, the robot is exposed to the interpretation of multiple points of view,

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without ever losing its effectiveness. Through this function, the child learns a way of structuring his or her thinking about the universe (Bateson, 1996);
2. the robot as a meaningful experience: the robot generates multiple teachable moments and it is through this generative spark, that the activity is recognized as meaningful and pupils are shown to be motivated to learn (Bybee, 2016);
3. the robot as a symbolic artifact: every human being tends to bring the technological artifact inside his way of experiencing, making it become a tool to enlarge the area of the body's sensibility towards the world (Benanti, 2016).

This is also why promoting educational environments simultaneously oriented towards autonomy and cooperation overcomes the barriers naturally posed by educational systems and reaches beyond and to all (Resnick, 2020).

The introduction of digital technologies in the space of children at school must be considered an opportunity to develop citizenship, a key competence for the construction of democracy, and citizenship also takes a digital form, which must be experienced and crossed with children (Lorenzoni, 2016).

First experiences with robots

Robotics is something children love. They like building, testing and improving their projects. This is an important practice that will help their creativity to be always trained. We often think of creativity as something linked only to arts, but each sector of our life needs creativity. Robotics also needs creativity to solve the problems one can find coding a robot.

Unfortunately, nowadays only few students still have this opportunity. If students meet a passionate teacher they can hope to test robotics in their curriculum, otherwise they will not have experience about it.

I often meet teachers that are afraid of using robotics at school because they think their students know the topic more than them. When I started using my first robot at school I didn't know anything about it. One student had brought his new robot to school and seeing their interest I used it to explain addition and subtraction on the line of numbers.

After this experience I bought my first robot and built it at school asking students for help. The presence of the robot was so engaging that all the students participated in an active way. From that moment we had the possibility

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to use two robots for our classes and students loved to create situations where the robot could interact.

Using the robot in class gave each student the opportunity to be more confident with the activity because giving instructions to the robot there was the possibility to see if the idea worked or not.

When you code a robot to do something you can see immediately if your idea works or not and this is really helpful for those students that often are afraid to say what they think. If you decide to bring robotics in your lesson, the first robot for students, even before kindergarten age, will surely be Cubetto, a nice robot made of wood created from PrimoToys. This robot has a platform that you use to code the robot self, you can make this using simple pieces that indicate the street to the robot. The material of this robot makes you think of Montessori schools because it remembers a lot of the elements of her method.

Students love this robot because they can try solutions to the challenge the teacher proposes and have instantly the feedback observing the lights on the platform.

The second robot we used at school and that you can use in a robotics curriculum is Blue Bot, a nice robot with the shape of a bee. It has arrows over the body that students use to code it. It is more difficult than Cubetto because when the robot is walking the student doesn't have lights to follow directions, for this motivation this one is better in a second step if you want to follow a robotics curriculum.

Students love using robotics at school because using these instruments is engaging for them. Often teachers think of robotics as something they have to do more in their works, but the secret is to let students explore and learn with them.

We need to think of robotics as instruments that we can use in our school days in activities of each subject.

For example if we have to teach the division in syllables we can prepare cards with different syllables to pose on the playground. Then students have to code the robot to collect the right syllables for the word the teacher asks for.

This is only an example that we can repeat in math or other subjects. We can read them a story, drawing the scenes of the story in little cards to pose on the playground and after the reading ask them to collect the images in the right order they listened to. Each card they collect will be posed in sequence,

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in this way students will work on language, coding and space-time line rebuilding the story with the images collected.

If the school has the possibility, it may engage one class or more in robotics competitions such as the First Lego League. Students in all the world from 6 years to high school practice a lot for this competition.

This is a competition divided in two phases, explore for younger and challenge for high school students. In the high school participants will have real robotics matches. Each year there is a different argument that participants will develop during the year until the final exhibition. The students participating in the explore competition will build a robotic model and a show poster to expose their research.

This competition is really engaging because students will address the topic from different points of view, exploring different subjects in a multidisciplinary learning. In this competition it is really important the team working skill that will grow up during the weeks. Each student can find a role in the group and students will help each one for the common goal.

Design examples with robots

To summarize the experiences described, we used the following table, which identifies three moments of learning: the challenge, the educational and instructional goal, and the outcome.

Tab. 1 - Synthesis of the paths designed and implemented in classroom

	Challenge	***Learning Goal***	***Learning experience***
1	*Storytelling with Cubetto*	*Linking storytelling to robotics*	*#Stream*
2	*Building a path*	*Collaborate for a Project*	*Coding express Lego*
3	*Tangible programming*	*Mistake as learning*	*M-Tiny*
4	*Recognizing emotions*	*Get excited for the robot*	*Programming Codey Rockey screen*
5	*Programming Ozobot*	*Working about learning process*	*Designing an environment and a story*
6	*Building a programming environment "drag and drop"*	*Orient yourself in the space*	*Understanding how it works with Lego WeDo*

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In Storytelling with Cubetto, the common thread was the story and the space-timeline. First, the children reasoned about the narrative sequences and the series of actions to be performed by the robot, so that it would follow the imagined path exactly (Figures 1 and 2).

Then they carried out a real transfer: the child took the place and appearance of the robot, to move along the path first imagined and then physically crossed (Figure 3).

After performing the design activity, the whole person participates in the experience, mind and body, in a pedagogical key consistent with embodied cognition (Clark, 1997).



Fig. 1 - Elaboration by Paola Mattioli

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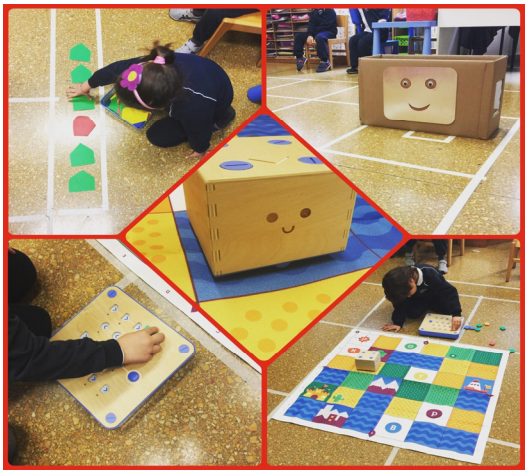


Fig. 2 - Elaboration by Paola Mattioli

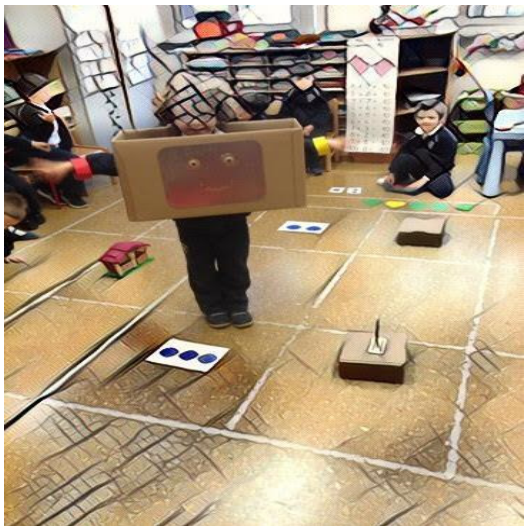


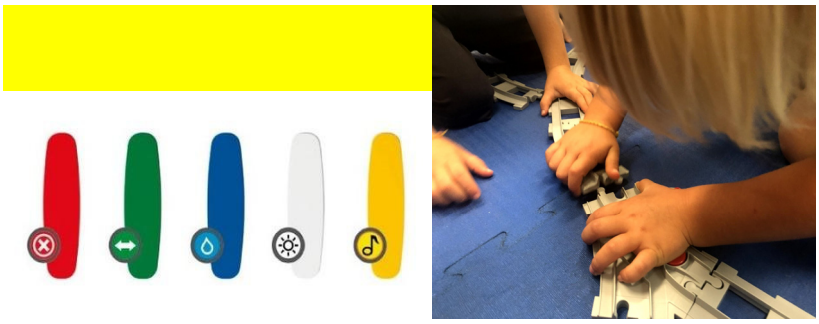
Fig. 3 - Elaboration by Paola Mattioli

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Lego's Coding Express is a creative set with DUPLO bricks and allows kindergarten children to learn the first concepts related to coding, to try their hand at problem solving, critical thinking, collaborative work, sequencing, social and emotional skills (Figure 4).

The first challenge to propose students is building the path with the tracks. Students are asked to collaborate to decide the best design and it isn't an easy task. Then they can test the train using the colored blocks that you insert in the tracks. When the train passes over them will read the message producing the action.

For example, when the train passes over the yellow block it will produce sounds; when the train will pass over the green block it will change its direction.



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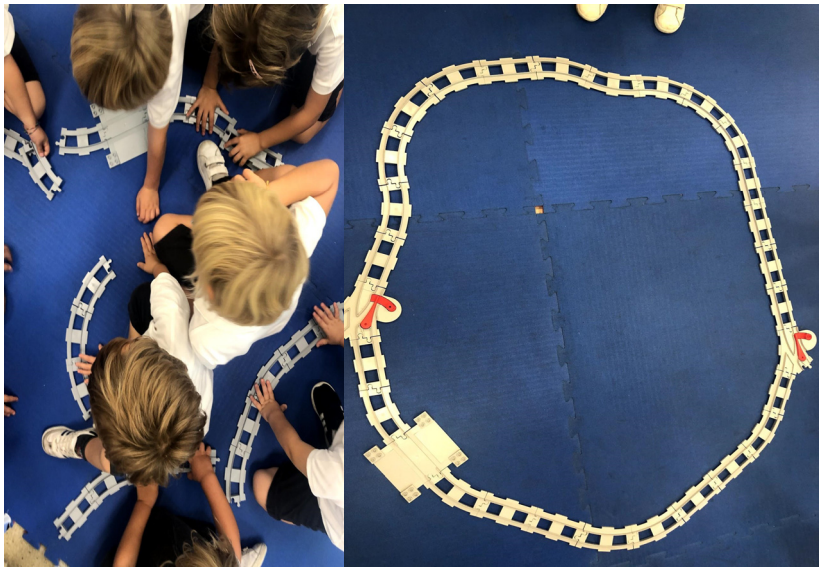


Fig. 4 - Challenge with Coding Express Lego - Elaboration by Paola Mattioli

The experience with mTiny uses tangible programming: blocks are read by a pen, which sends commands to the robot. mTiny is a perfect robot for preschool, it has the shape of a little Panda that students love.

Children build the path with puzzle blocks and have immediate feedback on whether there is a programmed error in the sequence (Figures 5 and 6).

This robot is really engaging for students because the robot has a screen where it shows the eyes of the Panda making visible the emotions it feels. This robot is a first step to talk about emotion and robotics.

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