SPATIAL AND COMPUTATIONAL THINKING AT KINDERGARTEN THROUGH THE AID OF AN EDUCATIONAL ROBOT

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FRAMING THE STUDY

This workshop discussed insights from a research project focused on the development of spatial and computational thinking with very young children, with the aim to introduce them to STEM (e.g., Benitti, 2012). In the project, two teaching experiments were carried out in two kindergarten classes (children aged 3 to 6), and a Blue Bot was used to create opportunities for mathematical explorations for the children in a playful environment. The Blue Bot is a little bee-shaped robot, which can be programmed to move by pressing sequences of commands (Figure 1, left and middle). Following Bartolini-Bussi and Baccaglini Frank (2015), significant processes that are typically mathematical or computer science-related emerge from play with this device, like counting, measuring, programming.

ACTIVITY DESIGN

In the initial part of the workshop, the principles that guided the activity design were presented to the participants. These principles are inspired by embodied cognition theories, which value the body in the teaching and learning of mathematics, and concern: the relationships between the children bodily movement and the robot movement; the interplay of imagining and observing, and of doing and creating; the passage from movement to trajectory to code, and vice versa; the multimodality of mathematical cognition (Ferrara, 2014). As an example, one of the first activities preceding the use of the tool involved bodily movement in space. Printed paper flowers of different colours were placed on the floor. The children first moved freely from one flower to the other, then the teacher asked them to perform variations of movement (faster, slower, with big steps, walking from one specific colour to another). This was done to raise awareness on bodily motion, explore constraints of movement, and share a common vocabulary to talk about movement. Next, the teacher turned the children attention to linear paths connecting two flowers, working on the comparison of their lengths by means of step-counting. The activity primed new activities that involved the robot and focused on its peculiar way of moving.

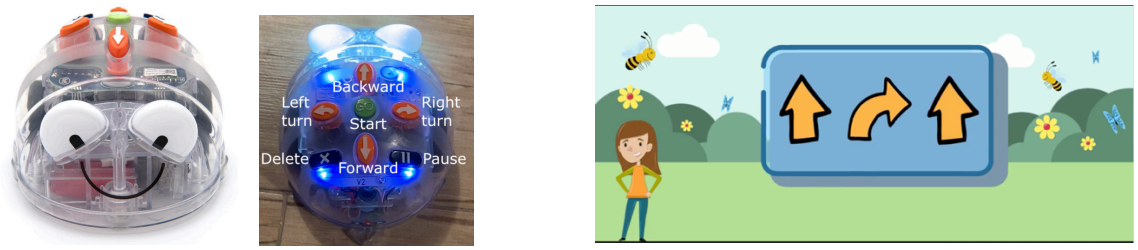

Figure 1. Blue Bot (front and back); the code discussed in the episode from the classroom

FROM THE CLASSROOM

In the second part of the workshop, a video of a brief classroom situation was watched, in which the children interact with the teacher to solve a task. In the video, the children have been exposed to a three command-code (Figure 1, right) and are asked to think of the robot movement. The teacher asks each child: "For you, which path will the bee follow?". One of the children, Samuele, is at the centre of the classroom in front of his classmates, with the code captured by three plastic arrows positioned on a paper sheet on the floor. The bee bot is at his disposal on the floor. Samuele gestures on the floor, creating a shape like the one sketched in Figure 2, and answers: "Straight, then crooked, then straight again." He repeats the same path three times. But Giovanni disagrees, so the teacher involves him in the discussion. Giovanni stands up and explains why: "Yes, because straight, then it turns, then it comes straight again". As possibilities of the robot movement are discussed, the teacher asks other children to participate with their thoughts, until she involves a third child, Lorenzo, who before was gesturing the movement trajectory in the air. Lorenzo is asked to move as if he was the Blue Bot, and a conflict emerges. Lorenzo walks along a shape like the one traced by Samuele, contrasting Giovanni's idea again. The Blue Bot is programmed by Samuele under the request of the teacher. But, as soon as the robot stops moving, Samuele exclaims: "No!", and annoyed lifts it up, convinced that it has not moved as he has programmed it.

Figure 2. Samuele gesturing the path he imagined

The dialogue continues, and Samuele and Giovanni discuss the code to reason about the movement of the bee bot. Giovanni tries to convince Samuele: "But Alice's code, Alice's code is like this: straight, turn, straight (*pointing to the three arrows, looking at Samuele*), not like this". This puzzles Samuele, who struggles with the gap between what he is imagining and what he sees.

Focus on this episode engaged the participants in a rich discussion concerned with the classroom dynamics that were nurtured by the activity design. We point out two main aspects raised in the discussion: 1) the turning arrow requires a change in perspective implying a rotation instead of a step in the movement; 2) the technology is somehow troubled on the way it works, appearing to do what it prefers instead of what the children want. These aspects appeared problematic with respect to the children's understanding of temporality and spatial displacement, which are embedded in the code, and are worth of further research. On a theoretical level, another key point was the difference between the linearity and discreteness of the code, versus the freedom and continuity of the bodily movements. The participants also questioned the role of the teacher in exploiting the different registers which are used to imagine, speak of, and enact the robot movements, another promising line of investigation.

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