Study and Development of Child-Robot Interaction in a Preschool Classroom Context: Improvements in the Design of Robotito to Increase its Insertion and Appropriation

EWELINA BAKALA, INCO, Universidad de la República, Uruguay
LEONEL GOMEZ-SENA, CICEA, Universidad de la República, Uruguay
GONZALO TEJERA, INCO, Universidad de la República, Uruguay
JORGE VISCA, INCO, Universidad de la República, Uruguay
ANACLARA GEROSA, CICEA, Universidad de la República, Uruguay
MARÍA PASCALE, EUCD, Universidad de la República, Uruguay
ALEJANDRA CARBONI, CICEA, Universidad de la República, Uruguay
JUAN PABLO HOURCADE, University of Iowa, USA

Fig. 1. Robotito in classroom activities.

In recent years, both educators and public policy makers have increased their interest in developing computational thinking in children and adolescents. Robotito was developed to prompt its development at early age as it can be programmed using colored cards. This project aims to improve its usability and create support material for educators, to improve the insertion of Robotito in the classroom.

CCS Concepts: • **Human-centered computing** → **Interactive systems and tools**; • **Social and professional topics** → *Children.*

Additional Key Words and Phrases: Educational robotics, young children, programming interfaces

ACM Reference Format:
Ewelina Bakala, Leonel Gomez-Sena, Gonzalo Tejera, Jorge Visca, Anaclara Gerosa, María Pascale, Alejandra Carboni, and Juan Pablo Hourcade. 2018. Study and Development of Child-Robot Interaction in a Preschool Classroom Context: Improvements in the Design of Robotito to Increase its Insertion and Appropriation. In . ACM, New York, NY, USA, 3 pages. https://doi.org/XXXXXXX.XXXXXXX

Manuscript submitted to ACM

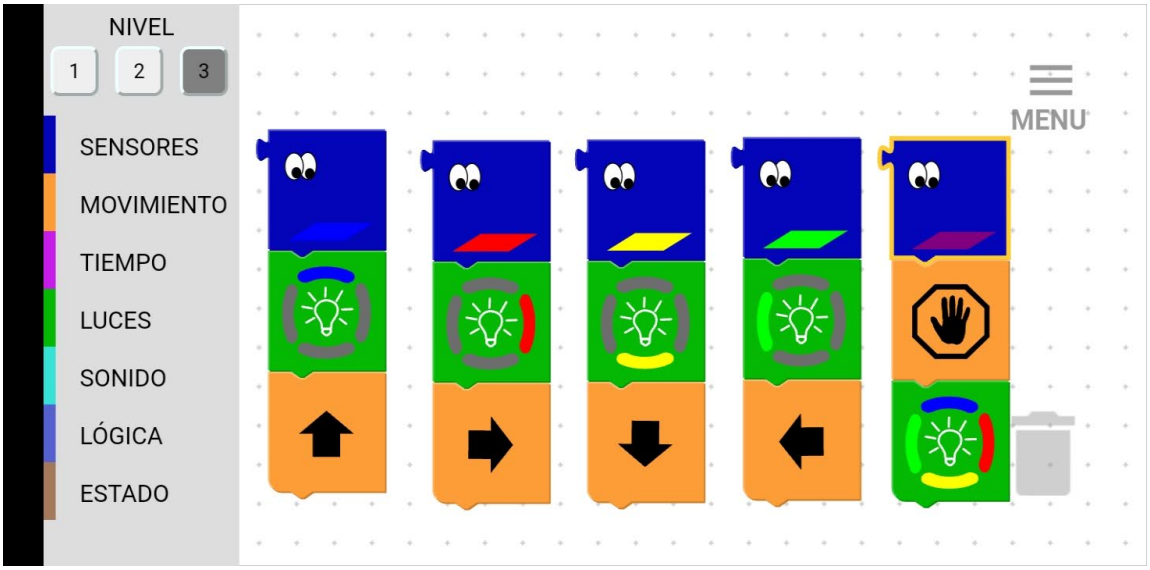

Fig. 2. Android app to design robobt's behaviors.

1 INTRODUCTION

Recent literature points to robotic platforms as suitable elements for addressing the use of educational technologies at an early age. This theoretical framework suggests that, given their tangible properties, the use of robots could help diminish the existing gap between learning through manipulating objects typical for early childhood and teaching programming as it is currently addressed in secondary education. Taking this into account, in 2018, we created Robotito, a robot whose main characteristic is to be programmable by configuring tangible objects in its environment. It uses six distance sensors and a combined sensor (color and distance sensor) to sense its environment and use movements and lights to communicate information. Robotito was used with small groups of preschoolers in controlled interventions and proved to be motivating and viable as a pedagogical tool. Despite this positive experience, the practice showed that improving child-robot interaction could improve and enhance its use, allowing greater autonomy, a necessary condition for its use in classroom contexts where the teacher-child ratio is generally 1: 20 or more.

This project aims to redesign the robot-child interaction proposed by Robotito to adjust it to the cognitive, perceptual, and motor abilities of children as well as the needs of educators. To develop the new version of the robot, both end users (children and teachers) will be involved from the beginning in the redesign process, which includes the evaluation of the current robot (usability tests, ergonomic evaluation, peer tutoring), instances of the definition of improvements (interviews, brainstorming, drawings) and commercial products evaluation (field studies, video analysis, observation sheets, usability tests). This participatory and incremental process will allow the development of a robot adjusted to the context of initial education, suitable for insertion in the classroom.

2 METHODOLOGY

To assess the skills and limitations of early childhood education children, a literature review phase is planned. Additionally, the usability of the current version of the robot will be evaluated with five children to determine the positive and

negative aspects of the child-robot interaction that it proposes. With the current version of the robot, we will use the peer tutoring technique [1] to assess what children think, understand, and imagine when interacting with Robotito. Five children from the previous phase (usability evaluation) will act as tutors, while another five will act as learners.

To enrich the usability study and generate new ideas, design methods such as brainstorming, drawings, and interviews will be used, involving both children and educators. Four sessions are planned, with the research team, teachers (1-2 early childhood educators per session), and children (a minimum of 10 children between 3 and 6 years old in each session) participating. These sessions will identify children's and teachers' interests, motivations, and preferences regarding the interaction with Robotito.

Field studies will be conducted with commercial robots to identify problems in their classroom use.

Based on the collected inputs, the final version of the child-robot interface will be defined and constructed. The variables taken into account when analyzing the material will include interaction with the interface (number of errors before reaching a solution, sequence of actions, cognitive load, creativity, and playability), collaboration, satisfaction, engagement, and interaction with the environment (environmental cues used to give instructions to the robot, perceived environmental characteristics, unnoticed ones, objects used, use of maps, etc.).

The final product will be compared to the current version of the robot to conclude its usability (focusing on efficiency and ease of learning) and suitability for the context of use.

3 ADVANCES

The project started in May 2022 and will conclude in May 2024. We have already conducted the literature review, brainstorming and drawing sessions, and teacher interviews. We evaluated the usability of Robotito in its current state and conducted peer tutoring sessions to understand common errors while programming Robotito for the first time. We evaluated Robotito and four commercial robots (Matatalab Lite, Code&Go, Qobo, Ozobot) in the classroom context.

Based on the collected knowledge, we concluded that is important to give Robotito a personality and an internal reference that allows directionality to work with children (right, left, forward, and backward). We observed that two predefined behaviors (color and distance behavior [2]) limited the coding activities, and the educators could not define new behaviors that could better fit their teaching practice. To solve this issue, we developed an Android application (see Figure 2) that allows designing robot's behaviors using a simple block-based programming environment.

We are currently working on improving the robot's communication with the user, personality, and directional reference, updating its firmware, and evaluating the developed application.

We plan to develop support materials (books with challenges, user manual, and video tutorials) to facilitate the appropriation of Robotito by teachers.

ACKNOWLEDGMENTS

This work was supported by the Agencia Nacional de Investigación e Innovación (Uruguay), under the project FSED_2_2021_1_169697.

REFERENCES

[1] Johanna Höysniemi, Perttu Hämäläinen, and Laura Turkki. 2003. Using peer tutoring in evaluating the usability of a physically interactive computer game with children. *Interacting with computers* 15, 2 (2003), 203–225.

[2] Gonzalo Tejera, Guillermo Amorin, Andrés Sere, Nicolás Capricho, Pablo Margenat, and Jorge Visca. 2019. Robotito: programming robots from preschool to undergraduate school level. In *2019 19th International Conference on Advanced Robotics (ICAR)*. IEEE, 296–301.