



HAL
open science

Students' acceptance of the multimodality of the social robot Pepper as an educational technology for learning mathematics

Antonio Vitale, Bruno Carbonaro, Gennaro Cordasco, Umberto Dello Iacono, Anna Esposito

► To cite this version:

Antonio Vitale, Bruno Carbonaro, Gennaro Cordasco, Umberto Dello Iacono, Anna Esposito. Students' acceptance of the multimodality of the social robot Pepper as an educational technology for learning mathematics. Proceedings of the Fourteenth Congress of the European Society for Research in Mathematics Education (CERME14), Free University of Bozen-Bolzano; ERME, Feb 2025, Bozen-Bolzano, Italy. hal-05283761

HAL Id: hal-05283761

<https://hal.science/hal-05283761v1>

Submitted on 25 Sep 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Students' acceptance of the multimodality of the social robot Pepper as an educational technology for learning mathematics

Antonio Vitale¹, Bruno Carbonaro², Gennaro Cordasco², Umberto Dello Iacono² and Anna Esposito²

¹University of Macerata; a.vitale11@unimc.it

²University of Campania "Luigi Vanvitelli", Caserta, Italy

Keywords: Social robot's acceptance, multimodality, educational robotics, mathematics learning.

Introduction

Social robotics is one of the most promising approaches to changing the way that teachers and students interact with mathematics content. Allowing students to have interactive and hands-on learning experiences, robotics can inspire a new generation of mathematics learning (Zhong & Xia, 2020). On the one hand, the use of robots can improve students' understanding of mathematical concepts. In this regard, Baccaglini-Frank et al. (2020) show how the use of the robot GeomBot makes mathematics lessons dynamic and interactive and facilitates students' understanding and visualization of geometric properties. On the other hand, robots can help students see real-life applications and develop lasting practical experience in a social context. Moreover, robots offer new opportunities to support the development of social and cognitive skills and to personalize the educational experience (Belpaeme et al., 2018). Understanding how social robots could enhance the students' learning experience is essential for their implementation in educational contexts. However, there are crucial aspects to be taken into account when using new technologies, such as social robotics. According to Venkatesh et al. (2003), the user perception of a new technology as easy to use is essential for its adoption. Therefore, for the integration of social robotics in the school environment, it is necessary to investigate their acceptance by students in order to have clear guidelines for their effective implementation.

The research study

In our research we are using the robot Pepper. Pepper is a semi-humanoid robot equipped with a tablet display. It is able to speak, move, and relate to the user by reacting in a personalized manner according to what the user does or says. Our research aims to evaluate the interaction between students and Pepper by focusing on multimodality, usability and acceptance in order to investigate students' comfort while interacting with it. Specifically, we are implementing inclusive learning activities in mathematics through storytelling, using Pepper as an inclusive, multimodal educational technology. Pepper is used to improve student engagement and to foster learning. This work is part of a larger project. The focus of this work is to investigate the level of acceptability of the students' interaction with Pepper. Specifically, our research question is: how does the multimodal interaction with Pepper influence its acceptance by students in a mathematics educational context? For an initial investigation, we involved eight students (two from middle school and six from high school) in a learning activity

regarding narrative, in particular a story problem on the Pythagorean Theorem. Pepper welcomes the student and introduces itself. Then it begins to tell the story problem. The student is asked to help the protagonist of the story solve a task. Pepper begins to ask the student questions related to understanding the story problem and provides feedback to her answers. The student begins to solve the problem. If she has difficulty, Pepper provides suggestions. In particular, at the student's request, Pepper provides contextualized examples on the use of the Pythagorean Theorem and properties of right triangles, helping with gestures and pictures that the student can see on the tablet robot. The activity ends with Pepper thanking the student for helping the protagonist of the story and saying goodbye. At the end of the activity, we asked students to answer the Robot Acceptance Questionnaire (RAQ) (Esposito et al., 2019) to investigate the students' interest in talking to Pepper and their emotional involvement during the interaction. In addition to the RAQ, students were asked to answer other questions concerning Pepper's multimodal abilities with the aim to investigate the extent to which Pepper's multimodality affects its acceptance in mathematical educational contexts. For all students, Pepper's comprehension of verbal expressions, its gestures, and the relationship between comprehensibility and gestures were outstanding. All students stated that Pepper had a high ability to understand their spoken expressions. They enjoyed its ability to give appropriate feedback according to their specific requests and to interact in a friendly way, especially in the initial getting-to-know-you process, making them feel comfortable. Moreover, all students stated that they appreciated Pepper's clarity in telling the story problem, its ability to offer personalized support in case of difficulties, and the effectiveness in making mathematical concepts accessible. This study seems to show a high student acceptance of Pepper as an inclusive educational tool in mathematics.

References

- Baccaglioni-Frank, A. E., Santi, G., Del Zozzo, A., & Frank, E. (2020). Teachers' Perspectives on the Intertwining of Tangible and Digital Modes of Activity with a Drawing Robot for Geometry. *Education Sciences*, 10(12), 387. <https://doi.org/10.3390/educsci10120387>
- Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science robotics*, 3(21), eaat5954. <https://doi.org/10.1126/scirobotics.aat5954>
- Esposito, A., Amorese, T., Cuciniello, M., Riviello, M.T., Esposito, A. M., Troncone, A., Torres, M. I., Schlögl, S., & Cordasco, G. (2019). Elder user's attitude toward assistive virtual agents: The role of voice and gender. *J Ambient Intelligence Humanized Computing*, 12, 4429-4436. <https://doi.org/10.1007/s12652-019-01423-x>
- Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), 425-478. <https://doi.org/10.2307/30036540>
- Zhong, B., & Xia, L. (2020). A Systematic Review on Exploring the Potential of Educational Robotics in Mathematics Education. *International Journal of Science and Mathematics Education*, 18, 79-101. <https://doi.org/10.1007/s10763-018-09939-y>