

MAKING LEARNING FUN: A ROBOT IN MATHEMATICS EDUCATION

Rachel Mah - University of Applied Sciences Wildau



An idea was born

As part of the author's internship project during her second semester, she programmed a NAO robot that was designed to teach elementary school children a few different mathematical concepts, namely basic multiplication from 1 to 10 as well as geometry. The robot could engage in "conversations" with the children, ask questions and provide quiz sessions as well as a brief introduction to the topic selected by the user. The project aimed to introduce the idea of a robot companion that could help children revise mathematical concepts in a fun and engaging way.

Motivation

In the field of education, several studies and experiments have proven that the use of humanoid robots in teaching have led to increased levels of interest and concentration displayed by children towards a certain topic. To reach the aim, existing research projects and first-hand experiences have brought many ideas into this project. Our experiences with the NAO robot have shown, that the NAO robot is very appealing for children. Besides that, there are different research projects, such as learning English for pre-school children with a NAO robot, which is researched by the University of Bielefeld (Germany). The public library "Stadtbibliothek Wildau" (Germany), which integrated the reading robot called "LeseNAO" developed by our team at the RoboticLab of the TH Wildau (UAS), won an innovation award for libraries in Berlin and Brandenburg, leading to the launch of a project that lasted for one year from 2018 to 2019 [1]. This achievement has further encouraged us to continue the research and development in the application of humanoid robots such as the NAO in areas including education and social services. The NAO robot has also been widely used in hospitality services and entertainment as social companions as well as in STEM education due to its compatibility with many common programming languages and has its own drag-and-drop block-programming application.

The result so far

What the NAO currently offers:

- Themes: Simple multiplication and geometry
- Quiz sessions
- Practice Sessions
- English and German modes

Workflow: How does one use the NAO?

1. As the NAO application is started, it first prompts the children to select and confirm a few options such as the language and the topic.
2. The children can navigate through the options by touching the robot's top and bottom head sensors, and confirm each selection by touching the middle head sensor.
3. The children can also assign avatar names to themselves by scanning QR codes encoded with these names as string values.
4. The children can then either choose to do some quiz questions or a practice session, where the NAO can accept answers by scanning QR codes encoded with these answers.

The children can also prompt the NAO to introduce itself and provide instructions on how to use and interact with it by touching the sensor on its left hand.



Fig. 1: Some materials that the children can use to interact with the robot including QR codes of avatar names and answer blocks

From code to classroom

On December 17, 2024, we invited a group of fifth graders from the Grundschule Wildau to test out the robot and evaluate their acceptance and experience with the robot. The children had the opportunity to test their multiplication skills through several quiz sessions, each consisting of five questions. A time limit of 30 seconds was set for each question. At the end of both sessions, we collected some feedback from the children who participated in the sessions and they expressed increased interest and enthusiasm about engaging with the robot.

Through our observation, although the children were already familiar with multiplication, the children remained highly engaged throughout the session, showing little to no signs of losing focus. Despite mentioning a few setbacks during the session including some QR codes that the robot could not read clearly, and said that they wished they had more time to answer each quiz question, they still had an overall positive experience with the robot.



Fig. 2: The author and her supervisor photographed with the robot during the interactive session with the fifth-graders

Future prospects

An overall improvement is planned. Different difficulty levels and types of quizzes will be added. We're currently working on migrating such as topic modules, questions, answers, and spoken responses, to a Content Management System (CMS), and are in the process of creating an application for supervisors or teachers to streamline and increase the efficiency of the workflow during learning sessions with the robot. In the future, we also plan to consult with educators and collaborate with them to explore and tailor the design of the experience, as well as the content of the lessons and quizzes, to suit the needs and interests of primary school children.

References

- [1] Janett Mohnke and Janine Breßler, "Can a Humanoid Robot Motivate Children to Read More? Yes, It Can!". In: Zaphiris, P., Ioannou, A. (eds) Learning and Collaboration Technologies. HCII 2023. Lecture Notes in Computer Science, vol. 14041. Springer, Cham, 2023. https://doi.org/10.1007/978-3-031-34550-0_19 [Accessed: Jun. 27, 2025]



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