

SECTION: EDUCATION.

SEKCJA: EDUKACJA.

How to cite: Kerneža, M., Bratina, M., Hari, D., & Zemljak, D. (2024). Robotics and language: How humanoid robots encourage first language learning in technology and engineering classes. *International Conference on Science, Innovations and Global Solutions*. (pp. 374-378). Futurity Research Publishing. <https://futuraity-publishing.com/international-conference-on-science-innovations-and-global-solutions-archive/>

Robotics and language: How humanoid robots encourage first language learning in technology and engineering classes

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Accepted: July 21, 2024 | **Published:** July 31, 2024 | **Language:** English

Abstract: This study explores whether the curricula for the subjects of Slovenian and Technology and Engineering allow the use of humanoid robots to improve students' language skills. The goals of the curricula that support the use of robots in teaching were analyzed. The results show that the existing goals of both subjects enable the integration of robotics, which can promote the development of students' communication skills. Research confirms that robots provide a tailored and interactive learning

experience, which is crucial for improving language and technical skills. Further research on the long-term effects and ethical aspects of using robots in education is proposed.

Keywords: communication skills, educational robotics, humanoid robots, STEM education, technology and engineering.

Introduction

In the modern educational environment, the integration of advanced technology is becoming crucial for preparing students for the future. Humanoid robots offer numerous possibilities for enhancing learning experiences, especially in technical and technology subjects. Although technology is usually associated with the development of technical skills, it can also play a significant role in developing students' language abilities. In this article, we will explore whether the curricula for the subjects of Slovenian and Technology and Engineering provide a foundation for the use of humanoid robots in technology and engineering classes to learn the first language, in our case Slovenian, and thus improve language skills.

Humanoid robots are primarily viewed in education as tools for learning STEM subjects and as teachers, with their potential being particularly evident in enabling individualized teaching and physical presence, which is lacking in computer-supported learning (Belpaeme & Tanaka, 2021). As we move from technology-oriented to human-centered applications in personalized learning, the prevalence of AI applications (e.g., chatbots and robots) is also increasing (Yang et al., 2021). Research has shown that robots, in addition to improving learning outcomes such as reading comprehension and interactive discussion, can also reduce stress levels and enhance language acquisition, as demonstrated by the use of the NAO robot tool (Breßler & Mohnke, 2023).

Several factors need to be considered when using robots in the classroom, as detailed by Zemljak and Kerneža (2023). The teacher must assess needs, identify specific needs and attitudes of students regarding the integration of humanoid robots into the learning process; plan and design a thorough implementation plan; execute and evaluate the plan; and ensure the sustainability of the model, which includes a long-term plan for maintaining the use of humanoid robots in the classroom. In addition to assisting teachers, robots are expected to have a significant impact on individualized learning (Okonkwo & Ade-Ibijola, 2021). Robots are particularly effective in the field of STEAM (Kalaitzidou & Pachidis, 2023), which includes the subject of Technology and Engineering.

A study by Woo (2021), which reviewed 23 studies examining social robots in natural school environments, found no evidence that social robots are more effective than human teachers, and maintaining long-term highly autonomous interactions between robots and teachers is also challenging. It is also important to consider the moral aspects of using robots in education (Smakman, 2021), which are only occasionally addressed in research (Woo et al., 2021). Belpaeme et al. (2018) emphasize that robots enable a more personalized and interactive learning experience, which is particularly important in technical education. Tanaka et al. (2015) note that interaction with robots encourages active learning and problem-solving. However, there is not much research examining the impact of using robots on students' language skills in the context of technical education, where clear, articulate, and precise communication is crucial.

The purpose of this article is to explore the hypothesis that the use of humanoid robots in Technology and Engineering classes can contribute to improving students' language skills. The hypothesis is based on the assumption that the general goals of the curricula for the subjects of Slovenian and Technology and Engineering allow the integration of robotics, which can consequently promote the development of students' communication skills as part of the curriculum for both subjects.

Research Results

To understand how humanoid robots can contribute to improving language skills in Technology and Engineering classes, we analyzed the curriculum goals for the subjects of Slovenian and Technology and Engineering. In this analysis, we identified specific goals that support the use of robots to promote students' language development.

Table 1

Overview of the General Goals of the Slovenian and Technology and Engineering Curricula that Allow the Use of Humanoid Robots in Technology and Engineering Classes to Improve Students' Language Skills

General Goals of the Slovene Curriculum	General Goals of the Technology and Engineering Curriculum*
<p><i>General Goal No. 2 of the Curriculum:</i> Students develop the ability to receive, understand, experience, evaluate, and create texts in the Slovenian literary language. At the same time, they cultivate language and literary culture.</p> <p>Particularly, the opportunity for developing this goal can be seen in the activities:</p> <ul style="list-style-type: none"> – Thoughtfully and critically receiving various non-literary texts published in different media – acquiring factual knowledge from them, using it in everyday life, and expanding it by using various manuals; introducing and reinforcing various strategies and learning approaches for effectively obtaining information from spoken and written non-literary texts, thereby developing their learning ability. – Safely, creatively, and critically acquiring information from digital texts, using it appropriately, and supplementing it as needed. They become aware of and assess both their own and the broader use of digital and other technology and the information obtained through it. – Developing readiness for conversation and correspondence, as well as for oral presentation and writing. They articulate their knowledge, thoughts, attitudes, desires, emotions, and experiences, negotiate, and peacefully resolve problems in various life situations. They are aware of the different circumstances in which texts are created, the various purposes that text creators have, and the different media through which texts can be conveyed, thus being capable of creating appropriate and effective texts of various kinds. Developing the ability to create texts and mastering and reinforcing strategies and principles for creating authentic, understandable, appropriate, and effective texts. <p><i>General Goal No. 4 of the Curriculum:</i> Students develop their linguistic (i.e., naming, syntactic, orthographic, and spelling) and stylistic abilities when receiving, developing, evaluating, and creating texts to confidently use the Slovenian literary language for their personal, educational, and interest needs.</p> <p><i>General Goal No. 4 of the Curriculum:</i> Students, while receiving, understanding, experiencing, and evaluating non-literary texts, also develop their metalinguistic ability – acquiring knowledge about the roles of language and the characteristics of the Slovenian</p>	<p><i>General Goal No. 1 of the Curriculum:</i> Understanding, researching, constructing, and building simple technical objects. <i>This goal requires the use of language to explain procedures and communicate ideas, which promotes the improvement of language skills.</i></p> <p><i>General Goal No. 2 of the Curriculum:</i> Observing, testing, analyzing, comparing, and understanding the components and functioning of technical objects and recognizing the connections between technical principles and scientific laws. <i>Students must express their findings clearly and precisely, contributing to a better understanding and use of Slovenian.</i></p> <p><i>General Goal No. 4 of the Curriculum:</i> Experimenting, recreating and creating, designing and planning, organizing and evaluating work to solve technical and technological problems, thereby developing creative abilities. They compare their activities with procedures in manufacturing companies and learn about the principles of modern technology. <i>The problem-solving process requires precise and effective communication in Slovenian.</i></p> <p><i>General Goal No. 6 of the Curriculum:</i> When designing and planning, analyzing, and making or building, they evaluate products together with the teacher. With assistance, they practice independently expressing ideas through sketching, reading, drawing technical and technological documentation, and oral and written communication. <i>Students practice independently expressing ideas through sketching, reading, drawing technical and technological documentation, and oral and written communication.</i></p>

literary language, which they complement by using various manuals and understand by observing and recognizing the role of given linguistic elements in non-literary and literary texts.	
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** The general goals of the Technology and Engineering subject are not as detailed as the general goals of the Slovene subject, so additional explanation and connection are added in italic.*

Source: author's own development

The analysis of the curriculum goals for the subjects of Slovenian and Technology and Engineering shows that there are numerous opportunities for integrating humanoid robots into the learning process. The goals of the Slovenian curriculum promote the development of language skills such as receiving, understanding, creating, and evaluating texts, while the goals of the Technology and Engineering curriculum include elements that require the use of language to explain procedures, express ideas, and solve technical problems. This opens up possibilities for using humanoid robots as tools that can help improve language skills through technical tasks and interactive learning. This hypothesis is based on the assumption that the general goals of the curricula for both subjects allow for the integration of robotics, which can consequently promote the development of students' communication skills as part of the curriculum for both Slovenian and Technology and Engineering.

Conclusions

The hypothesis of this article was that the use of humanoid robots in Technology and Engineering classes can contribute to improving students' language skills. The analysis of the curriculum goals for the subjects of Slovenian and Technology and Engineering showed that there are numerous opportunities for such integration. The goals of the Slovenian curriculum promote the development of language skills such as receiving, understanding, creating, and evaluating texts, while the goals of the Technology and Engineering curriculum include elements that require the use of language to explain procedures, express ideas, and solve technical problems.

Research has shown that robots provide a more personalized and interactive learning experience, which is particularly important in technical education (Belpaeme & Tanaka, 2021). Interaction with robots encourages active learning and problem-solving, which is essential for the development of both technical and language skills (Tanaka et al., 2015). However, there is not much research examining the impact of using robots on students' language skills in the context of technical education, where clear, articulate, and precise communication is crucial.

Further research should examine how specific interactions with robots affect the development of language skills. For example, studies could explore how different forms of interaction (such as conducting dialogues, problem-solving, and collaborating on projects) impact the improvement of vocabulary, grammar, and overall language competence of students. Additionally, it would be beneficial to investigate the long-term effects of using robots on language and technical skills and to develop models that enable sustainable integration of robotics into curricula.

Future research should also include the ethical aspects of using robots in education. It is important to consider moral issues such as privacy, safety, and the impact on social interactions between students and teachers (Smakman, 2021). A comprehensive assessment of these aspects will help in forming best practices for the use of robots in education.

Robots have the potential to become a key part of the modern educational process, promoting innovative approaches and interdisciplinary connections, which are essential for successful learning in the 21st century. Their use can contribute to creating a more interactive and personalized learning environment, where technological and language skills are developed in parallel.

Acknowledgements

The authors would like to express their appreciation to the research program P5-0433, Digital Restructuring of Deficit Occupations for Society 5.0 (Industry 4.0), financed by the Slovenian Research Agency (ARRS) for support.

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