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Social Robots in an Educational Context. An Overview

ABSTRACT: This paper aims to outline the application of social robots in educational contexts. The literature analysis indicates that interest in social robots in this field is growing. We examine the key characteristics of social robots and present examples of their use in educational settings (including examples from Poland). Furthermore, we analyse research findings on the benefits and potential risks associated with social robots in educational contexts.

KEYWORDS: social robots, educational robots, education, attitudes toward robots, hybrid intelligence.

STRESZCZENIE: Celem artykułu jest przedstawienie zarysu tematyki zastosowania robotów społecznych w kontekstach edukacyjnych. Jak wskazuje analiza literatury przedmiotu, zainteresowanie robotami społecznymi w tej dziedzinie rośnie. W artykule omawiamy cechy robotów społecznych oraz przedstawiamy przykłady ich wykorzystania w kontekstach edukacyjnych (odwołując się także do przykładów z Polski). Omawiamy również wyniki badań dotyczących korzyści i potencjalnych zagrożeń wynikających z obecności robotów społecznych w kontekstach edukacyjnych.

SŁOWA KLUCZOWE: roboty społeczne, roboty edukacyjne, edukacja, postawy wobec robotów, inteligencja hybrydowa.

Introduction

As noted in [Wasielewska & Łupkowski, 2021, p. 166], the growing popularity of robots and robotics has led to the emergence of a distinct (and continuously expanding) ecosystem of robots surrounding us (see also

Palomäki et al., 2018, pp. 3–4; Kossewska, 2024, p. 43). This ecosystem is not limited to physical robots, such as industrial robots, autonomous vehicles, cleaning robots, or assistant robots, but also includes robots appearing in films, animations, video games[1], and virtual assistants (such as Google Assistant and Siri). Robots are naturally part of a broader whole—our technological reality—which also extends into the realm of education.

In this short paper, we will examine how robots are used in education and discuss research findings from the literature on this topic. The objectives of this text are twofold: first, to illustrate possible scenarios for using social robots in education, and second, to identify potential opportunities and challenges associated with their use.

We will begin by exploring this especially interesting category of robots—social robots—and highlight the differences between them and other types of robots, such as educational robots. We will then discuss examples of the use of social robots in educational contexts, with a particular focus on applications in Poland. The article concludes with a brief review of research findings covering the benefits and potential risks associated with the presence of social robots in educational settings.

Social Robots

Social robots are a particularly fascinating class of robots—both from the perspective of roboticists and (perhaps even more so) researchers in the broader field of human-robot interaction [see, e.g., Wykowska, 2020; Łupkowski et al., 2022]. These robots are capable of engaging in social interactions, communicating with other social agents, and exhibiting at least semi-autonomous behaviour [see, e.g., Dautenhahn & Billard, 1999; Bartneck & Forlizzi, 2004; Sarrica et al., 2020].

A social robot combines specific technical and social aspects. According to Hegel et al. [2009, p. 171], these social aspects are the primary focus of this class of robots. For a robot to be considered social, it should possess certain communication skills. Consequently, it should behave in a socially appropriate manner within a given context and have a form that clearly signals its social nature to the user. A social robot is thus a combination of a robot and a so-called social interface. This interface serves as a metaphor encompassing all the designed functions that allow users to perceive the robot as having social

[1] For an overview see e.g. Ratajczyk [2019].

Figure 1. Social robot Vector (by Anki)
Source: ankicozmorobot.com/vector-robot.

attributes—in other words, all the features that lead observers to recognise the robot as a partner in social interaction.

The first social robot is often considered to be Kismet [see Bartneck et al., 2024, p. 12], developed by Cynthia Breazeal at the Massachusetts Institute of Technology's Media Lab in 1997. Kismet was designed for human interaction and could recognise and simulate emotions. Other, perhaps more well-known, examples of social robots include Asimo by Honda[2], Pepper by SoftBank Robotics[3], and Nao, which is mentioned later in this text (see Figure 3), as well as Sophia by Hanson Robotics[4].

An interesting example of a social robot is Vector. It is designed as a social robot but is far from being an advanced humanoid—see Figure 1. As described by Łupkowski et al. [2022, p. 3], Vector resembles a fist-sized cube. It has a front-mounted grip that helps it move and carry lightweight

[2] https://www.honda.pl/cars/world-of-honda/asimo/o-robocie-asimo.html [access: 23.07.2024].

[3] https://us.softbankrobotics.com/pepper [access: 23.07.2024]. You can meet Pepper, among other roles, as a product promoter in one of the shoe stores in Poznań: https://blog.eobuwie.com.pl/poznaj-peppera-kim-jest-robot-w-eobuwie/ [access: 6.11.2024], or as a receptionist and patient assistant at the Pediatric Center in Sosnowiec: https://www.termedia.pl/wartowiedziec/Nao-Sanbot-i-Pepper-dostali-etaty-w-Centrum-Pediatrii-w-Sosnowcu,42691.html [access: 10.02.2025].

[4] https://www.hansonrobotics.com/sophia/ [access: 23.07.2024]. Sophia gained significant attention in 2017 when it was granted citizenship by Saudi Arabia, https://businessinsider.com.pl/international/a-robot-that-once-said-it-would-destroy-humans-just-became-the-first-robot-citizen/8jz6htq [access: 13.01.2025].

objects. It moves using four wheels and a track system. At the front, it features a screen that serves as its face. Vector is equipped with multiple sensors to gather information about its surroundings and respond accordingly. It can hear voices, recognise people and objects, navigate a room while avoiding obstacles, and autonomously find its charging station when its battery runs low. The robot also has touch sensors, enabling it to detect when it is being touched or picked up. Vector communicates using its synthesised voice.

According to its manufacturers, Vector is a great little household companion designed to entertain and assist residents. Despite its relative simplicity, it has gained popularity as a home-use robot. In the aforementioned study, we reported findings on attitudes toward Vector based on natural language data—2,635 comments about the robot collected from YouTube and Reddit. The general observation is that Vector is described in line with its status as a social robot and tends to evoke positive emotions. It is perceived as an autonomous agent capable of expressing preferences and is even compared to a pet [Łupkowski et al., 2022, p. 8].

Due to their capabilities, social robots have a wide range of applications. Bartneck et al. [2024] list several uses, including customer service, entertainment, healthcare and therapy assistance, personal assistance, service industry tasks, security support, collaboration with humans in industrial and workplace settings, and education. It is this final area—the use of social robots in education—that will be the focus of this article.

Social Robots in Educational Contexts

The use of robots in education seems to be a natural consequence of the observed process of adoption of information and communication technology in this field [cf. Lampropoulos et al. 2025]. Usually, we think of the so-called educational robots in this context.

Although it is difficult to find a definition of this type of robot in the literature[5], the definition of educational robotics as "a field of study that aims to improve learning experience of people through the creation, implementation,

[5] Such a definition can be found in [Atman Uslu et al., 2023, p. 2], but it is so general that it seems not to distinguish educational robots from other robots. According to [Atman Uslu et al., 2023, p. 2], who refer to [American Robotic Institute, 1979], educational robots are defined as programmed machines designed to perform various tasks, made from different parts, working with operators or autonomously. These robots can take the form of humans, animals, or vehicles of various shapes and sizes.

improvement, and validation of pedagogical activities, tools (e.g., guidelines and templates), and technologies, where robots play an active role and pedagogical methods inform each decision" [Angel-Fernandez & Vincze, 2018, p. 41] sheds some light on the matter. This definition includes various categories of the application of robotics in education: robotics as a subject of teaching, an educational tool, and learning support. It seems that the term 'educational robots' most often refers simply to various types of robots used for educational purposes.

The simplest educational robots are designed as educational aids in very specific fields, most often programming, and do not need to have a social aspect.[6] A good example here would be Ozobot robots (by EDU Sense[7]). Ozobots are miniature robots specifically designed to facilitate the learning of programming. Interestingly, they can be controlled entirely using coloured markers and stickers. This illustrates that robots can be more engaging than virtual tools (instructional videos, tablets, or computer applications). Belpaeme et al. [2018] also emphasise that robots become a natural choice in educational contexts that require direct manipulation of objects in the world (such as in teaching physics or learning to write). As shown in the given example, this can also apply to learning of programming.

The introduction of social robots into this picture can significantly expand the range of possible usage scenarios and the benefits of their use. Lampropoulos et al. [2025] present an extensive literature review (361 literature items from the years 2013–2024) on the application of robots in educational contexts. The results of this review clearly indicate a growing interest in the topic of social robots due to their multidimensional role and impact on education. The main reason for this is that social robots (unlike simple educational robots) are able to recognise and express emotions [Lampropoulos et al., 2025]. Their social interface opens the way to a whole range of applications in education, making this class of robots so interesting and, at the same time, challenging (both for researchers in the field of human-robot interaction and practical implementations in classroom environments). As noted by Konijn et al. [2020, p. 1], unlike build-and-use robots, social robots provide educational experiences through social interaction with students,

[6] Konijn et al. [2020, p. 1, as cited in Catlin et al., 2018] distinguish three types of robots used in education: (i) build bots, (ii) use bots, and (iii) social robots. According to the authors, the first two types are mainly used as tools for learning to construct robots, acquiring programming skills, and learning about robots (e.g., Lego Mindstorms and Reamer robots).

[7] https://ozobot.pl/ [access: 15.02.2025].

can support the teacher in educational tasks (e.g., helping with repetitive tasks and taking attendance), act as tutors, or support learning through peer relationships. Examples of social robots used in education include Keepon and Dragonbot, which resemble animals, and humanoid robots such as Nao, Wakamaru, and Robovie.

The website robotsguide.com, developed by IEEE[8] features a comprehensive guide to robotics, categorising various types of robots, including those utilised in educational contexts. Analysing the robots within this category reveals their diversity, as well as the presence of numerous social robots, some of which have been discussed in this article.

Lampropoulos et al. [2025] emphasise that recent research has focused more on integrating robots into the educational process. In particular, it is noted that students tend to accept robots with long-term use. There is also visible acceptance of robots as teaching aids and their ability to engage students in cooperative tasks. The benefits of using them for inclusive learning, as well as their potential to increase student engagement, improve concentration, and enhance the process of acquiring and recalling knowledge, are highlighted.

Guggemos et al. [2022] emphasise the role of empathy in social robots as a significant feature in educational applications. They point to several key mechanisms. One of them is emotion recognition (analysing students' facial expressions, tone of voice, and body language to identify their emotional state). Robots can adjust their responses based on the recognised emotions (e.g., offering support, praise, or encouragement to improve the student's well-being). Social robots are also capable of simulating empathetic behaviours, such as smiling or nodding. These mechanisms allow social robots to tailor their interactions to the individual needs and preferences of students (personalise them), which can increase the sense of understanding and support. Social robots can also support the development of social and emotional skills by interacting with students in a human-like manner, helping them understand and manage emotions.

Moreover, as noted by Belpaeme et al. [2018], the need for technological support in education arises from demographic factors (the increasing number of students and the simultaneous demand for greater personalisation of curricula) and economic factors (decreasing school budgets). Embodied social

[8] IEEE (Institute of Electrical and Electronics Engineers) is the world's largest professional technical organization dedicated to advancing technology related to electrical engineering, electronics, computer science, telecommunications, and related fields of science, see: https://www.ieee.org/about/index.html [access: 10.02.2025].

robots play a unique role in providing this support, positively impacting the learning process.

Social robots can take on many roles and contexts in education. They can act as teachers, teacher assistants, or 'peers' to students. Confirmation of these observations can also be found in the aforementioned literature review by Lampropoulos et al. [2025].

As teacher assistants or tutors, social robots provide personalised instructions and feedback to students. Youssef et al. [2023] analyse the use of social robots in this role. We can imagine the following scenarios for using a robot. First, a social robot can be used to convey messages from students to teachers regarding the evaluation of the presented material. This way, students feel more encouraged and open to express their opinions about the material. Second, we can imagine a robot that provides additional explanations for the material already presented by the teacher. The student can interactively query the robot about the content they did not understand. Youssef et al. [2023] also report that this way of using the robot improves interactions among the students themselves.

Guggemos et al. [2022] recommend that the scenario of using a social robot in educational contexts should support the teacher's tasks. The teacher and the robot should perform planned activities together to complement each other. This way, the idea of so-called hybrid intelligence can be realised. In this concept, it is recognised that the best possible solution for integrating artificial intelligence (AI, as applied, for instance, in social robots) in a social context is to use the strengths of AI and humans so that they perform assigned tasks more effectively together than it would be done separately [cf. Dellermann et al., 2019; Moradi et al., 2019].

Researchers also point to the applications of social robots in language teaching. Robots are mainly used here for games and activities related to repeating vocabulary learned in a traditional way. An example of this is the EMYS robot (Figure 2), which is used in kindergartens in Kłodzko for learning English[9]. The robot not only speaks but also responds to touch and has facial expressions.

Thematic analysis of the collected literature [Lampropoulos et al., 2025] also points to the most frequently discussed topics regarding the use of social robots in education. The most popular ones include the use of robots in

[9] https://www.radiowroclaw.pl/articles/view/125760/Roboty-beda-uczyc-w-klodzkich-przedszkolach [access: 5.11.2024].

Figure 2. EMYS (by emys.co).
Source: robotsguide.com.

special education and the role of social robots in STEM education (science, technology, engineering, and mathematics). Social robots are used to support students with special needs, offering tailored help and increasing engagement through interactive and adaptive teaching methods. In STEM education, social robots can be used as a platform for learning to program the robots themselves, as exemplified by the Nao robot owned by a school in Jasło[10] (Figure 3) or the Sanbot robot purchased by the Technical School of Automation and Robotics in Łódź[11]—see Figure 4.

Thanks to the aforementioned abilities of some social robots to simulate human feelings and emotions, they find particular application in the education of children with Autism Spectrum Disorders (ASD). In this context, the educational function of the robot overlaps with its therapeutic function. In interactions with children on the autism spectrum, social robots can take on roles such as diagnostic agents, teachers, leaders or peers in social interactions, partners in games and activities, emotional guides, mediators of triadic interactions (mediating interaction with a therapist or another person), therapist assistants, tools for reinforcing positive child behaviours, or tools through which the child can express their emotions (emotional proxy) [Scassellati et al. 2012; Cabibihan et al. 2013]. Social robots can support both an early diagnosis of autism (e.g., by monitoring gaze patterns – see Kossewska,

[10] https://rzeszow.wyborcza.pl/rzeszow/7,34962,28511604,jaslo-pierwsza-szkola-w-polsce-ktora-ma-wlasnego-robota-humanoidalnego.html [access: 5.11.2024].

[11] https://radiolodz.pl/70687-sanbot-czyli-robot-asystent-w-lodzkim-technikum-automatyki-i-robotyki-login,129262/ [access: 6.11.2024].

Figure 3. Sanbot (by Sanbot Robotics)
Source: commons.wikimedia.org.

Figure 4. Nao (by SoftBank Robotics)
Source: commons.wikimedia.org

2024, p. 45) and the learning and strengthening of social, communication, or motor skills in children on the spectrum. These skills include imitating gestures, establishing and maintaining eye contact, joint attention, recognising and expressing emotions, developing communication skills, and independently initiating interactions [Cabibihan et al., 2013]. Additionally, engaging children in play with the robot teaches them, among other things, to wait their turn and to cooperate.

Among the social robots used for the education of children with ASD are Nao (described above, and according to Pennisi et al. 2016, the most commonly used robot in autism therapy), Kaspar (shown in Figure 5), Keepon (BeatBots), Kismet (mentioned in the Introduction), Robota (École Polytechnique Fédérale de Lausanne), and Flobi (University of Bielefeld)[12]. Some of them are also used in Poland. For example, the Nao robot is used in therapeutic centres[13] (e.g., at the Pediatric Center in Sosnowiec[14]) as a tool supporting

[12] More robots used for these purposes are listed by Scassellati et al. [2012], Cabibihan et al. [2013), and Pennisi et al. [2016).

[13] https://autyzm.life/2024/08/21/wykorzystanie-robota-nao-w-terapii-innowacyjne-podejscie-do-wsparcia-dzieci-ze-spektrum-autyzmu-i-innych-zaburzen-rozwojowych/ [access: 10.02.2024].

[14] https://www.termedia.pl/wartowiedziec/Nao-Sanbot-i-Pepper-dostali-etaty-w-Centrum-Pediatrii-w-Sosnowcu,42691.html [access: 10.02.2024].

Figure 5. Kaspar (designed by the Adaptive Systems Research Group from Hertfordshire University)*.
Source: robotsguide.com.

the therapy of children with ASD. Another example is the Gdańsk University of Technology, whose project on the use and development of the Kaspar robot was awarded in the EDUinspiracje competition15. This project enabled contact with the robot for children with ASD and therapists, as well as students who may design similar robots in the future16. As Magda Tytuła writes: "Interestingly, in Kaspar, as much as its functions and technical capabilities, its appearance matters: it is sufficiently robotic for patients who have difficulty interacting with other people to accept it and want to work with it, while at the same time it is sufficiently human for the behaviours developed during therapy with Kaspar to be transferred to relationships with people"17.

Guggemos et al. [2022] note that most social robots used in education are humanoid. This is confirmed by the analysis by Youssef et al. [2023, p. 74]. The robots most frequently mentioned as used in education are Nao, Pepper,

* https://www.herts.ac.uk/kaspar/the-social-robot [access: 10.02.2024].

15 https://www.sztucznainteligencja.org.pl/spoleczny-robot-pomaga-dzieciom-z-autyzmem/; https://pg.edu.pl/aktualnosci/2023-12/kaspar-wyrownuje-szanse-pg-nagrodzona-za-projekt-wspierajacy-dzieci-z-autyzmem [access: 10.02.2025]

16 https://perspektywy.pl/portal/index.php?option=com_content&view=article&id=9010:kaspar-innowacyjny-robot-socjalny&Itemid=119 [access: 10.02.2025].

17 https://perspektywy.pl/portal/index.php?option=com_content&view=article&id=9010:kaspar-innowacyjny-robot-socjalny&Itemid=119 [access: 10.02.2025]; translated by the authors.

Furhat, Zenbo, Maggie, MIRO, Reeti, and CommU. However, it is worth noting that the noted robotic ecosystem indicates the possibility of using other forms related to robots and robotics in education. An example of this is the cooperative board game THREE, described by Łupkowski & Wasielewska [2019, 2025][18].

Social Robots in Education – Benefits and Challenges

A meta-analysis on robots used in education [Belpaeme et al., 2018] revealed many benefits of using robots in this field (e.g., supporting the development of social skills or facilitating language learning). It is noted that when a robot plays the role of a peer to students, it not only supports the student in learning but also motivates the student to take on the role of a teacher, explaining certain topics to the robot. Belpaeme et al. [2018] also indicate that social robots more effectively encourage students to cooperate and engage in specific behaviours (such as precise manipulation of objects) compared to traditional teaching materials, e.g. instructional videos.

Smakman et al. [2021] report that both teachers and parents perceive social robots as potentially useful and valuable tools in educational applications. These observations are also confirmed by the literature review by Lampropoulos et al. [2025].

On the other hand, Youssef et al. [2023] point out that the attitude of the students towards the robot plays a crucial role when designing scenarios for the use of social robots in education. Interestingly, research results [Lampropoulos et al., 2025] indicate that younger students perceive robots more as toys, while older students more often see them as people with fewer cognitive abilities than the students themselves.

In the context of the use of social robots in ASD therapy, Cabibihan et al. [2013] highlight that although many interactive computer programs and computer-assisted therapy models (such as computer-assisted storytelling) have already been developed, research using social robots suggests that these robots are much more effective tools. The advantages of using social robots compared to other methods, both computer-based and those limited to human

[18] https://gratrzy.wordpress.com/informacje/game/ [access: 7.02.2025]. Players take on the roles of humanoid robots organized into a rescue team. Their goal is to find and rescue three missing astronauts. During the mission, they must follow Asimov's Three Laws of Robotics. The game provides a good experimental field for exploring moral dilemmas related to human-robot interaction, and more generally, ethical issues related to robotics (see discussion in Łupkowski, Wasielewska, 2019, p. 94).

interaction, include the repeatability and predictability of robot behaviours (often preferred by children on the autism spectrum), reduction of sensory overload and stress (through a controlled environment, limiting stimuli, and using only basic facial expressions and simple emotions), lack of social pressure and judgment from robots, ability to adapt to the child's needs, attractive, interactive elements that help focus the child's attention on the robot, and the ability to reward positive behaviours in real-time [Cabibihan et al. 2013]. Compared to computer software, social robots are more interactive and better mimic human interactions. Children are more willing to engage in interactions with a physical robot than with a virtual environment. Furthermore social robots can operate partially autonomously, relieving the therapist of repetitive tasks and allowing them to focus on more demanding aspects of therapy.

Youssef et al. [2023] list various challenges of implementing social robots in education. Such implementation must consider the age, environment, gender, and context of the robot's interaction with students. It is also necessary to clearly define the robot's role in the educational context (whether it is to be a teacher, companion, assistant, or student). It is also necessary to clearly define the context of interactions with social robots, which includes determining whether interactions are to take place one-on-one or in a school or home environment. It is also worth considering whether these interactions should involve groups of students, e.g., in the context of classroom work or team collaboration. The scope of the robot's abilities and skills must also be taken into account, as these directly affect how it is perceived by students (in terms of acceptance, credibility, trust, and satisfaction with the interaction).

The study by Smakman et al. [2021] highlights the vital role of having appropriate regulations related to the safe introduction of social robots, especially in the context of early education. Attention is also drawn to the need to consider the moral and ethical challenges associated with the use of robots in educational contexts. The authors list a range of values related to the implementation of social robots in education, which are perceived from the perspective of children and/or teachers. This broad range of values to be considered when implementing a robot in education includes psychological well-being (as robots that mimic human behaviours can evoke various emotional reactions in students, such as trust, a sense of comfort, and the like).

Other related values of using such robots in education include freedom from bias and the need to avoid ambiguity and misunderstandings. An example might be a situation where the robot creates the impression that it cares about the student, which can affect the level of trust the student places in the robot. The possibility of developing an emotional attachment or friendship with the

robot should also be considered in long-term interactions. An important issue is the potential impact of these interactions on the student's social relationships with peers, teachers, and other people in their environment. An attachment to the robot that is too strong may limit the natural development of social competencies, so it is necessary to design interactions precisely in order to minimise these harmful effects.

Another group of factors is technological ones, such as the robot's performance (i.e., considering its actual capabilities in the context of its applications), the robot's usability (i.e., its suitability for the role it is to play), and whether the selected robot is accessible and can be used by users with different levels of ability.

Safety issues are also significant, including both the physical safety of children during actual interactions with robots and the protection of their personal data. In the context of physical safety, potential risks arising from the robot's mechanical actions, such as the possibility of accidental injury, should be considered. Privacy protection includes issues related to collecting, storing, and processing data about children. Another important aspect is the responsibility for the robot's actions. Usage scenarios must clearly define who is responsible for monitoring, supervising, and controlling the robot's activities.

Summary

In this paper, we have reviewed the use of social robots in educational contexts. A literature analysis indicates that these robots are gaining popularity in the domain of education. Social robots can serve various roles in educational settings—teacher assistants, therapists and their aides, tutors, classroom companions, or peers in interactive learning, games, and educational activities. They can also function as guides or mediators, assisting children in developing various skills. Their implementation brings several benefits, including increased student engagement, improved concentration, and support for inclusive education. Social robots play a particularly significant role in working with children on the autism spectrum, where, in addition to diagnostic and therapeutic functions, they can aid in developing social, communication, and cooperative skills.

We also discuss the challenges identified by researchers in implementing social robots in educational settings. While generally perceived positively, it is crucial to consider the attitudes of potential user groups toward these robots, as well as demographic differences among users. A thorough analysis of the context in which interactions are planned is essential. Additionally,

technological challenges such as robot performance, realistic assessment of their capabilities, and ensuring user safety must not be overlooked.

Social robots are undoubtedly one of the most intriguing elements of the robotics ecosystem, as discussed in the introduction to this text. Their application in education reveals how many fields they intersect—making them of interest to both practitioners and researchers in the broader field of human-robot interaction.

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