Empowering Education: Student Perceptions and Attitudes to the Role of Social Robots in Learning Contexts

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Abstract

Successful integration of social robots in education relies on the acceptance of robots in learning contexts by students. Using a participatory design workshop, students interacted with a KettyBot and ideated potential roles for robots in the classroom. This was followed by a questionnaire and the Godspeed Questionnaire Series (GQS) to understand student perceptions and attitudes towards social robots in education environments. Learners described potential use cases and our results demonstrate students envision robots as assistants rather than teachers, emphasising the importance of human connection in learning.

CCS Concepts

• **Human-centered computing** → *Interaction design*; • **Computing methodologies** → Artificial intelligence; • **Applied computing** → *Interactive learning environments*;

Keywords

Human-Robot Interaction, Social Robots, Education, Participatory Design, Student Perceptions

ACM Reference Format:

Jessica Turner, Nicholas Vanderschantz, Judy Bowen, Jemma L. König, and Hannah Carino. 2026. Empowering Education: Student Perceptions and Attitudes to the Role of Social Robots in Learning Contexts. In *Companion Proceedings of the 21st ACM/IEEE International Conference on Human-Robot Interaction (HRI Companion '26), March 16–19, 2026, Edinburgh, Scotland, UK*. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3776734.3794527

1 Introduction

Advances in Human-Robot Interaction (HRI) and the rise of Artificial Intelligence (AI) through the use of Large Language Models (LLMs) enables social robots to engage and speak in human-like conversations with users. We can, therefore, realistically consider the role robots may play in educational environments. While we might consider that there is some hype in the envisioned futures which suggest that teachers may be replaced either with AI or robots to address teacher shortages; or that incorporating AI in education results in more successful and pleasant learning experiences [3, 15], these are grounded in realistic technical developments and aspirations. For example, the Sixth Global Forum of the Future of Education and Skills 2030 (Japan, 2024), discussed envisioned educational futures including the impacts of Generative AI (GenAI) and social robots in the classroom demonstrating that educational leaders have an expectation that both robots and AI will become part of the mainstream in educational contexts.

Popular culture and science fiction depict aspirational uses of social robots across a variety of contexts, not just education, with robots often being shown as more capable than they actually are and representing idealised futures rather than actual behaviours [20]. This impacts peoples' expectations of how robots might contribute in educational settings. As a result, we need to use appropriate methods to ground such expectations and work with end users to fully understand potential needs and benefits.

Participatory design techniques help to ensure the acceptance and relevance of a system by including stakeholders in all aspects of the design process [24]. When considering the inclusion of social robots in classrooms we must include key stakeholders, such as students, in shaping how robots can be used to empower their learning. Participatory design workshops allow us to investigate how students perceive and envision roles for social robots in their learning environments through the use of ideation, while scales like the Godspeed Questionnaire Series (GQS) [10] allow us to understand their user perceptions. However, balancing ideation to allow creativity but create feasible designs is a challenge when we consider the widespread narratives from popular culture.

In this paper we use participatory design techniques to allow students to ideate, create and envision roles for social robots to empower their learning environments. The primary contribution of this paper is clarification of preferred robot roles in education from the student perspective, gathering insights and understanding of their imagined classroom futures with AI enabled social robots. Our results highlight the need for human-in-the-loop approaches to ensure correctness, trust and safety in learning environments.

2 Related Work

The use of participatory design (PD) methods is essential in the development of social robots, especially when they are intended

HRI Companion '26, Edinburgh, Scotland, UK

ACM ISBN 979-8-4007-2321-6/2026/03
https://doi.org/10.1145/3776734.3794527

to interact with diverse user groups such as children [5], older adults [32], or individuals with specific needs [9]. Engaging end-users in the design process ensures that the robots are not only technically proficient but also socially and contextually appropriate. Acceptance and trust are key considerations for social robots and the use of PD supports these considerations by empowering end-users to contribute to their design.

In work with older adults, caregivers and medical professionals, Sienkiewics et al. ran multi-stage workshops using card sorting and story-boarding techniques followed by semi-structured interviews to understand stakeholder needs for social robots for elderly care [35]. They included brainstorming activities to foster empathy and understanding and also examined how issues relating to understanding of technology and technological challenges might impact user interaction. While this work makes use of several different existing PD methods, Winkle et al. sought to develop a PD process specifically for HRI, they aimed at using both PD and co-design in an end-to-end process involving domain experts alongside technical expertise [37].

One of the challenges of PD for HRI is in including stakeholders with a non-technical background whose views of robots and expectations may be shaped by popular media describing social robots. Weiss and Spiel discuss balancing the expectations created by such media with the technical capabilities of actual robots, discussing the implications this has for design processes [36]. When combined with the multi-disciplinary nature of robot design teams, tools and frameworks which facilitate conversations among stakeholders with different levels of technical knowledge are essential to the success of a robot's design [8].

In educational contexts robots are proposed for a variety of uses, most commonly as teaching tools [1], study buddies [11], teachers or teaching assistants [14, 30]. Several systematic literature reviews have identified that in teaching contexts there is, unsurprisingly, a focus on robots as a tool to teach programming [7] or in the wider context of subjects in the STEM field [6]. Such approaches have influenced several educational robots such as Lego Spike[1], Bittle or Nybble Q by Petoi[2] and Yanshee by UBTECH Education[3] with a focus on teaching programming as a way of controlling and interacting with the specific robot. There are also examples, however, of the use of robots to teach specialist skills, such as the Pepper social robot as a sign language teacher [26].

Kroeger states that robots may be used to attract students' attention, create engagement, allow absent children to participate through the use of telepresence robots or use social robots for practicing conversation [23]. With a focus on how teachers may use these technologies to enhance their existing practices, she highlights the real possibilities for social robotics in education. While it is well understood from a technological perspective the role robots may play, students must be involved in this process to ensure acceptability and adoption of these approaches, ensuring relevance to their learning experiences.

In other learning contexts, robots have also been used as a study buddy across a wide variety of subjects and applications. Cagiltay et al. explored the use of a robot as a homework companion, and found that both children and parents saw the robot as an aid to support student motivation and engagement [11]. Social robots, like Pepper, have also been used as teaching assistants, enhancing student experiences on university campuses [27].

With the rise of technology and personal computers in the 20th century, robots have become an integral part of popular culture [34]. Popular portrayals of robots such as R2-D2 in Star Wars[4] and H.E.R.B.I.E in the Fantastic Four: First Steps Movie[5] impact human perceptions and understanding of robot capabilities [13]. Oliveira and Yadollahi analysed popular movies and franchises involving (fictional) social robots and considered how such fictional robots compared with real robots in terms of their abilities. Their results showed that the depiction of fictional robots was polarised, emphasising either extreme social abilities or violent and destructive motives. As a result, the relations between humans and robots tended to be either friendship or antagonism [29]. Fictional robots are often portrayed as having advanced technical abilities that allow them to navigate multiple complex social settings and engage in different occupations typically performed by humans, in contrast with the actual abilities of current popular commercially available robots. From such studies we can identify that there is a need for further research in the social robotics space in order to bridge the gap between high expectations, as a result of fictionalised robots, with actual capabilities.

Rubegni et al. describe children's hopes and fears of social robots, where participants were happy with robots helping them with or doing their homework for them, but almost all found it unacceptable to allow a robot to walk their dog [33]. This highlights how childrens' attitudes towards robots are often different to that of adults and how they represent a unique target group in terms of design decisions.

3 Participatory Workshop: Marching with Marshmallow

To understand how robots can be used to empower learning contexts, we developed a participatory design workshop to address the following research question:
RQ: What are the current perceptions school students have of robots in the classroom and how do they envisage they could be used?

The workshops were aimed at secondary-school students (aged 16 and above) who were enrolled in Digital Technology Courses. The students' participation in the workshop was voluntary and ethics were approved by *anonymised institution* prior to the running of the study. The robot used in the study was a KettyBot (developed by Pudu Robotics[6]). KettyBots are service robots typically used in restaurants to deliver food and collect dishes; or similarly as a tour guide in museum settings. As a result, they can be used for educational purposes, especially when providing historical information on a guided tour.

The workshop comprised three phases. In the first phase students were introduced to "Marshmallow" (the KettyBot) and given the opportunity to interact with it. Marshmallow was presented to the students as a development platform from which they could

[1]See https://spike.legoeducation.com/.
[2]See https://www.petoi.com/.
[3]See https://ubtecheducation.com/yanshee/
[4]See https://www.starwars.com/databank/r2-d2
[5]See https://www.marvel.com/movies/the-fantastic-four-first-steps
[6]See https://www.pudurobotics.com/product/detail/kettybot

ideate their concepts. Students were first introduced to Marshmallow's functionality, such as talking, video playback, following instructions, guiding and carrying.

The second part of the workshop aimed to understand the students' perceptions of robots in the classroom and encourage them to ideate different solutions. They were given worksheets and asked to brainstorm ideas and design a new Marshmallow and think about how it could be used in an educational setting such as at their school. Following this they were encouraged to take one of their ideas and create a storyboard to design interactions and think about the user experience. They were asked to consider who was involved, how they were interacting with Marshmallow and what the end users do during the interaction. Students could also write notes during the storyboarding process to emphasise their ideas.

Finally, in the third phase the students completed a questionnaire asking for their insights and perceptions on social robots in learning contexts. Students were asked to: describe a robot in three words; state whether you think robots would enhance your education experience, Yes or No; state what do you think a robot's role in the classroom could be and why; state whether you would like to see robots in schools, Yes or No. Following this the students completed the Godspeed questionnaire [10] (GQS) which was used to gather their perceptions of specific factors of the robot used in the study.

4 Results

The workshop, called "Marching with Marshmallow" took place at *anonymised location* with 36 participants. All participants were currently enrolled at secondary school and were aged 16 - 18. At the start of the session participants completed a demographic questionnaire which also asked about any prior experience of interacting with robots. Only 3% had no prior experience at all with robots, 63% had some experience and 34% reported having interacted with robots often. Our primary focus in this work is in identifying student perceptions of robots in education. As such our results focus on phase three, the questionnaire and GQS.

The first question in the questionnaire asked students to describe a robot in three words. Of the words that appeared in the responses more than once, the most used were 'smart' (14), 'helpful' (10) and 'cool' (9). We performed a manual sentiment analysis on the words and labelled 59% as positive, 13.5% as negative and 27.5% as neutral. Neutral words were mostly technical in nature (e.g. robotic, machine, AI), with a small selection of descriptive words (fast, unique, tough). The individual sets of (three) words provided by each student were not always internally consistent in sentiment, the data included examples such as "smart, logical, clunky" and "unsettling, helpful". There were also antonyms apparent in some submissions, for example "helpful, unhelpful", suggesting uncertainty or ambivelance in attitudes.

For the remaining questions, most of the students, 81%, indicated that they thought robots would enhance their education experience and 86% stated they would like to see robots in schools. In terms of the role robots would play, however, the most popular choice was as a teaching tool (50%), suggesting that students were focussed on the functional nature of the service robot. While 41% thought it could be useful as a teaching assistant, only 4 students (11%) suggested it could act as a teacher, essentially replacing humans in this role. One student did not select any of the roles and two selected all roles. There were also 4 students who selected the study buddy role.

For the text responses to the 'why' supplementary question about robot's roles, one participant stated that *"It will be intriguing to be taught by robots, and having them as a study buddy may improve studies and as a teaching assistant it can help those the teacher couldn't get to"* [P35]. A participant who selected the use of the robot as a classroom tool stated : *"Can help with research and provides useful information which saves a lot of time"* [P31]. This suggests that interpretation of what constitutes a 'tool' may also include intelligence.

Participants who selected Teaching Assistant as a robot's main role said they could see robots automating the simple, everyday tasks that teachers complete. For example: *"Robots can be personal helpers for answering questions and helping students, but I think the human touch a teacher has is not replicable by robots"* [P26]. Others also highlighted that the robot could not replace a teacher, *"I would find it hard to learn from a robot as a teacher but it would make it easier for the teacher to get to all the students that need help and hand out papers, pens, textbooks, etc."* [P3] and *"When the teacher is busy, it can help students with basic work"* [P24].

Participants who selected the study buddy role highlighted that being able to ask the robot questions would provide further assistance for specific exercises: *"When studying you can ask it questions ... but it can also get things to help you study like worksheets"*[P30]. In contrast to the other participants, students who selected the teacher role reversed the roles of teacher and teaching assistant, where the robot acted as a teacher and had a human assistant: *"Robot teachers would be able to help anyone due to it having the ability to change teaching methods. A human assistant to correct some wrongs the robot teaches."* [P15].

Some participants did report concerns about robots being used in learning contexts. For example, one participant noted robots may be *"Distracting students from work"* [P17] or *"It could make the teaching job easier... But a robot taking the job of a teacher would take away the essence of humanity and realism in learning."* [P36]. This demonstrates that students understand the value of their teachers in the context of learning.

Table 1: Godspeed Questionnaire Results (5-point scale)

Dimension	Mean (M)	Standard Deviation (SD)
Anthropomorphism	2.62	0.89
Animacy	2.89	0.91
Likeability	3.78	1.04
Perceived Intelligence	3.67	1.01
Perceived Safety	2.82	0.70

Table 1 presents the mean scores and standard deviations for each of the five Godspeed dimensions measured on a 5-point scale. Participants rated the robot lowest in Anthropomorphism and Animacy, indicating that it was generally perceived as more mechanical than human-like or lifelike. Ratings were highest for Likeability and

Perceived Intelligence, suggesting participants found the robot relatively pleasant and capable. Perceived Safety received a moderate score, indicating mixed feelings about comfort and trust in interacting with the robot. Standard deviations across all dimensions were moderate, reflecting some variation in participants' perceptions but no extreme disagreement.

5 Discussion

Presenting the KettyBot as "Marshmallow" allowed us to personify the robot, a practice known to reduce eeriness and impact acceptability [16, 25]. To avoid gender stereotypes we deliberately chose a non-gender specific name, allowing students to envision a wide variety of applications and settings for Marshmallow. High likability results for Marshmallow were shown in the GQS results, which we propose is influenced by the personality aspect, reflecting outcomes of previous studies, such as Esterwood et al.'s work for example [18]. In future work, we need to carefully consider how appearance, behaviour and personality affects robot design and suggest that personality is a key factor for uptake and acceptance in education environments.

The use of a mixed methods approach in the workshop provided a richer understanding of the participant's design choices and perceptions rather than using a framework like GQS alone. While the scale allowed us to reason about the qualitative results, the best insights into integrating robots into real learning environments come from the reflection on the roles robots could have in education settings. Algerafi et al. argue that the role of teachers in classroom settings for higher education has been reduced to a minimum, and that their results demonstrate students are willing to accept AI-based robots in their education [4]. However, they only use the Technology Acceptance Model (TAM) to investigate their hypotheses, without gathering qualitative data. Our results here similarly show that robots can be used in education settings and are likely to be accepted by students, however, our participants do not advocate for them to replace teachers, placing a high value on correctness and human connection.

With the rise of AI and LLMs we have seen an increase in social robots that can converse naturally with end-users and provide specific detailed responses [21, 31], changing the way social robots could be incorporated in education settings. However, in our results (Section 4) we see the majority of participants preferring social robots being used for support roles in the classroom, such as helping hand out papers and pens or answering questions in an assistant context. This demonstrates that students place a high value on their teachers and the student-teacher dynamic. Our results are in line with those from Chan and Tsi, who explored the roles that generative AI can have in higher education, finding that the majority of participants argued that AI cannot replace human teachers as a result of their critical thinking, emotions and the importance of the social-emotional competencies developed from human interactions [12]. Therefore, while our participants agreed that there is a place in the classroom for social robots, they cannot and should not be used to replace teachers.

Some participants, however, also raised concerns around correctness, such as P15 suggesting the robot has a human assistant to correct anything wrong the robot may say, or P24 suggesting it could help students with "basic work". This demonstrates that students have awareness of the limitations of AI-enabled technology and the impacts this could have on their learning. This is particularly important when we consider the hallucination problem in generative AI, where models create information that sounds correct but is actually fake, requiring the need for a human-in-the-loop to allow the identification of false information [22]. When we consider students identifying social robots as suitable as a "Study Buddy" or "Teaching Assistant" their designs reflect the human-in-the-loop approach disseminated in research [2, 17], providing a pathway for empowering education through the use of social robots while protecting academic truth and integrity.

A limitation of this work is that the majority of participants had prior exposure to robots before taking part in the study. Future research could explore whether students with minimal or no exposure to robots would produce similar results. Similarly, we only used one robot as part of this investigation. Given the importance of appearance on the acceptability of robots [19, 28], it is possible that using different robots would give further insights.

Lastly, in this research we focus on the student perspective of using social robots to empower learning experiences, specifically working with participants at secondary school levels. Given the impact of the needs and perspectives of different target audiences on participatory design as outlined in section 2, further user groups should be investigated including different age groups as well as educators, caregivers and parents.

6 Conclusion

To empower education through the use of social robots our findings show that students see robots as having a role in their learning environments, however, this role is limited to that of an assistant or study buddy rather than that of a teacher. Participants highly valued their teachers despite the robots used in this study having high likability and moderate intelligence scores. Furthermore, our results showed students had a preference for functional and task-oriented support, where robots are used to enhance existing learning environments.

In future work diverse student groups should be explored, such as pre-school, primary and university to determine how different students envision robots being used in their learning environments. In addition, the perspectives of educators, caregivers and parents is essential to ensure successful adoption of robots in these educational contexts. Due to the impact of appearance, personality and behaviours, multiple robot designs should be investigated beyond service robots like Marshmallow, as these will provide broader insights. Our results demonstrate that students believe social robots have the potential to empower education if designed in a supportive role, aligned with their expectations and integrated thoughtfully alongside their human teachers.

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Received 2025-12-08; accepted 2026-01-12