

Bringing Social Robots to Preschool

Transformation or Disruption?

Young children are growing up in a digital age that is constantly evolving. They are experiencing new and emerging technologies, such as mobile devices, virtual reality, smart toys, voice-activated assistants, and social robots.

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This article focuses on exploring what social robots are and how they could disrupt and transform early childhood education.

What Are Social Robots?

A robot is an automated machine that completes a set of actions programmed via a computer. With advancing technology, robots have been designed that are capable of socially interacting with people in meaningful ways as they communicate through speech, facial expressions, and physical gestures. These robots are known as social robots and have been defined as “an autonomous or semiautonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact.”¹ With these characteristics, social robots have the potential to take on different relationship-based roles, such as companions, friends, peers, and tutors.²

Children may anthropomorphize social robots, assigning human emotions, such as feeling happy or sad, to them.³ This tendency to view social robots in anthropomorphic ways can



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influence how children respond to social robots.⁴ Young children may even believe social robots have biological functions, such as eating and growing. Because of these perceptions, it is important to understand children’s views and expectations of social robots, especially when they are used for educational purposes.

Did you know . . .

The word “robot” was first used in a play called *Rossum’s Universal Robots* by Czech writer Karel Čapek in 1920. Čapek actually derived the word from the Czech word “robota,” which means “forced labor” or “drudgery.” The play tells the story of a group of artificial humans (robots) who are created to

do work for their human creators, but who eventually rebel against their creators and take over the world. The play helped to popularize the idea of robots in science fiction. Since then, the word “robot” has come to be used to describe any artificial or mechanical device that can be programmed to perform a specific task or set of tasks.

Types of Social Robots

Increasingly, social robots are being designed to appear more friendly in appearance, with the addition of a human-like face, eyes, arms, and legs. Social robots such as NAO or ASIMO are regarded as humanoid robots, with bipedal mobility for



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walking, moving, and dancing. Social robots also can be semi-humanoid in form, such as Pepper, Tiro, and Robovie, and use wheels rather than legs to move around. Pet-like social robots like Dragonbot and Pleo have fur or skin coverings and come in different colors.

Some social robots are capable of visual recognition via inbuilt cameras; they have digital eyes that can change shape or color, or glow to express certain emotions such as happiness or sadness. They can talk and respond to children through verbal exchanges and possess movement sensors to avoid surrounding obstacles. Their physical and social communication features allow social robots to interact with children in their homes or classrooms.

In countries around the world, people are using social robots for education, entertainment, food services, travel guides, security and defense work, cleaning, and caring for the elderly. In schools, social robots are being used to provide children with interactive learning experiences across a range of curriculum areas, including

science, mathematics, language, and literacy.⁵

Social Robots and Early Learning

Robots in education generally have been used for helping children learn about *robotics*, which includes learning about STEM (science, technology, engineering, mathematics) and computer programming skills. For example, a small programmable floor robot, such as a Bee Bot robot (15cm x 15cm), can help support the development of preschoolers' coding, problem solving, spatial directions, and sequencing skills. More recently, use of *social robots* to engage children in classroom activities and to support social-emotional skills is increasing. Humanoid social robots, such as NAO (57 cm tall), are designed specifically to communicate with children through language exchanges and build social relationships by responding to children in human-like ways through eye contact and physical gestures. Social robots engage young children in conversations by greeting them and asking them questions such as, "How are

you?" or "What are you going to do today?"

Social robots appeal to young children because they provide a whole physical experience, known as *physical embodiment*, that is difficult to experience with personal computers or mobile screens such as tablets.⁶ It is suggested that this physical embodiment may provide children with increased motivation, satisfaction, and enjoyment during child-robot interactions.⁷ Children have been observed to respond positively to social robots by hugging them, giving them a thumbs up, and treating them like a friend or companion.⁸

Social Robots as Learning Assistants

Social robots can act as guides in the preschool classroom and help children learn skills such as handwriting, math and science, and storytelling. Social robots may serve in the role of tool (technology aid), peer (provides prompting and feedback), or tutor (guides learning).

Children can learn a second language with the help of social robots. Turkish children who had immigrated with their families to live in the Netherlands said that they liked to use a social robot for learning a new language and felt connected to the social robot.⁹

These robots can be programmed to adapt their responses to children, providing positive feedback through verbal encouragement (e.g., by saying "That's great work!" or "I like your drawing!"). Social robots can use physical gestures to supplement the verbal feedback, such as using their arms to demonstrate the word "big." They can use pointing gestures with their hands to direct children's attention to the pictures and words

in a storybook, then talk with them about the story.

Children can learn social skills from social robots, such as sharing with others. Closer examination of child-robot interactions is key to extending our understanding of how preschool children respond to and interact with social robots, and how this may affect their social-emotional, cognitive, and physical development.

Social Robots and Teacher Workload

Teachers worldwide are experiencing increasing class sizes and demanding workloads. To help reduce the pressures on them, social robots could be used as teaching assistants that offer one-on-one attention for children. For instance, if a child is having difficulty with a learning concept, a social robot could provide an

age- or ability-level activity for the child and work with them in non-judgmental ways to strengthen that skill. Social robots also may be of assistance for children with physical or cognitive disabilities, catering to children's varied learning needs and interests. This potentially provides greater opportunities for more personalized learning experiences.

Potential Barriers to Using Social Robots

Although several advantages of bringing social robots to preschool have been suggested, the limitations of social robots also should be noted. Social robots may lack the fine motor skills to physically pick up objects. Also, a social robot's ability to recognize facial expressions and emotions is currently limited and this technology may take 5 to 10 more years to

become fully developed.¹⁰ Even with further advancements, the risk remains of simplifying important learning interactions. Social robots are not capable of the full range of empathic and emotional approaches that a human teacher provides to young children.

It is also important to ensure that strong *ethical frameworks* are created to guide use of social robots in an educational setting. Indeed, the potential impact of artificially intelligent (AI) social robots on teaching needs close attention. Questions are emerging about how children and teachers perceive, make sense of, trust, and engage with social robots that collect and deploy data through their online inbuilt cameras. This issue must be tackled to ensure young children's safety, security, and privacy rights are protected.¹¹ Furthermore, we must consider how a social robot might manage



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children's behavior in the classroom. Another important issue to address is how to ensure equity in terms of who can access these digital tools and resources.

Due to unknowns such as these, it is essential to ensure that ethical standards, policies, and guidelines are carefully developed and applied to avoid possible risks, threats, and disruptions. Consideration of the cost and technical expertise needed to code, program, and operate social robots, and support professional development for teachers, also would be necessary to successfully integrate social robots into the preschool classroom.

Implications for the Future

Social robots have the potential to transform children's learning experiences, but also carry the risk of disrupting teaching practices. A thoughtful approach to integrating social robots into preschool classrooms is particularly important, taking into account such factors as learner diversity, teacher workloads, school resources, personalized learning, and ethical frameworks. Future decisions by policymakers will shape how social robots will be adapted and introduced into classrooms to best support our young learners in this digital world.

It seems unlikely that social robots will replace human teachers. Nevertheless, as with any tool, we need to know how to best use it for early learning. In their current form, social robots have many limitations; used appropriately, however, they may enhance children's early learning experiences. Increasing our understanding about how children build relationships with social robots will be key to determining the full potential of social robots.



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Notes:

¹ Bartneck, C., & Forlizzi, J. (2004). A design-centred framework for social human-robot interaction. In *Proceedings of IEEE International Workshop on Robot and Human Interactive Communication, Japan* (pp. 591-594).

² Toh, L. P. E., Causo, A., Tzuo, P.-W., Chen, I.-M., & Yeo, S. H. (2016). A review on the use of robots in education and young children. *Journal of Educational Technology & Society*, 19(2), 148-163.

³ Bartneck, C., Croft, E., & Kulic, D. (2009). Measurement instruments for the anthropomorphism, animacy, likeability, perceived intelligence, and perceived safety of robots. *International Journal of Social Robotics*, 1(1), 71-81.

⁴ van den Berghe, R., de Haas, M., Oudgenoeg-Paz, O., Kraemer, E., Verhagen, J., Vogt, P., Willemsen, B., de Wit, J., & Leseman, P. (2020). A toy or a friend? Children's anthropomorphic beliefs about robots and how these relate to second language word learning. *Journal of Computer Assisted Learning*, 37. <https://doi.org/10.1111/jcal.12497>

⁵ Belpaeme, T., Kennedy, J., Ramachandran, A., Scassellati, B., & Tanaka, F. (2018). Social robots for education: A review. *Science Robotics*, 3, 1-9.

⁶ Causo, A., Vo, G. T., Chen, I. M., & Yeo, S. H. (2016). *Design of robots used as education companion and tutor*. In S.

Zeghloul, M. Laribi, & J. P. Gazeau (Eds.), *Robotics and mechatronics. Mechanisms and machine science* (pp. 75-84). Springer.

⁷ Kanero, J., Geçkin, V., Oranç, C., Mamus, E., Küntay, A. C., & Göksun, T. (2018). Social robots for early language learning: Current evidence and future directions. *Child Development Perspectives*, 12, 146-151.

⁸ Kim, Y., & Tscholl, M. (2021). Young children's embodied interactions with a social robot. *Educational Technology Research and Development*, 69, 2059-2081.

⁹ Leeuwestein, H., Barking, M., Sodacı, H., Oudgenoeg-Paz, O., Verhagen, J., Vogt, P., Aarts, R., Spit, S., de Haas, M., de Wit, J., & Leseman, P. (2021). Teaching Turkish Dutch kindergartners Dutch vocabulary with a social robot: Does the robot's use of Turkish translations benefit children's Dutch vocabulary learning? *Journal of Computer Assisted Learning*, 37(3), 603-620.

¹⁰ de Haas, M. (2022). *Staying engaged in child-robot interaction: A quantitative approach to studying preschoolers' engagement with robots and tasks during second-language tutoring*. Tilburg University.

¹¹ Guggemos, J., Seufert, S., Sonderegger, S., & Burkhard, M. (2022). Social robots in education: Conceptual overview and case study of use. In D. Ifenthaler, P. Isaias, & D. G. Sampson (Eds.), *Orchestration of learning environments in the digital world* (pp. 173-195). Springer.