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Bringing Social Robots to Preschool: A Disruption or Transformation?

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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. 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 viewed as an automated machine that completes a set of actions programmed via a computer. With advancing technology, robots have been designed to socially interact with people in meaningful ways and communicate through speech, facial expressions, and physical gestures (Breazeal, 2003; Neumann, 2020). 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” (Bartneck & Forlizzi, 2004, p. 592). With these characteristics, social robots have the potential to form relationships with people and take on different roles such as companions, friends, peers, and tutors (Toh, Causo, Tzuo, Chen, & Yeo, 2016).

Children’s tendency to view social robots as having human behaviours and emotions, such as feeling happy or sad, is known as *anthropomorphism* (Bartneck et al., 2009). Young children up to 12 years old are more likely to anthropomorphise social robots than adults and the tendency of children to view social robots in anthropomorphic ways can influence how children respond to them (van den Berghe et al., 2020). For example, young children may believe social robots have biological qualities such as eating and growing and have real feelings. This highlights the importance of understanding children’s views and expectations of social robots, especially when they are used for educational purposes (Kory-Westlund & Breazeal, 2019).

Types of Social Robots

Over the past few decades social robots have become increasingly *anthropomorphised* and designed to appear more friendly in appearance with the addition of a human-like face, eyes, arms, and legs. A variety of social robots have been commercially developed to be used by children. For example, social robots such as NAO or ASIMO are regarded as humanoid robots because they are designed with bipedal mobility for walking, moving, and dancing. Social robots 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 colours (Causo et al., 2016). Some social robots have visual recognition via inbuilt cameras with digital eyes that can change shape, colour, 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 robot to relate and interact with children in their home or in classroom settings (Han, 2008).

Social robots can be used for a range of purposes

In several countries around the world (e.g., Sweden, Germany, France, Japan, China, United Arab Emirates, USA, UK, Australia) people are using social robots for different purposes such as education, entertainment, food services, travel guides, security and defence work, cleaning, and caring for the elderly (Hameed, Strazdins, Hatlemark, Jakobsen, & Damdam, 2018). In schools, social robots are beginning to provide children with interactive learning experiences across a range of curriculum areas such as science, maths, language, and literacy (Belpaeme, Kennedy, Ramachandran, Scassellati, & Tanaka, 2018).

Social robots and early learning

Robots in education have been generally 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 (Chalmers et al., 2022). More recently, using *social robots* to engage children in classroom activities to support social-emotional skills is increasing and a growing area of educational research. Humanoid social robots such as NAO (57 cm tall) are different from the Bee Bot floor robots because they are designed specifically to communicate with children through language exchanges and build social relationships through eye contact, physical gestures, and respond to children in human-like ways. Social robots engage young children in conversations by greeting them and asking them questions such “How are you?” or “What are you going to do today?”.

Social robots further appeal to young children because they provide a whole physical experience, known as *physical embodiment*, which is difficult to experience with personal computers or mobile screens such as tablets (Causo et al., 2016). It is suggested that the physical presence and embodiment of social robots may provide children with increased motivation, satisfaction, and enjoyment during child-robot interactions (Kanero, Geçkin, Oranç, Mamus, Küntay, & Göksun, 2018). Children have also been observed to respond positively to social robots by hugging them, giving them the thumbs up, and treating the social robot like a friend, companion, or learning assistant (Kim & Tscholl, 2021).

Social robots as learning assistants

Social robots can act as guides in the preschool classroom and help children learn skills such as handwriting (Zhexenova et al., 2021); maths and science (Konijn & Hoorn, 2020), and storytelling (Crompton, 2018). Social robots may assist children in learning a second language. For example, 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 (Leewestein et al., 2021). Social robots may take on the role as a tool (technology aid), peer (provides prompting and feedback), and tutor (guides learning) (Mubin et al., 2013). They can be designed to adapt their responses to children by visually attending to children and providing positive feedback such as verbal encouragement (e.g., by saying “That’s great work!” Or “I like your drawing!”) (Neumann, Neumann, & Koch, 2022). Social robots can use physical gestures and perform actions to demonstrate meanings of words such as using their arms to demonstrate the word ‘big’ which in turn may supplement the robot’s verbal response and feedback (de Wit, Schodde, Willemsen, Bergmann, de Haas, Kopp, Krahmer, & Vogt, 2018).

Social robots can use pointing gestures with their hands when reading a story book to direct children’s attention to the pictures and words then talk about the story (Hameed et al. 2018; Michaelis & Mutlu, 2017). And children can learn social skills such as prosocial behaviours from social robots such as sharing with others (Peter, Kuhne, & Barco, 2021). Closer examination of child-robot interactions is key to extending our understanding of how preschool children respond to, engage, and interact with social robots; and how this may impact on their social-emotional, cognitive, and physical development (Crompton et al., 2018).

Social robots and teacher workload

Teachers worldwide are currently experiencing increasing class sizes and demanding workloads. To help reduce this time pressure in the future, it could be possible that social robots could be made available as teaching assistants to provide one on one attention to individual 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-judgemental ways to help them strengthen that skill. Social robots may also assist children with physical or cognitive disabilities, catering for varied learning needs and

interests of children. This potentially provides greater opportunities for more personalised learning experiences (Leyzberg et al 2014; Neto, Nicholau, & Paiva, 2021)

Potential barriers to using social robots

Although several advantages of bringing social robots to preschool have been suggested, there are also limitations of social robots in terms of their physical mobility and voice recognition that need to be considered. Social robots may lack the fine motor skills to physically pick up objects with their hands or use their fingers. Also, a social robot's ability to recognise facial expressions and emotions is currently limited and this technology may take 5 to 10 more years to become fully developed (de Haas, 2022). Even with the further advancement of social robots there is a risk of simplifying important learning interactions resulting in possibly a "robotic style" of teaching rather than the full range of empathetic and emotional approaches that a human teacher would normally provide to young children.

It is also important to ensure that strong *ethical frameworks* are created that clearly detail how social robots can be used with children in an educational setting (Sharkey & Sharkey 2021). Indeed, the potential impact of artificially intelligent (AI) social robots on teaching with children in the classroom needs close attention. Questions are emerging such as how children and teachers perceive, make sense of, trust and engage with social robots that can collect and deploy data through their online inbuilt cameras. This must be tackled to ensure young children's safety, security, and privacy are met (Guggemos et al., 2022). Furthermore, how would a social robot manage children's behaviour in the classroom and how would equity be addressed in relation to who can access these digital tools and resources?

Due to unknowns such as these, it is essential to ensure that ethical standards, policy, and guidelines are carefully developed and applied to avoid possible risks, threats, and disruptions that might arise. Consideration of the cost and technical expertise needed to code,

program, and operate social robots, and support professional development for teachers would be necessary to successfully integrate the social robots into the preschool classroom.

Implications for the Future

Social robots have the potential to transform children's learning experiences but also disrupt teaching practices. Taking a thoughtful approach to integrating social robots into preschool classrooms is particularly important because of a range of factors such as learner diversity, teacher workloads, school resources, personalised learning, and ethical frameworks. Future decisions by policy makers 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 but like any tool, we need to know how to best use it for early learning. In their current form, social robots have many limitations however they may also enhance early learning experiences for children. Increasing our understanding of how children build relationships with social robots will be key to determining the full potential of social robots.

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