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PAPER

Social Robots, Mindfulness, and Kindergarten

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ABSTRACT

The following review examines the use of social robots in mindfulness practices, with a focus on their application in preschool settings. Additionally, it explores the key attributes of social robots that could enhance their effectiveness in achieving targeted outcomes. This study is the initial phase of a project that aims to investigate the advantages of technology and mindfulness in kindergarten. The selection of this age group is based on its significance in the comprehensive development of children, despite the lack of extensive study on mindfulness in this specific context. The objective of this paper is to present existing research on social robots and mindfulness, assess the potential benefits and challenges of integrating these two fields in kindergarten, and, most importantly, inspire future studies on the use of robots and mindfulness in early childhood education. A bibliographic review of articles was conducted. The findings of our study suggest that the use of robots and human-robot interactions can enhance self-development, well-being, and mindfulness. Robots have the capacity to capture attention and motivate young children, specifically. Both humanoid and non-humanoid robots seem suitable for facilitating mental well-being exercises. However, a well-designed social robot for children should incorporate both human-like and mechanical features. Our primary aim is to encourage further study on the integration of robots and mindfulness in preschool education, as there is still a vast unexplored territory in this rapidly advancing field.

KEYWORDS

socially assistive robots (SAR), mindfulness, kindergarten

1 INTRODUCTION

Scholars acknowledge robots as cutting-edge educational tools with the potential to revolutionize education and assist students in various learning environments [1]. The application of robots in educational environments demonstrates considerable potential. The field of educational robots facilitates the development of several cognitive abilities, including problem-solving, computational thinking, motivation, and cooperation [2].

The study demonstrates that integrating robotics into the kindergarten classroom enhances educational practice. Educational robots can foster a collaborative,

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student-centered environment. However, their appropriate integration into curricula requires concerted action to develop activities suitable for this age group [3].

The concept of mindfulness is increasingly being recognized as a means to enhance well-being and as a valuable life skill that can be developed through regular practice [4]. Mindfulness refers to the ability to consciously perceive bodily sensations, thoughts, and feelings without judging them [5]. Studies have demonstrated that children who exhibit higher levels of mindfulness earlier in life have enhanced self-regulation abilities and are less prone to developing behavioral issues [6]. Research has shown that educational interventions initiated throughout early childhood exhibit more enduring effects compared to those initiated during later stages of development [7].

Numerous studies acknowledge that executive functions (EFs) and self-regulation are crucial for school readiness and pro-social behavior during the preschool years. EFs typically refer to advanced cognitive abilities that govern goal-directed behavior, influencing the control of thoughts, actions, and emotions [5]. Executive function is a broad concept in psychology that encompasses various cognitive processes essential for achieving success in daily activities. Self-awareness, defined as the mental state in which an individual focuses on oneself [8], and self-regulation, the capacity to control emotional and behavioral reactions, are both vital elements of executive function. Individuals can improve their problem-solving performance and real-world function by effectively self-regulating their cognition and emotions in a systematic manner [9]. During the period from three to five years old, children undergo rapid development of skills crucial for school readiness [10].

During the practice of mindfulness, children are instructed to continuously direct their attention to their current experience. They are encouraged to focus on a specific item, such as their breathing or an external stimulus, and then redirect their focus back to that object whenever their mind wanders. Mindfulness-based interventions have the potential to enhance the development of self-regulation skills [11]. Therefore, the use of mindfulness meditation could be a valuable strategy for improving emotional regulation and reducing the impact of stress, anxiety, and depression. Recent studies indicate that employing social agents, such as social robots, as coaches can lead to advantages in boosting engagement, motivation, and ultimately the efficacy of cognitive training. Socially-assistive robots (SARs) are mechanical devices designed to engage in social interactions and enhance well-being [12]. However, studies on preschool education, which is essential for a child's overall development, have been limited.

This paper focuses on two research questions: 1) Can SARs enhance mindfulness training in kindergarten, and 2) What are the main characteristics of robots that optimize their results in mindfulness training? With this in mind, the report first explores the potential benefits of social robots and mindfulness in a more general context. Then, it examines whether social robots can be an educational tool to promote mindfulness in preschool children, and finally, it identifies the characteristics that robots should have to optimize the educational process of mindfulness. The study aims to raise questions for future research.

2 METHOD

This study is a literature review of articles. Our main aim was to outline the existing knowledge on the subject and identify possible gaps in the literature. To stay up-to-date with the latest innovations in the field, we primarily analyzed articles

published in the last decade. We used Google Scholar, ResearchGate, and Mendeley as our databases, and the research was conducted with the following keywords: social assistive robots, mindfulness, and kindergarten.

3 SOCIAL ASSISTIVE ROBOTS

Robots are adaptable technologies that have great potential as tools to enhance teaching and learning in both educational settings and domestic environments. Educational robots have been found to have a beneficial influence on the learning process. They also have the ability to engage and entertain children, increasing their concentration and fostering a greater sense of purpose. Additionally, it is noteworthy to emphasize that this attention control plays a pivotal role in the retrieval and modification of working memory [13]. Robots have shown effectiveness in special education, particularly in educating children with autism spectrum disorder (ASD) [14]. Undoubtedly, robots have a fascinating and stimulating quality, especially for young children [15].

The use of robots in the learning process can be defined as robot pedagogy. The role of robots in the educational environment changes depending on the educational purposes. In the educational environment, robots can serve as teachers, materials, or peers. We can also categorize them as social robots or robot kits. In the literature, robots used as peers or teachers are called social robots, while robotics kits involve the use of robots as hardware, mainly for teaching programming skills to different age groups [16]. This research focuses especially on social robots. A socially interactive robot has the ability to not only perceive and utilize social indicators such as eye contact and hand movements but also has the cognitive capability to retain and acquire knowledge from the interactions experienced during a social engagement [17].

We can use robots flexibly in various locations and at different times because of their portability. Interacting with a robot can help reduce negative emotions. Robots offer instant engagement without promoting social comparison or peer pressure. Previous studies on human-robot interaction indicate that feeling a sense of co-presence with an integrated therapeutic agent can enhance motivation and performance [18].

Socially assistive robotics helps vulnerable populations through social interaction. Many children with autism and ADHD have benefited from their use. Specifically for children with autism, who typically have impaired social skills, robots encourage them to initiate and maintain social interaction. The primary objective of these robots is to enhance the well-being of the children by assisting therapists in maintaining continuous surveillance [19]. Additionally, social robots can establish structured settings that aim to alleviate stress that may arise from typical social interactions, especially in children with autism spectrum disorder [20].

Although supportive interventions have had beneficial outcomes, SARs encounter a significant obstacle in terms of their adoption across various stakeholders [21]. A study has demonstrated that special education teachers exhibit a high level of skepticism about the implementation of social robots in educational settings. People often believe that robots primarily perform mechanical and repetitive tasks. Furthermore, educators have expressed concerns regarding the potential consequences of using social robots on the cognitive growth of children. There is a suggestion that robots may have a dehumanizing impact on children, potentially leading to increased social isolation if children develop a social connection with a robot.

Lastly, they also expressed concerns regarding their lack of proficiency in operating the robot. Nevertheless, many educators expressed their belief in the robot's capacity to augment and optimize the educational process, foster learning beyond the walls of the classroom, alleviate stress in underachieving pupils, and assist and inspire students [22].

3.1 Examples of social robots

The NAO robot has demonstrated consistent utilization across various domains, including autism spectrum disorder (ASD), cancer, and wellness [23]. The inherent simplicity of the activity appears to engage the user without bombarding them with social stimuli.

According to Duradoni et al. [23], PROBO and PARO are the most widely utilized robots, following the NAO robot. PROBO and Paro have an animal-like morphology. Interaction and touch, related to therapy using real animals, are crucial therapeutic components that can offer social and emotional assistance. The soft texture of PROBO and PARO renders them suitable for therapeutic intervention. Furthermore, it seems that animal-like robots are more favorable for managing symptoms of anxiety. The study supporting their utilization resembles the approach of animal-assisted treatment, which has demonstrated its potential advantages in alleviating anxiety in diverse patients [24].

The development of Fribo aimed to tackle the issue of social isolation. Fribo is a social networking robot that uses audio to communicate with friends about routine household duties. According to the findings, Fribo reduces feelings of loneliness and encourages more in-person social contacts [18].

The study by Kewalramani et al. [25] highlighted the positive interaction children had through the use of robotic toys during quarantine due to COVID-19. Interviews with parents and children, digital observations, and children's drawings revealed that children engaged in creative conversations with their AI robots. These conversations were based on empathy and elicited feelings of delight and a sense of coherence with the robots [25].

Romibo is a robot that can move, make gestures, speak, and enhance cognitive and educational abilities. It must be controlled remotely. The humanoid puppet-like avatar, known as Kaspar, which stands for kinesics and synchronization in robotic personal assistants, assists educators and parents of children with autism and other serious communication disorders. Kaspar was intentionally designed with an expressive facial cutout because autistic children struggle to interpret voices and read expressions [26].

Shybo is an android capable of assuming the role of a character in narratives and scenarios. This robot can receive auditory stimuli and respond with basic actions, such as changing its illumination to various colors and adjusting the position of its hat. With the aim of aiding children in acquiring knowledge, Shybo possesses a crucial attribute: the ability to teach. To interact with Shybo, children must undergo training by engaging with different sounds and matching colors. They can adjust its mode, select different colors, and record sounds. Children have expectations regarding the robot's abilities that the prototype cannot fulfill. Regarding the experience, one initial issue was that parents might not feel comfortable with their children participating in a class that involves a robot. Concerning the sequence of activities, one challenge was that the activities occurred sequentially, potentially causing boredom and distraction for children [27].

Additionally, Leite et al. [28] suggest that robots have the capacity to exhibit empathy, meaning they can accurately perceive the behaviors of people and react in a suitable manner. These robots have superior efficiency in establishing and maintaining positive relationships with individuals. The authors conducted a research study where an autonomous robot named iCat, having empathic capabilities, played the role of a social companion for two participants engaged in a game of chess. The robot exhibits a range of facial expressions and linguistic utterances in response to the movements made on the chessboard, demonstrating empathy for one player while maintaining a neutral attitude towards the other. The findings from a study involving 31 participants indicate that individuals who received empathetic treatment from the robot evaluated the robot as more likable. This supports the concept that empathy is a crucial factor in human-robot interaction [28].

Socially assistive robots hold significant promise in the area of education and learning, especially for children with impairments. For instance, Amato et al. [29] studied the use of a pepper robot in children with ADHD. Their aim was to enhance the appeal of the treatment and capture the children's attention. The robot was equipped with a touch screen for interaction through an app. It also had two cameras that therapists could control to provide personalized exercises and, most importantly, monitor the child's level of attention. The children reported feeling like they were in a therapeutic environment, and using pepper helped reduce their anxiety [29].

3.2 Social robots and kindergarten

Programmable robotics and artificial intelligence toys are educational tools that provide children with a fun learning environment to enhance their theory of mind abilities and expand their knowledge of robotics and creativity. Robotics has the potential to improve children's social relationships, increasing their willingness to participate in activities and collaborate with their peers [30].

In their study, Conti et al. [15] conducted a study with a sample of 81 kindergarten students, instructing them to memorize two fairy tales narrated by a humanoid robot. The robot used in the study was the NAO robot, a small, toy-like humanoid robot that is widely used in studies on the interaction between children and robots. The robot has the capability to recognize faces and create the illusion of eye contact by adjusting its head movements accordingly. Additionally, it can change the color of the LEDs around its eyes to mimic various emotions. Moreover, it is equipped with sensors and microphones that allow it to gather extensive data about its environment [15].

Therefore, the children listened to the narration of two fairy tales by the robot NAO and a human. The first fairy tale contained cognitive content, while the second had emotional content. Both the human narrator and the robot narrator displayed varying social behaviors, presenting the fairy tales in both static and expressive styles. The findings suggest that expressive behavior positively impacts robot storytelling, showing a level of effectiveness comparable to that of a human engaging in similar activities and surpassing that of a static, non-expressive human. The robot demonstrated improved efficacy in narratives containing knowledge-based information, but its limited ability to convey emotions led to reduced effectiveness in narratives involving emotional content. The analysis of the test results indicates that preschool-aged children retain tale elements better when the robot engages in expressive social behavior during narration [15].

Park et al. [31] designed the Furby robot for children aged 4 to 6 years. This robot can recognize its name and display happy and sad expressions. It can also sing and dance and has language-learning functionality. However, since children found it challenging to understand Furby's language, the researchers created an artificial intelligence application called ARA to assess the children's responses based on their language proficiency levels. The study's results suggest that children who interact with robots can enhance their communication skills and conversational abilities.

Crompton et al. [32] conducted a qualitative study to investigate the potential integration of the humanoid robot NAO into three preschool classrooms. The findings indicate that the robot facilitated educational advancement for pupils across various domains of learning. The children showed a strong intellectual curiosity about the robot. The data indicates the participants' willingness to engage in verbal communication, ask questions, establish visual contact, and acquire further knowledge about the robot. The robot's appearance generated immense enthusiasm and provided students with an opportunity to practice patience. Additionally, it offered numerous opportunities for communication and language development. Students actively participated in conversations and proactively integrated their newly acquired understanding of robots into their play activities [32].

Keren et al. [33] found that teachers can greatly benefit from the use of social robots trained to recognize students' emotions through facial recognition and gestures. Another study, in which the NAO robot was used in an educational context with preschool children, was Kindergarten Assistive Robotics (KAR). This study primarily focused on children aged 4 to 6, acknowledging the preschool years as a crucial stage for their holistic development [34]. KAR is a novel tool that facilitates the advancement of children's personal growth by fostering social engagement. Through playful interactions with children, this study elucidates the efficacy of KAR in facilitating the instruction of geometric thinking, a fundamental component of spatial knowledge, among kindergarten educators through the facilitation of playful interactions with children. The majority of children exhibited positive engagement with the robot and derived a lot of pleasure from their interactions with it. Engaging in interactive activities with the robot enhances children's proficiency in geometric reasoning and metacognitive tasks [34].

4 SOCIAL ROBOTS AND MINDFULNESS

The philosophy of mindfulness refers to the deliberate and conscious act of focusing one's attention on the present moment. Mindfulness is considered a set of techniques for mental training and rehabilitation. Through the practice of observing thoughts, sensations, and emotions arising from experience in real-time, mindfulness training aims to cultivate self-awareness, self-regulation, and a positive relationship between oneself and others [35]. Although there are multiple methods and strategies for teaching self-regulation, mindfulness techniques have recently been implemented in educational environments to enhance the well-being and self-regulation skills of both children and instructors [36].

Mindfulness could also help individuals ascend the emotional intelligence pyramid, as outlined by Drigas et al. [37]. Individuals with higher levels of mindfulness exhibit improved abilities to manage negative emotions, utilize positive coping strategies in the face of challenges and setbacks, and maintain interpersonal relationships. The encouraging outcomes seen in adult populations have inspired educators and educational researchers to explore the implementation and assessment

of mindfulness training in children. Presently, most studies have focused on school-aged children. Nevertheless, there is growing evidence indicating that mindfulness training can enhance diverse executive functions in preschool-aged children [38].

The deliberate act of focusing one's attention on the current moment is known as mindfulness, while meditation serves as the method to achieve this condition [39]. Researchers have not extensively investigated social robots as a tool for mindfulness-based techniques. A pilot study was undertaken utilizing a randomized controlled design to assess the acceptability and perceived effectiveness of a robot in boosting the mental well-being of individuals in a higher education context [40]. The findings of a research investigation that employed robot-guided mindfulness exercise, assessed by monitoring EEG changes during exercise sessions, indicated that a robotic coach had the capacity to aid people in achieving a state of awareness. The present study aimed to examine the efficacy of an autonomous humanoid robot in promoting well-being through a 10-minute engagement with a mindful breathing exercise. This was compared to a brief interactive session that was specifically developed to enhance relationships. Social robots provide supplementary advantages through their advanced digital and electronic software. Social robots in healthcare are frequently regarded as fascinating and captivating, making them appropriate in educational settings [40].

Yoon et al. [12] examined the impact of human-robot interaction-facilitated mindfulness meditation on brain activity. Two distinct groups of participants were subjected to the collection of EEG signals. One group engaged in mindfulness meditation with the assistance of a social robot, whereas the control group solely received a lecture delivered by the robot. The findings demonstrated a notable decrease in global phase synchronization within the beta frequency range among participants in the meditation group. The results indicate that SARs have the capacity to be incorporated into mental health care and enhance the effectiveness of interventions [12].

Ayoub et al. [41] investigated whether the robot Cozmo, which uses breathing exercises, can serve to relax employees under stress. At the same time, it was examined whether this interactive breathing exercise would also lead to an improvement in attention, increasing the performance of the workers. This robot can move its eyes and head, and it also has wheels to move around. Additionally, it has face detection software and can express its emotional states through its eyes and the sounds it makes. Using a speech synthesizer, he could give clear commands to users. The results showed that the breathing exercises with the help of Cozmo affected the level of anxiety; however, they failed to improve the attention of the participants. Hence, researchers proposed that the primary purpose of integrating a robot with breathing exercises into everyday job routines could be to induce relaxation and enjoyment through interaction [41].

Alimardani et al.'s research [39] aims to develop a robotic assistant that facilitates mindfulness training through a brain-computer interface (BCI) system. In order to accomplish this objective, the researchers gathered electroencephalogram (EEG) signals from two distinct groups engaged in both meditative and non-meditative human-robot interaction. The participants were exposed to meditation instructions delivered by a Pepper robot in the meditation group or a lecture on mindfulness in the control group, all while wearing an EEG cap [42]. Based on their findings, there was a notable primary impact of time on participants' self-reported feelings, indicating enhanced mood following engagement with the robot, irrespective of the nature of the interaction [39].

Huang et al. [18] utilized an NAO robot and audio to explore the variances between two test groups in the practices of mindfulness. The outcomes of their study

revealed that the robotic voice did not assist the participants, who felt a stronger connection to the anthropomorphic audio voice. Additionally, they did not observe any outcomes with walking mindfulness, which may be due to the need for more time to take effect [18].

People are integrating social robots into their daily lives to enhance their physical and mental health. Bodala et al. [4] conducted a study that explored the use of social robots in mindfulness sessions. A remote-controlled robotic platform was designed to facilitate mindfulness training sessions with an experienced human coach. This platform imitates the upper body and head movements of the robot Pepper in real-time. The participants experienced positive benefits from these mindfulness sessions [4].

The study conducted by Mitsea et al. [42] details the utilization of a NAO robot as a yoga instructor. The robot could modify the training based on its ability to identify and understand human movement actions. More precisely, the robot showcases predetermined workouts, and the user performs the showcased exercises in collaboration with the robot. The system tracks and analyzes the user's exercise performance and then adapts the session to optimize the effectiveness of the workout. Yoga enhances cognitive-motor abilities, concentration, and alertness. Furthermore, it is simple to acquire and adjust according to the child's age and level of functionality. Yoga promotes mindfulness, which is a cognitive skill that includes being aware of oneself, regulating one's behavior, remembering information, being mentally flexible, having confidence in oneself, and thinking and solving problems [42].

A separate study [42] introduces a robot named Sophia. Sophia has the ability to engage with humans in a sympathetic manner, with a specific focus on fostering self-awareness, self-fulfillment, and self-transcendence in people. Sophia conducted a short pilot study involving 10 participants, guiding them through discussions and meditation exercises aimed at inducing relaxation and enhancing the cognitive ability of imagery. The findings demonstrate that the connection between humans and robots has the potential to enhance personal growth, overall happiness, and consciousness. Meditation activities can alter motivation and improve processes of self- and emotion-regulation, such as the ability to control attention and engage in conceptual thinking.

The therapy framework known as STAR, as introduced by Hurst et al. [43], incorporates recognized and evidence-based therapeutic practices provided by embodied Moxie. The therapeutic framework, in conjunction with Moxie, aims to establish a stimulating, protected, and stable setting for children aged five to 10. With Moxie, children can engage in activities such as playing, drawing, and reading while also serving as a mindfulness trainer. Moxie actively identifies behaviors to enhance children's engagement and utilizes an internal curriculum to plan and involve each child in activities that optimize outcomes [43].

Kewalramani et al. [25] introduced the Alpha Mini Robot, an artificial intelligence robot with voice and facial recognition. An application can program the robot to imitate playful activities such as meditation, mindfulness exercises, and Tai Chi, as well as to display emotions. This feature provides children with the opportunity to co-create social-emotional stories that enhance their ability to express feelings and develop self-regulatory behaviors [25].

Another study [21] examined the viewpoints of individuals who participated in a mindfulness training program that included both a human coach and a remote robot coach. Participants assigned much higher ratings to the human coach compared to the robot coach in terms of vividness, likability, and perceived intellect. These data demonstrate the differences between a remote-controlled robot and a human trainer in various aspects. Individuals evaluated their interactions with

the human coach as more dynamic and authentic. When the robot was not visible, people found it to be nice and likable. Participants appreciated the chance to have a meaningful interaction with the robot, where it regularly assessed their well-being and allowed them to share their ideas on their development. The participants proposed integrating other functionalities into the coach robot, including the ability to personalize the topics and length of mindfulness sessions, as well as providing feedback and guidance according to individual progress [21].

5 ROBOT CHARACTERISTICS

Humanoid social robots can differ in the extent to which they exhibit anthropomorphic physical traits. When creating a robot, it is important to take into account the users, including children, adults, and the elderly, as well as the specific context in which the robot will be used, such as households, education, and rehabilitation settings. Researchers utilized the KASPAR humanoid robot, designed to mimic a young child, specifically for children diagnosed with autism spectrum conditions [44].

Already for several years, there has been the theory of the "uncanny valley," according to which the level of human realism of the robot has a negative impact on users. At the same time, the size of the robot affects its interaction with users. Larger robots seem to be less likeable to children compared to smaller ones. A small, toy-like robot with a low level of realism could be integrated into the kindergarten environment. Such a robot creates a pleasant interaction experience for children. Also, speech style and expression integration play an important role in the robot's effectiveness. For example, Fridin and Yaakobi [19] designed KAR with a female voice because it is more associated with kindergarten. At the same time, it can express feelings and use vocabulary appropriate for the children's age.

The study has demonstrated that the design of a robot can impact how children perceive the robot's personality or capabilities [45]. The social and emotional engagement between humans and robots differs fundamentally from their interactions with most other technologies. Various types of robots, including humanoid robots, animatronics robots, and mechanical robots, have been developed to imitate human facial expressions, movements, and other physical and motor abilities. The inclusion of both visual and functional features, such as lighting, distinctive vocalizations, musical compositions, and auditory stimuli, can effectively capture the attention of youngsters and foster positive reinforcement [20].

Federico Manzi et al. [44] conducted a comparative analysis of the performance of two humanoid robots, NAO and Robovie, with varying levels of anthropomorphism. The Robovie robot has a greater number of mechanical and physical attributes in comparison to the NAO robot. The study included children who were five, seven, and nine years old. The results of this study indicate that young people tend to assign human-like characteristics to humanoid robots, such as Robovie, that have mechanical features. Specifically, the research indicates that the age of children should be taken into account when developing a robot [44].

In addition, the external appearance of robots can influence how humans interpret their actions. For instance, the NAO humanoid robot has the ability to elicit empathy due to its endearing and childlike appearance, which may simply be attributed to human-like characteristics. Empirical studies have demonstrated that the robot's artificially intelligent activities, such as speech, smiling, and movement, in conjunction with interactions with children, can serve as a compelling and impactful illustration that has the potential to enhance children's empathy skills [25].

Axelsson et al. [46] investigated the essential characteristics that robots should possess to maximize their potential. They discovered that robots should encourage users to practice daily, offer praise, respond to emotions, and adjust facial expressions based on the conversation. Survey participants also showed a preference for positive feedback and affirmations. However, it is crucial to ensure that positive feedback does not result in overly mechanical interactions. Participants suggested that using a robot alongside a human trainer would be beneficial for demonstrating and performing various exercises, such as yoga poses. They also envisioned the robot serving as an educational tool, capable of guiding breathing exercises and posing specific questions. The authors emphasized the importance of the robot's ability to analyze practice routines and track progress to enhance its long-term effectiveness. Participants expressed a desire for the robot to be personalized according to their physical activity levels and emotional states. They believed the robot could intervene at the appropriate moment to encourage physical activity. Participants also felt that the robot's design should align with its intended function, as people tend to form expectations based on its appearance. If the robot resembles a human, it should exhibit human-like behavior [46]. Children haven't developed do not perceive robots as human, but human-like qualities to robots to understand their functions and behaviors [47].

Spitale and Gunes [48] recommend using autonomous humanoid robots to perform exercises that promote physical well-being. This involves allowing users to mimic the robot's movements and equipping the robots with sensing capabilities to monitor the user's emotional state during exercise and the duration of activity. They propose that researchers design an emotional robot—an autonomous robot capable of expressing and recognizing emotions—to promote mental well-being. Both humanoid and non-humanoid robots seem suitable for performing mental well-being exercises. It is suggested that robots should be able to generate expressions and recognize the emotional state of their users. In these ways, they can provide wellness exercises more effectively and adaptively [48].

The findings indicate that using an anthropomorphic design can increase children's attraction to robots. However, an excess of human-like qualities may negatively affect the robot's positive features and lead to the Uncanny Valley phenomenon [44]. Ultimately, children feel more at ease when interacting with robots that possess a blend of human-like traits.

6 RESULTS AND DISCUSSION

This paper aims to address two research questions:

1. Can SARs enhance mindfulness training in kindergarten?
2. What are the main characteristics of robots that optimize their results in mindfulness training?

Regarding the first, the literature review suggests that SAR can indeed play an important role in mindfulness training. They can be engaging and entertaining, and they may help reduce anxiety levels while enhancing self-regulation and executive functions in children. Early childhood and the preschool stage of development are a dynamic period for the acquisition of social-emotional skills. Schools are increasingly using yoga and mindfulness practices for social-emotional learning, yet their effectiveness in early childhood settings remains largely unknown. Mindfulness training has emerged as a potentially effective training approach for enhancing

self-regulation and boosting mental well-being. Many researches underline the potential transformative impact of smart technology, with a specific focus on robotics, on the delivery of mental health education.

However, it's important to note that there is no evidence that robot coaches lead to better results than human coaches, and the existing studies have largely focused on older children and adults.

Regarding our second research question, we concluded that the robot's design has been shown to influence children's perceptions of the robot's character or abilities. When designing a robot, we should take into account the age of the users and the context in which it will be used. An excessive resemblance to humans triggers the Uncanny Valley effect. These data indicate that an effective social robot for kids should incorporate elements of both human and mechanical characteristics. The majority of studies in kindergarten used the NAO robot. In kindergarten, in particular, small-sized robots that resemble toys with a low level of realism are suggested. They should respond to the emotions of the children and change facial expressions when necessary. Additionally, they should provide feedback and positive affirmations. Future research should prioritize investigating the design attributes of social robots to enhance well-being. Specifically, determining the most suitable type of robot for a particular purpose, such as physical activity or cognitive stimulation, is crucial.

While a robot may not completely replace the human trainer during the entire training session, it has the potential to assume certain tasks and responsibilities of the teacher. Although robots may not entirely replace human trainers, they can provide a sense of empathy and presence, as well as motivate children to focus on themselves.

When kindergartens introduce social robots, they must consider and address several ethical and procedural issues regarding their interaction with this type of technology. It is important to take into consideration the attachment that can be formed, as children tend to develop emotional bonds not only with humans but also with artificial beings. Children perceive robots as both informative and trustworthy interaction partners, and they are more likely than adults to follow the suggestions made by robots. Therefore, there are several ethical issues that should be considered when implementing robots in kindergarten.

7 CONCLUSIONS

In a broader context, the concept of robotic companions capable of forming meaningful relationships with humans remains distant from reality. For robots to achieve this, they must engage with humans in a way that mirrors the natural interactions among humans, utilizing social mechanisms that humans employ during their interactions. Currently, SAR is primarily utilized by the elderly, individuals with dementia and cognitive/motor impairments, and children with autism. Studies have shown that robots can improve language and communication skills, as well as support physical, cognitive, and social-emotional learning experiences for children, while also displaying autonomous social behavior.

Although robots are unable to replace human professionals, they can offer alternative solutions to current procedures and enhance the quality of people's lives. By comparing interactions between humans and interactions between humans and robots in similar circumstances, we can gain insight into how users' perceptions and expectations of these interactions evolve over time. The results indicated that robot

treatment has the potential to enhance mindfulness training, leading to improved self-regulation abilities and, consequently, enhanced cognitive and social adaptability. Nevertheless, there is little empirical evidence to support the notion that robots surpass humans in terms of substituting and displacing human teachers.

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