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Children's Existential Meaning-Making of Educational Robots: A Call for Dialogue

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As technological advances become increasingly integrated into children's learning environments, this paper aims to initiate a dialogue about the place and meaning of educational robots in children's lives. We reviewed the existing literature on robots in education and the field of philosophy for children. While the existing studies undoubtedly enrich our understanding of learners' experiences with educational robots, they stop short of explicitly dealing with existential questions. Therefore, we recommend two avenues to study children's existential meaning-making of educational robots: educational robots as cultural tools and educational robots as part of children's play.

Keywords: children's existential questions, children's meaning-making, educational robots

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Introduction

Rapid advances in education and learning tools are shaping today's children's early play and learning experiences (Henning & Kirova, 2012). Educational robots are the offshoot of the robotics technology that has been widely used in manufacturing, engineering, and computation (Wang et al., 2023). These robots are programmable by children and can perform single or a series of actions. The main purpose of utilizing them in educational environments is to introduce computational thinking to children and ultimately strengthen their understanding of STEM concepts and skills (Tarres-Puertas et al., 2023). A review conducted by Mubin et al. (2013) underscored educational robots as a vital tool for captivating and motivating young learners in educational settings. Indeed, through hands-on coding and building exercises, robots offer unique opportunities for fostering cognitive development and promoting STEM skills among young children. 20 years ago, during a "robophilosophy" conference, Luciana Floridi (2014) addressed a crucial existential question: although robots differ from humans, our lives with robots have the potential to make us reflect on our lives and the existential conditions for humans in general. As robotics technology becomes an ever more prevalent component of young children's learning landscapes, this paper aims to initiate a dialogue about the place and meaning of educational robots in their lives. The existential questions children formulate in response to technological learning tools constitute a rich area of inquiry for educators and education researchers alike. In particular, incorporating educational robots into learning environments raises questions for educators and education researchers as to how children construct meaning from their encounters with such a tool and what impact such interactions have on their perception of life and personal philosophy. By prioritizing this line of research, stakeholders can contribute to cultivating well-rounded curricula that promote meaningful dialogues around cutting-edge innovations while remaining sensitive to the underlying ethical, social, and cognitive dimensions inherent in child-robot interactions. Understanding the questions that children grapple with could guide decisions related to designing learning environments and planning educational interventions involving robots.

Existentialist philosophers, such as Søren Kierkegaard, Jean-Paul Sartre, and Simone de Beauvoir, emphasized the profound questions that human beings might pose about the essence of their existence and life conditions. Engaging with existential questions can reshape the core values, outlooks on life, interpersonal relationships, and resulting actions of both adults and young children (Hartman & Torstenson-Ed, 2007). These existential inquiries can manifest as direct questions or speculative reflections, emerging in specific contexts. Humans instinctively question and reflect on

any new phenomena they encounter, such as ongoing conflicts around the world or increasing use of artificial intelligence, and research has shown that children form existential questions related to everyday experience (Hartman &Torstenson-Ed, 2007; Lilja et al., 2020; Pramling & Johansson, 1995). According to Hartman and Torstenson-Ed (2007), children form existential questions about their immediate environment and experiences, and preschool and school constitute a place where questions of existential nature naturally arise. Pramling and Johansson (1995) explained that through existential questions,

> Children work on expressing and trying to understand concerning themselves and life. Existential questions focus on everyday living and fundamental human life, that is, small and large, local and global. …the child's work on right or wrong and good or evil in behavior, life, and the world. (p. 126)

As noted in the citation above, existential questions are not only concerned with grand themes such as the meaning of life but also with ordinary everyday life at preschool. For example, ethical questions about classroom rules' fairness and justice are common for children at preschool. Philosophers Matthew Lipman (1976, 1991) and Gareth Matthews (1994) have long emphasized children's ability to ask questions and investigate their surroundings.[1] In line with Lipman, we believe that children need opportunities to dwell upon any philosophical issue that could affect their lives and that their philosophical thinking could also be developed and nurtured.

Unraveling children's philosophical reflections on their educational robots can provide valuable insights for designing future generations of instructional robots and tailoring immersive, interactive education experiences that foster growth and critical thinking. For example, a study by Okumara et al. (2023) examined children's responses to robots and found that children interact more with socially interactive robots compared to less interactive ones. In the study "'I am scared': Little children reject robots," Shiomi et al. (2016) found that 13 out of 57 children aged 1 to 6 years displayed avoidance behaviors and declined engagement with the robot. Children's rejection of interaction with robots raises important concerns regarding the integration of robots into early

1 The philosophy of childhood came to be regarded as a branch of philosophy, like, for instance, the philosophy of mathematics and the philosophy of religion (Matthews, 1994, p. 7).

childhood education classrooms. Specifically, how might this technology impact children's free play experiences, feelings of autonomy, and relationships with peers and teachers? Understanding these nuances is crucial for developing informed educational strategies that maximize benefits while minimizing potential drawbacks.

In the established field of Robotics, Veruggio (2005) introduces the concept of "roboethics," exploring what will happen when intelligent robots enter our lives and educational environments. This question is also relevant to children's daily experiences in preschool and school. Therefore, our focus in this paper extends beyond mere physical and psychological welfare to encompass the broader concept of children's overall well-being, which includes fostering "philosophical health" (de Miranda, 2022). This notion entails nurturing young individuals' capacity to comprehend a world filled with open-ended questions and ambiguities. De Miranda (2022) states,

> One is engaging in philosophical health when one's behavior is careful (and care-full) in considering not only the physical or psychological individual balance but also a certain idea of what the collective and holistic good of humans and all beings on earth might be. (p. 1)

Namely, a collective and holistic perspective on well-being extends far beyond the care of the individual; rather, it encompasses our collective well-being. With the proliferation of educational robots in preschools worldwide, understanding the types of questions elicited across varying cultural milieus enables educators to cater effectively to each learner's distinct needs while simultaneously informing general approaches to early childhood education.

While children may eventually come to view robots as mere tools, the implications of such technologies for their daily meaning-making and the formation of their philosophy of life must be considered. By focusing on younger children's thoughts from an existential perspective, we hope to gain insight into the technological choices and decisions made in early education. To date, many pedagogical decisions concerning the implementation of cutting-edge tools in early education have been made without adequate consideration of their broader implications for children's emerging comprehension of existence. Our exploration seeks to address this gap and encourage thoughtful dialogue around responsible technological decision-making in early childhood education.

Review of Previous Studies

Educational researchers have stressed the need to investigate children's existential questions because children readily express such questions if given a chance (e.g., Hartman, 1986; Hartman & Torstenson-Ed, 2007; Pramling & Johansson, 1995; Pramling et al., 2007). Hartman (1986) and Hartman and Torstensson-Ed (2007) have dedicated extensive effort to investigating the existential queries posed by children and highlighting the significance of sense of belongingness in shaping children's emergent philosophy of life. They found that some questions manifest across various historical periods and sociocultural contexts, whereas others remain closely tied to the particular temporal and situational factors of each child's upbringing. Hall and Liljefors Persson (2020) found that children aged between 11 and 12 years posed existential questions similar to those of children 50 years ago. However, children in that study also asked new questions, that is, questions were not salient in Hartman's (1986) and Hartman and Torstensson-Ed's (2007) studies but rather aligned with contemporary challenges. According to Hall and Liljefors Persson's research, today's children are concerned about nature and climate change rather than, for instance, space and space travels. Thus, we assume that interacting with various kinds of robots in education would also give rise to existential questions.

Through keyword searches (e.g., "existential questions," "robots," and "educational robots") within educational databases, our literature review uncovered numerous empirical studies examining the efficacy of integrating robots in educational settings to bolster young children's learning outcomes and socio-emotional competencies. In a systematic analysis, Mubin et al. (2013) surveyed the landscape of robotics in language, science, and technology education and explored the dual capacities of robots as both tutors and peer collaborators. They stressed the need to increase robots' speech interpretation and make their behavior more human-like to optimize learner-robot interactions.[2] Jung and Won (2018) reviewed studies on the use of robotic kits for young children (from preschool to Grade 5) with the aim of mapping research trends in children's learning of robotics concepts. The authors found that most studies focused on the gains for subjects such as science, technology, engineering, and mathematics following children's exposure to a robotic-enhanced curriculum. Furthermore, the majority of the studies employed a constructivist methodology, drawing on Piaget's constructivism or Papert's constructionism. They

2 For a review on social robots as tutors in education, see Belpaeme et al., 2018

conclude that research needs to move beyond input-output research and consider investigating children's meaning-making processes, which aligns with the aim of this paper. Recent research has specifically highlighted the positive impact of employing robots in therapeutic contexts designed to support children diagnosed with autism spectrum disorder. For instance, Alabdulkareem et al. (2022) reported that children with autism spectrum disorder demonstrate enhanced performance across multiple domains, including communication, cognition, and social interaction, when engaged in collaborative activities involving specially programmed robots. Van Duuren et al. (1998) argued that when people interact with robots or robotic tools, they cannot help but compare the robots' functions to those of humans. The researchers noted that adults predominantly assess robots based on their cognitive capabilities and evaluate them in comparison to human counterparts. In contrast, children exhibited patterns of reasoning markedly distinct from those of adults when engaging with robots. Children's reflections were related to questions about animacy, consciousness, and intentional agency. Somanader et al. (2011) found that if children observe that the robot is controlled by a remote, they are less likely to view it as alive; conversely, self-generated movement appears to strengthen perceived animacy. A more recent study on children's perception of robots has shown that they, in various ways, anthropomorphize robots (Okanda et al., 2021). Nowadays many educational robots share salient features with more advanced humanoid robots, such as having a head, a body, and the ability to move without direct contact. Even seemingly simplistic devices like Bee-Bots adorned with eyes and smiles may entice young learners' interest and engagement, from which new existential questions may arise.

Goldman et al.'s (2023) study demonstrated significant age and cognitive development differences between three- and five-year-old children when they are asked to judge whether something is alive. The study findings reveal that only a few three-year-old preschoolers can correctly judge the robot as not alive. Okumura et al.'s (2023) investigation of five-year-olds demonstrated increased generosity (sharing more stickers) in the presence of a social robot—that is specifically designed to perform human-like behavior and with which they have interacted—compared to the presence of robots that did not move or speak. This demonstrates the five-year-old children's increasing cognitive and social-emotional awareness, and ability to distinguish nuances in human-robot interactions. Serholt (2018) studied children's social interactions with humanoid robots. The students in Serholt's study were willing to respond and socially interact with the robot despite being informed that it could not understand their actions and responses. Eventually, the robots' inability to recognize the specific social cues and responses from the children limited the interaction. Child-

robot interactions prompted researchers to examine whether the robots were effective in responding to children's behaviors and actions. Muneeb et al. (2017) studied children playing a game with a robot to investigate which kinds of adaptions—game-based, memory-based, or emotion-based—the robot can pursue and has the best potential to extend children's interaction beyond the novelty effect. The most effective adaption was emotion-based, in which the robot could detect four different emotions on the child's facial expression and, based on that, communicate a relevant response.

Several studies in our literature review examined the impact of utilizing robots on children's development. Crompton et al. (2018) researched the use of humanoid robots in early childhood education classrooms and their effects on all domains of development. Drawing from rich qualitative datasets comprising classroom observations and interviews, the researchers uncovered a consistent theme: Children exhibited a strong caretaking disposition toward humanoid robots, often making explicit comparisons between their own physical attributes and those of the robots. Despite concerted efforts to encourage existential thinking (e.g., prompting children to ruminate on their curiosities regarding the robot), Crompton et al. (2018) principally analyzed responses through the lens of speech and language development. Similarly, Berghe et al. (2019) reviewed studies attempting to target children's language skills by using social robots. They reported that using robots to assist children in academically oriented learning tasks increased and positively affected children's motivation levels, such that they were less anxious to make mistakes and more self-confident to take on the suggested task. Self-confidence relates to the overall perception of the self and our existence and, in turn, relates to existential dimensions concerning what it means to be human. Further, a study by Malinverni et al. (2021) investigated children's attitudes toward robots and underscored the immense potential of educational robots in encouraging children's reflections on ethical, societal, and cultural implications of robotics technology. In this context, Bers's contributions (2019, 2022) designed curricula seamlessly integrating coding with social-emotional development for young learners aged four to seven years. Such designs enable children to work in collaborative group coding projects because they promote children's social and emotional development. For instance, such curricula help children develop essential values such as honesty, fairness, generosity, gratitude, and forgiveness. However, Bers did not investigate conceptions of the robots on an existential level.

In addition to educational science databases, we also reviewed research on philosophy for children. Philosophy for children is a broad field of study inspired by the groundbreaking work of Lipman (e.g., 1976, 1988, 2003) and colleagues (e.g., Sharp, 1987). *The Routledge international handbook of philosophy for children* (Maughn et al., 2019) features empirical research on philosophical activities with children and chapters that discuss developing theories in the filed as well as the importance of bringing philosophy into different educational contexts. However, none of the chapters address children's meaning-making of educational robots. Moreover, our search in the journal *Childhood & Philosophy* (2005–2022) yielded only one hit relatively close to our focus: Zanetti's (2020) study, which discusses the need to deal with children's existential questions and the challenges that teachers may experience with such task. Nevertheless, the study contains no explicit reference to children's meaning-making of educational robots or any other new technology.

In summary, existing research primarily emphasizes the cognitive dimensions of child-robot interactions and investigates means to stimulate creativity and engagement through these interactions. While these contributions undoubtedly enrich our understanding of young learners' experiences with educational robots, they do not explicitly deal with existential questions. This gap in the research literature inspired us to start a dialogue about children's existential meaning-making of educational robots and highlight the importance of researching this phenomenon. We believe that attending to children's subjective accounts of robots and their endeavors to ascribe meaning to their being can offer novel insights and provocative questions about children's existential interpretation of educational robots.

Educational Robots at the Intersection of Existential Meaning-Making in Education

Although sympathetic to a general call for more knowledge about children's engagement with educational robots to support their gains in STEM areas, we call for looking into how children make sense of artifacts such as educational robots on a more profound, existential level. As the prevalence of educational robots in learning environments for young children continues to rise, we find ourselves compelled to probe the existential questions that may arise in their wake. Guided by this premise, we propose two avenues for studying children's existential meaning-making processes of educational robots. First, we advocate for observing the existential questions children articulate when confronted with robots as familiar technological artifacts that they can build and control.

Second, we propose to examine children's play interactions with robots because they contextualize and provide insights into children's existential questions.

Educational Robots as Common Cultural and Technological Artifacts

Although existential questions, in one sense, are personal, they also relate to current trends in society and the specific culture in which we live (Lilja et al., 2020). In other words, children's meaning-making processes are deeply entwined with experiencing and assimilating novel phenomena. Scholars such as Henning and Kirova (2012) argued that the objects introduced to young children may have different meanings depending on their backgrounds. That is, cultural differences may influence children's perceptions of robots. Some countries are ahead of others when it comes to technology, which may influence which questions may emerge. In addition, preschools' approach to technology, its tools and activities continually evolve. For example, educational robots such as Lego Mindstorm, Sphero, Ozobot, Cubelets, and Arduino have begun permeating preschool curricula in many countries. Paralleling these trends, researchers have harnessed the potential of educational robots as technological artifacts in various empirical studies (e.g., Datteri et al., 2013; Karaahmetoglu & Korkmaz, 2019).[3] We think that these developments necessitate a deeper exploration and understanding of children's meaning-making processes of educational robots.

Existing research commonly approaches robots in education from a constructivist theory of learning (Anwar et al., 2019; Mubin et al., 2013), whereas our stance on the subject departs from a social-cultural perspective. This approach provides knowledge that accounts for situated aspects (Rogoff, 2003). Central to this approach is the idea that humans' meaning-making is the result of the continuous interaction between their individual perspectives and their surroundings, which are shaped by cultural norms, beliefs, and values. Applying this lens to child-robot dynamics enables us to capture how children actively co-construct meaning through interacting with educational robots in socially constructed environments such as preschools. In a shared activity, such tools can help children relate to the same context form individual experiences (Mahn & Steiner, 2012).

3 For a comprehensive overview, refer to Jung and Won (2018).

Furthermore, shared cultural tools and children's interactions with objects within a particular cultural context play a significant role in their meaning-making (Resnick et al., 1991; Schoultz & Säljö, 2001). For instance, Kuperman and Mioduser (2012) studied how children perceived robots and whether children's understanding of the robots' behaviors was from an "anthropomorphic" or a "technological" stance. They discovered that children could better distinguish educational robots' technological and non-human components when they are actively involved in the robots' programming and construction tasks rather than just passively observing a tech expert completing those tasks. The results emphasized the importance of understanding children's cognitive and psychological perceptions of technological artifacts integrated into their learning environment. We want to further this thought and suggest that any analysis of the learning process should also consider children's existential meaning-making of the cultural tools and practices presented to them. Children engaged with any tool or artifact could raise questions about how a particular object or material is connected to the larger cultural context and its past and present functions and come up with predictions about its future. For example, manipulating educational robots may prompt children to reflect on existential questions such as what it means to be alive or what ethical issues arise regarding robots. Thus, we believe we can better understand children's existential perspective of educational robots when they are presented as cultural and technological tools within a specific context.

Children's Play

Recent research (e.g., Eboo Alwani et al., 2024) has spotlighted the increasing significance of play in the post-COVID-19 era and its role in fostering children's social and emotional well-being. Embracing this notion, we posit that investigating children's existential meaning-making of educational robots through the lens of play constitutes a critical avenue for exploration. Given that play is a spontaneous and instinctive activity for preschool children, educational robots occupy a strategic point at the juncture of children's play and learning (Samuelsson, 2018). Furthermore, play represents a natural environment for the emergence of children's existential questions. Simopoulou (2017) conducted observations of particular questions preschoolers posed when playing at the nursery. She found that existential themes were standard features in children's play:

> Children encountering nothingness, strangeness, ontological insecurity, death, and selfhood, playing them out in imaginative ways and symbolic languages. The existential did not emerge as a question per se but was embodied in their play and in their stories. (p. 231)

Play is children's intrinsic behavior and a fundamental human right during early childhood, according to the UN Convention on the Rights of the Child (United Nations, 1990). Through play, children gain control over their motor actions, learn to navigate social rules and democratic citizenship, encounter and solve problems, develop self-image, and most importantly, increase autonomy in decision-making. Growing evidence demonstrates that when provided with the autonomy to choose their preferred play activities, children exhibit higher degrees of engagement, motivation, and focused attention (Barnett, 2013; Einarsdottir, 2005; Howard & McInnes, 2012; Yilmaz & Pala, 2019). Further, young children are more likely to demonstrate deeper engagement in play behavior when they have the freedom to select from a variety of open-ended play materials and resources available in their environments, such as preschool, home, parks (Dankiw et al., 2024; Filiz & Tugrul, 2024). Yilmaz and Pala (2019) interviewed preschool and elementary school children to decipher how they perceived play and whether there were differences between preschoolers' and elementary schoolers' perceptions of play. Their findings indicated that children, regardless of grade level, viewed an activity as play if it incorporated elements of free choice, physical motion, and toy selection. Therefore, we argue that it is valuable to study which existential questions children encounter when they independently elect to engage with robots.

How children approach and play with robots may reveal what meaning they ascribe to robots and their potential place in their lives. We may further learn about children's reflections on the general role of robots in society and engage children in philosophical inquiries through their imaginative play, as demonstrated by Stanley and Lyle (2017). The researchers show how philosophical concepts can be investigated by carefully listening when children play, engaging their imagination, and co-constructing stories with them, thereby creating opportunities for philosophical investigations. Another compelling rationale for delving into children's existential questions in the context of play with educational robots lies in play's potential to foster collective learning experiences among children, educators, researchers, and philosophers alike (Johansson, 2017). The heightened likelihood of children encountering and engaging with educational robots within educational environments makes play a critical context for observing and investigating children's existential meaning-making processes. As children engage with educational robots, several intriguing existential questions might arise, such as "Could robots eventually take over tedious tasks, acting like servants?" or "Can a robot become a friend?" By being mindful of children's perspectives on the nature of their engagement—whether they view it as play or work—teachers

and researchers can deepen their comprehension of children's experiences. The increasing integration of technology within educational settings requires educators to incorporate an understanding of young children's existential meaning-making processes in shaping these modern learning landscapes. Starting in children's play nurtures authentic experiences, empowering children to explore and develop personal connections with advanced learning technologies organically.

Conclusion

In this paper, we aimed to draw the attention of education practice and research in particular to a relevant facet in today's learning landscapes: children's existential meaning-making of their encounters with educational robots. We believe that knowing which existential questions children struggle with is crucial for developing pedagogies that can nurture "philosophical health" (de Miranda, 2022). That is, although existential questions lack definite answers, dealing with philosophical or existential questions can create a sense of meaning in an otherwise chaotic world.

Our review of the educational research literature yielded no specific results on the topic in question. Existing studies mainly centered around robots' impact on children's cognition and language development. By examining the existential questions that arise from using educational robots, we can foster a meaningful and age-appropriate implementation of technology in early childhood education settings. Educators can foster critical and ethical discussions surrounding artificial intelligence and its role in society. These conversations should be inclusive, valuing input from adults and children, to promote responsible innovation and cultivate a shared understanding of human-robot interactions within educational contexts. One of our recommendations is to approach researching educational robots as cultural tools that children encounter daily. This perspective stems from sociocultural theories to ensure sensitivity towards the diverse cultural context children inhabit. Such an approach emphasizes the shared social contexts that shape learning experiences and inform children's existential questions. We further propose that observing children's interactions with educational robots during play is an optimal research avenue. Play is a crucial context where existential concerns can spontaneously arise (Simopoulou, 2017). The topics and questions children raise while engaging with robots can provide valuable data to inform early education planning and guide the design of future educational robots. Preschools and school-age educare may develop their didactics by initiating activities that combine play and existential questions in line with Stanley and Lyle's (2017) approach.

In this paper, we strived to spark an interdisciplinary discourse concerning children's existential meaning-making of educational robots among scholars specializing in diverse fields, including but not limited to early childhood education, philosophy with children, psychology, and instructional technology. We aimed to lay the groundwork for intellectual exchange, thereby increasing our collective understanding of the complexities surrounding children's engagement with advanced technologies. By capitalizing on this convergence of interests and contexts, scholars can begin to decipher the complex web of associations linking children, play, educational robots, and existential inquiry—ultimately generating knowledge that informs the researchers, educators, and policymakers invested in designing next-generation learning environments.

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