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Emissary Educator Playmate Oracle (EEPO): A Human-Technology Framework and XR to Support Child Well-Being

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Abstract

Augmented Sociology refers to the use of tools to increase the opportunities and capacities for healthy growth, development and relationships in humans; emphasizing the need to create supportive technologies that help bridge the gap between humans and technology. This work focuses on the role of technology in child development, parenting and the relational space in-between children and parents. It presents the Emissary, Educator, Playmate, Oracle (EEPO) human-technology framework to support mental health, development and well-being in children. The framework can be used as an exploration to create a balance between the effective use of technology in children's lives while building and maintaining strong relational human connection. This ensures children and parents do not become overly reliant on digital tools at the expense of responsive and attuned interactions, healthy development, emotional connection and love. To deepen this concept this paper contributes to the development of a prototype EEPO mixed reality system, toward human-centered, empathetic, connected, meaningful experiences and interactions with technology while enhancing human abilities. This paper proposes the EEPO human-technology interaction framework to support child-technology interaction and an early proof of concept XR and AI system to consider how technology can respond to human needs and emotions.

Index Terms: [Human-Centered Computing]: Human Computer Interaction- HCI theory, concepts and models; [Applied Computing]: Law, Social and Behavioral Sciences-Psychology and Sociology; [Computing Methodologies]

1. Introduction

Children have been growing up with and developing in technological environments for generations. Until recently children's engagement with technology has largely been one-sided and generally within the control of parents. The early stages of technology, such as televisions and personal computers focused on consuming content. There was a desire to create content for social good to support and educate children for their greatest well-being [1]. Recent advancement has made technology more accessible for all populations, there has been a shift in utilizing technology to interact, engage and connect with others in real time. There are positives for children's technologically enhanced social interactions and engagement such as the development of social and problem-solving skills. However, the negative impact of habit-forming behaviors and excessive use of technology can lead to isolation, addiction, and exposure to inappropriate content, all of which causes emotional and neurological impacts [2]. Parents often are less aware of and able to support children's social world and engagement with technology as it becomes more advanced and integrated into daily life. With the new emerging technologies such as artificial intelligence and large language models such as ChatGPT [3] and LaMDA [4], humanity is on the precipice of significant evolution, creating opportunities for children to engage deeply and meaningfully with autonomous technology in the form of an independent social companion and support [5]. This research intervenes in this dynamic space between children and technology, by providing a framework for the design of an extended reality, conversational and internet-of-things (IoT) Social Emotional Development Companion Agent and Parental Support for Children.

2. Background

2.1 Technological Implications

There are several AI parenting solutions ranging from smartphone applications to smartphone applications paired with peripheral devices and full-fledged conversational anthropomorphize mechanical robots [6]. The concern (and failure) continues to be whether the technology is reliable, respecting privacy and ethical considerations for children [7,8,9]. As parents obtain more tools to assist with their parenting responsibilities, additional concerns arise regarding over reliance on tools when making decisions about and for their children [10]. Thus, potentially blurring the intended use of the tool in providing support for parents and using technology to replace parenting responsibilities such as with interaction and engagement [11]. Moreover, the safety and technological challenges intrinsic in the design of home-based devices revolve around increasing their capacity to provide high-performing local storage and processing power to handle AI inferencing and IoT edge data collection – which is especially important for technology which collects and stores data about children. Responsible design of such systems is of utmost importance in building trust and keeping children safe.

The EEPO framework has been prototyped as a smart-home companion supporting parent-child relationships and child development. This requires a focus on multiple features of the smart-home eco-system of technologies, including those that allow the environment to sense and adapt, as well as interfaces for human-environment interaction, particularly through conversation and immersive experiences. The literature exploring the use of conversational agents (CA) in children's home learning and play experiences and environments, as well the investigation of mixed reality (MR) technology in exploring the possibility of enhancing the immersive conversational experiences is examined.

Conversational agents (CA) are designed to interact through natural language and feature "personalities" which make

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the system more human-like [12]. This is seen through the industry focus on speech agents, such as Apple's Siri, Google's Assistant, Amazon's Alexa, and others. Wherein the IoT environment, devices and information can be accessed and controlled through speech-commands, and through conversational exchanges with users [13, 14]. This builds on natural language processing advances in recent years, and is now a staple, alongside mobile smart phone interfaces. The home environment has become an always-on, ever listening entity that is accessible to all in the environment which provides an opportunity to support parent-child relationships and holistic child well-being [9].

Mixed Reality (MR) is a technological mechanism that overlays real world environments with virtual content [15]. It offers opportunities to allow a smart-space to become an immersive entity, which can express itself to its users in multiple formats. Through hands-on experience, users can interact with augmented objects within different scenarios in a safe and controlled environment. The lack of corporeal presence of the home-as-agent creates an issue in providing a complete interactive and immersive experience. The Mixed Reality Agents framework [16] highlights the importance of considering the corporeal presence, agency, and interactive-ness dimensions, within the design of agent system actors. Further, where mixed reality technology is merged with IoT sensing, this is often referred to as Cross-Reality or Extended Reality (XR) [17]. Together they allow for a new visual dimension to be engaged alongside the natural language dimension, and the agent-environment activator/behavior dimension, toward a new class of smart-home companion. In addition to providing shared visual space, the MR paradigm also enables embodied agents that can communicate by transforming a virtual character's body gestures and emotional status. MR technologies also can provide multi-modal interaction, such as gaze-based interaction. This approach can bring a more natural human-agent communication and make users feel comfortable [18]. People use these technologies differently depending on their age and ability, younger children typically engage in non-verbal communication, including facial expressions and body language, such as nodding to indicate 'yes' or 'no'. These non-verbal responses are difficult for conventional CA's, which are typically only embedded in smart speakers, to detect. This emphasizes the need of a multi-modal interactive agent which can understand non-verbal communication and provide developmentally appropriate responses and feedback for engaging and supporting children in early childhood.

2.2 Child-Technology Interaction

Artificial Intelligence through conversational agents are interacting and engaging with families in their homes, 41 percent of families with children aged 0-8 has a conversational agent in their home [19]. Children's use of technology has increased substantially since the COVID-19 pandemic [20, 21]. On average children birth to age 8 spent approximately 2.5 hours a day engaged with technology [22, 23, 24, 25]. While children between the ages of 8 to 18 are engaged with technology approximately 7.5 hours a day [24] . Most children (98 percent) have access to a mobile device at home and 42 percent have their own device [24]. Younger children engage with technology passively through videos, as they become more developmentally able to engage with technology they play games, engage in educational activities and communication, well continuing to consume videos. It is important to explore the impacts of these tools on children's mental health and well-being.

Children anthropomorphize technology, imagining and believing it has human characteristics and qualities. Humans are born to love, connect and learn [26] all interactions and experiences affect their holistic development including those with technology. Research has shown that social cues provided by the CA increased feelings of satisfaction, learning, understanding and the AI reflects the need for social interaction and emotional engagement [27]. In the following studies the AI responds to the child's questions and requests in a format that is easily understandable, children typically asked questions about the world around them and how it works [19, 28, 29, 30]. Garg [31] studied children's voice logs with CA's and revealed they use smart speakers for playing games, listening to music, seeking knowledge, or searching, they also engage in small talk such as "Are you listening to me?", "I want to play with you", and expressing emotions such as, "I miss you Google" and "I love you Google", attributing human-like identity such as, "When were you born?", or observing social norms such as, "How are you doing today Google?" [31]. Hoffman [19] reported 34 percent of children's questions were about science, 29 percent were practical, 15 percent were about the agent itself, and 7 percent were cultural. Children believe the CA was intelligent, friendly and trustworthy, with older children attributing more intelligence and younger children spending more time asking questions about the AI itself [19, 32]. The researchers captured parasocial interactions within the verbal exchanges between children and the CA's and discovered younger children were more likely to believe the AI was alive, friendly and trustworthy [19]. Children did not treat the CA's as exclusively intellectual devices, they characterized the CA and believe it had personalized thoughts, emotions, needs, and wants. The child develops trust with the character (CA) and behaves as if it is a friend and exhibits empathy such feeling sadness if it makes a mistake [19]. CA's are capable of providing a collaborative experience which maintains the attention and encourages interactive learning, reflectivity, reciprocity and feedback while supporting skill and socio-emotional development of children [19].

2.3 Parenting with Technology

Parenting is challenged by the pace of change in information and technology, leading to impacts on child development and parent-child relationships [33]. Children are experiencing diverse perspectives through learning and growing in online environments, such as virtual classrooms, YouTube, social media, games, chat forums, the web and virtual reality worlds [34]. As a result, their neurological, physiological and socio-emotional development, perspectives, and understanding of the world are being created and impacted by diverse communities and multiple viewpoints. This can build empathy and perspective taking but certainly creates risks to children's safety, security, values, and experiences [35, 36]. Children's use of technology is influenced by their parents and caregivers. Parents model behavior and technology use for their children and often struggle with exhibiting life-technology boundaries, as the neurologically habit forming, and communication tool permeates their lives [37]. Parents are often concerned about the amount of time children spend engaged with their devices and feel a need to control and provide healthy boundaries and balance. They often monitor the use, restrict usage time and or create access to the technology as negative reinforcement to manage behavior. Moreover, parents' attitudes towards certain technology or media influence children's access, perception, understanding and affect their use, while potentially impacting their identity and relationship with technology [38]. Research indicates, parents are worried about their inability to participate in or contribute to their children's education, monitor their progress, or understand the technology's capabilities as much as their children [31]. Thus, there is a fear, they will not have the technical skills or expertise to support their children in creating safe and secure virtual relationships, experiences and understanding of the world. Parents can feel vulnerable and scared as the child potentially has greater skill and expertise which makes supporting their identity, relationship, development and learning with

technology difficult and outside of their purview [39]. Conversely, they are concerned that if they restrict their child's use of or engagement with technology they will be left behind as technology advances at a remarkable pace, leaving their child unprepared for the future of work and humanity. This highlights the importance of parents sharing a joint role and exploring how technology can support parenting and child development. Creating healthy, safe, secure and trusted technological experiences to support children's holistic well-being will create a better future for humanity and allow humans to develop with technology not attempting to catch up or fixing an unintended outcome years later [40].

3. EEPO Framework Development Theoretical Background

The interdisciplinary EEPO project focused on a vision of early childhood development, well-being and parenting, supporting the ethical, agile, technology-based assistance for children and the world which surrounds them. The social-emotional development of children was emphasized as experiencing attuned, responsive, secure, trusting and loving interactions with parents and caregivers as central to healthy child development [26]. While developing healthy and safe opportunities for children and parents to benefit from the current technological advancements within consumer-ready Artificial Intelligence, augmented reality and smart home devices. Developing a robust child and parent framework and solution in alignment with the United Nations mandates for the safe and responsible development of AI [41].

Three theoretical models were used to inform the design of the EEPO human-technology interaction framework, Brofenbrenner's socio-ecological model [42], Maslow's hierarchy of needs [43] and Vicente's human-factor model of technology [44]. The socio-ecological model places the child at the center of the ecosystem which directly impacts the life of the child and their experiences in and with the world around them. With the child placed at the centre of the world, the model highlights the relationships with external connections such as parents, family, teachers and professionals, environments such as early learning and care or school, social policy and government, organized from proximal to distal as a circle surrounding the child [42]. The hierarchy of needs states that only when the foundational physiological needs of the child are met such as food, water and shelter can a child evolve to higher functioning, including the evolution through safety, love, belonging, and self-esteem, to self-actualization, the ability to be their best self [43]. The human-factor model describes human needs for technology from a multi-dimensional lens including a progression up a ladder beginning with the physical, psychological, social, organizational, and ending at the most distal political level [44].

Figure 1: Theoretical Models, Ecological Model, Hierarchy of Needs, Human Factor Model

An integration of these theoretical frameworks informed the development of the EEPO human-technology interaction framework and the proposed system which aims to guide the future of child centered design of interactive technologies which impact children's daily lives (Figure 2 EEPO framework).

Encompassing these theoretically models are the experiences and interactions children require which live under their skin, impact their holistic well-being and understanding of the world [45]. Parents and caregivers are essential to the healthy development of children. Attuned, responsive, trusting and secure relationships are fundamental to the healthy growth and development of infants and young children throughout their lives [46]. Parental and caregiving roles and expectations ensure children have the diverse experiences to support their neurological, physiological and emotional development ensuring they have the best start and positive trajectory in life. The roles, parents and caregivers are required to provide in supporting children to gain these experiences are; as a teacher, to learn about the world and how to interact in it; as a playmate, to joyfully participate in the children's lives, sharing interest and acceptance; as a nurturer, to support and comfort the child when upset and helps contain and teach how to manage emotions; and as a limit setter, to provide consistent structure and limits so the child feels safe and a sense of predictability, that they know, understand and can follow the rules and boundaries of the family and society [47]. Children require these types of experiences as they develop, learn and grow. Parents and caregivers will feel more competent in some of these roles than others, and therefore need multiple kinds of support; as having a loving and supportive network for the child is helpful for healthy development and mental health for all members of the family [47].

4. EEPO Human-Technology Interaction Framework

The EEPO human-technology interaction framework was developed to support this augmented sociology for children with love, attuned and responsive connection embedded into the identification of four dimensions of interactions or relationships required by children for their holistic healthy growth, development and well-being.

- The **Emissary** provides the consistent rules, structure, boundaries required for children to learn and grow, the Emissary creates safety and security in the online environment and helps the child understand the social rules, routines, structure and organization required to live a healthy functional life.
- The **Educator** provides the child with safe, supportive and caring educational information, scaffolding of knowledge, tutoring and support to help with their holistic learning and development.
- The **Playmate** provides children with a peer to socialize, engage, discover, explore, be silly, and have fun. The Playmate is a developmentally appropriate social companion and friend to learn through play and support the child with understanding the world.
- The **Oracle** provides sage advice and a holistic perspective, this dimension creates the opportunity for children to feel emotionally and intellectually supported in understanding others, including their motivations and perceptions, supporting their understanding of relationships and the world around them. The Oracle can additionally provide the child with an expansive perspective such as universal knowledge which they can integrate into their understanding of the world, creating opportunities to see and understand the wonders of the world and relationships.

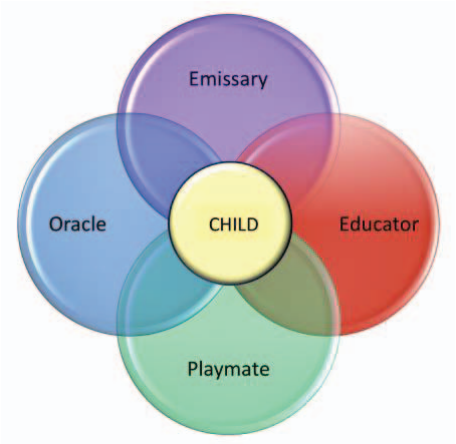

Figure 2: The EEPO human-technology interaction framework for healthy child development and well-being.

Whomever children place their trust in to answer their questions will impact their understanding of their self and the world around them [19]. Thus, it is important to consider the parenting and teaching roles we design for support technology systems like AI as it will influence the child's understanding and perception of themselves and their world. Human interaction and experience is essential for the growth and healthy development of children and the evolution of humanity. Technology cannot take over parenting but can perhaps support children's experiences and understanding of interactions and the world, always in conjunction with human love, responsive attunement, trusting conversations and support. To learn to be human we must experience humans. The EEPO framework has a broad scope: toward the evolution of emerging technologies and support of the future of human well-being through the perspective of the child.

5. Vision of EEPO System

As an early, proof-of-concept use case for the EEPO framework, a social-emotional support using artificial intelligence enabled parental support tools has been designed, for smart-home environments, using conversational and mixed reality interfaces. The EEPO system prototype is an extended reality and internet of things, social-emotional development companion agent system which is simultaneously a parental support system targeted towards both children and parents. The scope of the project is to understand these areas and how to bring them together in a proof-of-concept prototype. The challenge of designing an EEPO system that features embodied conversational agents performing cross-functional roles: educator, emissary, playmate, and oracle, for children and parenting. Parents and children engage and use CA's differently which necessitates unique needs and functionality, such as parenting knowledge and information on child development which is important for parents, and social emotional engagement for children [31]. This use case combines these two aspects and set the design goal of supporting parenting and providing users with multiple interactions.

Developing a support and companion system for child development and parenting is a considerable design challenge with many open research aspects and opportunities for contribution. Addressing this challenge involves designs to fill the need for technology enhanced parenting support which becomes a growth-companion. The complexity inherent to this domain also involves

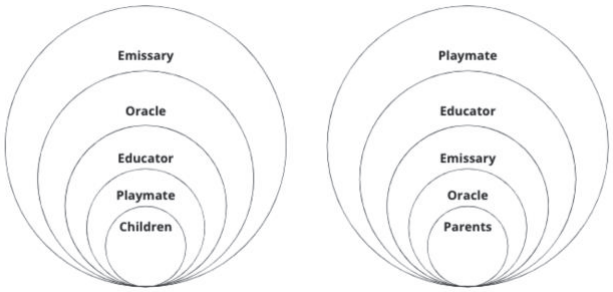

Figure 3: Exhibiting the role of the agents with children and parents, demonstrating the unique goals and intentions of the users of the EEPO system.

the ethical implications wherein the privacy and security needs for children in a smart environment is a factor; that is smart-home context-aware, conversational, and embodied systems must also be designed toward safety. Although, in this initial stage this aspect has not been developed, it is envisioned as an area for further study. Figure 4 shows the early prototype of the EEPO conversational support system, as envisioned. This prototype involves an EEPO virtual character with a conversational system, as viewed within a virtual reality head mount display. It is expected that such a design will become common as mixed reality gains adaption. Similarly, conversation frameworks like Wit.ai, and large language models, like LLaMA and ChatGPT, are components of the design space. In the early prototype, only a Wit.Ai schema for conversation has been implemented in this work.

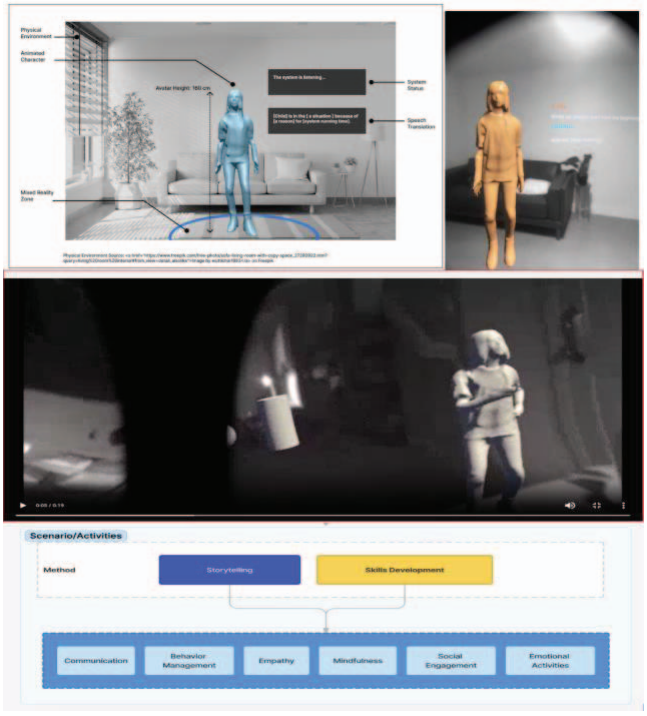

Figure 4: Early Design of EEPO System, engagement with AR. The proof-of-concept EEPO system would be available to a child or parent and would provide language model support such as storytelling and games for skills development, and also mixed reality visualization through its embodied interactions and behaviors.

A more detailed design of the EEPO agent remains for further exploration in future work, and the current prototype serves to visualize and highlight the need (and potential) for such a system. It is a step toward a smart-home conversational user interface system, with a mixed-reality based immersive embodiment for corporeal presence representing an early contribution to the interdisciplinary literature between mixed reality computer science and early childhood fields of study.

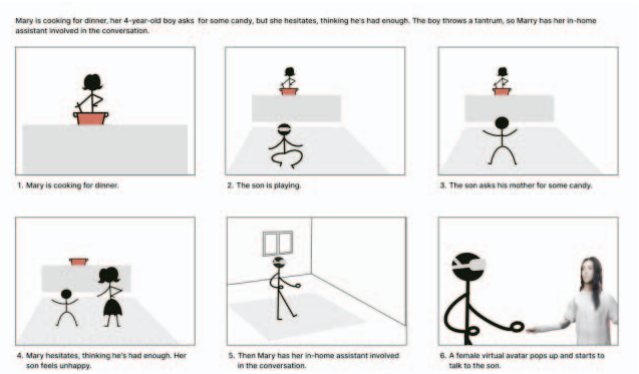

Figure 5: Use case scenario of a parenting situation for the EEPO System. It is noted that such scenarios will become mainstream as mixed reality gains household adoption and streamlined in the future.

6. Discussion and future work

People unconsciously anthropomorphize and apply social norms to technology such as AI, attributing emotion, social relationships, connection and meaning to their interactions. This raises an ethical issue of transparency of algorithms which are hidden from users, which creates difficulty in understanding how results are produced [48]. Most importantly these conversational agents and other mobile technologies, are in children's homes, daily lives and are often an under-supervised use of technology, becoming as if a member of the family, where children are developing real emotional connection and trust in the technology, indicating the needs for safety and ethical transparency of these systems and their inner workings. Seeber [48] suggests, similar to food labels autonomous agent technology should provide transparency regarding "personality" traits, and their use as social-emotional tools exhibiting "empathy" or its use as an analytical tool. Additionally, we believe including the developmental and educational benefits, privacy and possible neurological risks of the resource and or technology in child friendly language (not only to parents) to support critical thinking and informed decision making for the child and parent is an important step in keeping children safe and supporting their healthy development with technological advancement. The child experiences immersive technologies, like mixed reality embodied characters and AI as if it is a real, emotional, caring, a confidant, a friend, developing emotional attachment and trust to the modern technological systems. [48, 49]. This has the effect of putting children in a position in which they may potentially become more comfortable "socializing" with the AI over real people, experiencing the friendliness and "empathy" as real, which can lead to unintended social consequences and significantly impacting the lives of the child and humanity [48]. Research and child (human) centered practice is required into how to design such support systems to promote positive supportive interactions, of which the EEPO human-technology framework can lead the way.

Children need to continue to be parented by humans. If we want humans to be human, we need to ensure humans are the most important influence in a child's life, modelling what it means to be quintessentially human. The EEPO human-technology interaction framework is a step toward ensuring children grow and develop with a healthy balance of human-parental support, love and engagement, supported by advancing technologies such as mixed reality and AI technologies.

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