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Abstract:

The main protagonist in Kazuo Ishiguro's latest novel is Klara, an artificial friend whose existential goal is to be children's companion. Some aspects of this fictional narrative have begun to gradually enter our daily lives. Products reminiscent of Klara are available abundantly on the market: smart toys, adaptive learning applications, and companion robots. Children can relate to these products and perform activities together with them. Preliminary research has shown fundamental differences between existing technologies and these emerging children's digital companions. However, we still do not know much about their benefits and risks. This paper explores different and even contradicting perspectives on the phenomenon. We present the discussion from four perspectives - temporality, use, trust and ethics, and sociotechnical design - and conclude the paper with an agenda for interdisciplinary IS research. The agenda points to the needs for a psychological, medical, engineering, and temporal research community to understand this emerging sociotechnical phenomenon and design its future for the better.

Keywords: Children's Digital Companions, Embodied Conversational Agents, Responsible Artificial Intelligence, Children Interaction With Digital Technologies.

[Department statements, if appropriate, will be added by the editors. Teaching cases and panel reports will have a statement, which is also added by the editors.]

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1 Introduction

In his latest book "Klara and the Sun", the Nobel Prize-winning author, Kazuo Ishiguro (2021), recounts the story of human-robot friendship. Being a so-called Artificial Friend, Klara's existential goal, is to help children to be less lonely. She – the main protagonist of Ishiguro's novel – is equipped with abilities resembling those of humans, albeit with superior speed and accuracy. Besides, Klara can communicate and interact with children and adults equally well, even though she cannot smell. She recognizes emotions based on voice, facial expressions, and choice of words. Her loyalty is so strong that she is willing to make sacrifices for Josie, her owner, who is a genetically engineered teenager.

The story indeed highlights Klara's human-like qualities and her socialness. While artificial friends like Klara are no more than fictional characters in dystopian novels, their less sophisticated counterparts are real to us and our young ones. We can easily observe the abundance of smart toys, adaptive learning applications, and digital assistants for children on the market. Winky (https://heywinky.com), Miko (https://store.miko.ai), Moxie (https://embodied.com), and Misa (heymisa.myshopify.com) are only four examples of them. These products are conversational agents (CAs), artificial intelligence (AI) based entities which can understand children's natural speech and, in turn, articulate their responses in such a manner that is understandable by children. These conversational agents are embodied, making them a vivid and haptic digital companion to our next generation. We refer to all these devices as children's digital companion, an embodied conversational agent which children can relate to and perform tasks together.

Physical distancing due to the COVID-19 pandemic may have played an important role in promoting their adoption. Schooling took place in digital and hybrid environments, and it was sometimes even accompanied by robots (Zhao et al., 2021). These changes have influenced the way children learn (Pokhrel & Chhetri, 2021). But children's digital companions are probably meant to address issues beyond the distant learning challenge. They are on the one hand destined to be tutors, whose main goal is to make at-home learning experience more tailorable. On the other hand, they are also equipped with a wide range of leisure activities and targeted exercises, such as those to improve emotional intelligence and social skills. Time named Moxie one of the best inventions in 2020 for being "a compassionate pal" for children who "sends them on missions meant to spur engagement", from writing notes to sharing their feelings with a friend (Korn, 2020). Because of the different ways they are designed, children may have different interaction and experience with them. However, **we still do not know much about how and why children can benefit from their digital companion. Neither do we know much about the risks and threats such an interaction can have on children.** And because this concerns children's development and social prowess, there is a lot at stake.

This paper explores different and even contradicting perspectives on children's digital companions and propose a research agenda for the Information Systems (IS) community. Our objective is to enrich our understanding of the nature, intentions, mechanisms, and potential benefits and threats of these digital companions and to introduce a new research area to pursue the objective. Like Klara, they are designed as social digital companions for our next generation. We believe the IS research community can and must contribute to shape this emerging phenomenon for the better.

The next section defines what we mean by a child's digital companions. The section that follows describes the market offerings of children's digital companions and the different layers of their functioning. Next, we discuss some emerging issues related to children's interaction with their digital companions. The discussion is presented around four perspectives: temporality, use, trust and ethics, and sociotechnical design. Finally, we conclude the paper with a set of research questions for the IS community. Parts of the paper are inspired by a panel discussion at the 30th European Conference on Information Systems (ECIS 2022) in Timisoara, which was organized by the author team and joined by four coauthors in person.

2 Defining a Child's 'Digital Companion'

We define children's digital companion as *an embodied conversational agent which children can relate to and perform activities together.* This definition is inspired by three constructs: relational artifact, intelligent agent, and embodied conversational agent.

The idea of a relational artifact was coined by Sherry Turkle to refer to "technologies that have "states of mind" and where encounters with them are enriched through understanding these inner states" (Turkle et al., 2006, p. 347). The construct captures how children interact with humanoid robots Kismet and Cog (see Turkle et al., 2007) and, similarly, how seniors interact with seal pet robot Paro (see Turkle et al., 2006). The way children interact with a relational artifact differs significantly from their interaction with a toy or a classic computer program (Turkle et al., 2007). A toy can be described as an evocative object, something which evokes certain feelings or memories (Turkle et al., 2006). The idea of an evocative object is inspired by the Rorschach test: When completing a Rorschach test, the participants project their inner states when describing what they see in the vague ink blots (Rorschach, 1998; Turkle, 1980). Similarly, children attribute their feelings and memories to a toy, in particular when they describe what the toy is currently feeling or thinking about (Turkle et al., 2006).

The concept of an intelligent agent is composed of two terms: agent and intelligence. An agent is “a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives” (Jennings & Wooldridge, 2012, p. 4). Intelligence is a "mental activity directed toward purposive adaptation to, selection, and shaping of real-world environments relevant to one's life" (Sternberg, 1985, p. 45). In other words, entities that are intelligent are capable of adapting to their environments and even shape the environments to fulfill their purposes. The same can be said about an intelligent agent. Furthermore, intelligent agents are expected to be able to communicate with humans, thus, they include a social dimension. To summarize, an intelligent agent differs from a non-intelligent agent in the sense that it is expected to be reactive, proactive, and social (Jennings & Wooldridge, 2012).

Contemporary conversational agents are prominent exemplars of intelligent agents. Conversational agents are “software that accepts natural language as input and generates natural language as output, engaging in a conversation with the user” (Griol et al., 2013, p. 760). They can be disembodied (i.e., text-based only) or embodied (i.e., represented with a form), both of which can be designed to show human-like characteristics (Araujo, 2018). Some embodied conversational agents have physical bodies that can be touched, for instance SPECIES agents that embody interview kiosks (Nunamaker et al., 2014).

Children’s digital companion is relational, intelligent, embodied, and conversational to some degree. The literature has shown that humans tend to treat computers as social actors (Nass et al., 1994; Nass & Moon, 2000). Despite knowing that a computer program is not a human, they assign human characteristics towards computers (Nass & Moon, 2000). Because digital companions at least partially emulate human communication patterns, it is not surprising that children consider them social actors and can relate to them. Children can indeed distinguish artificial entities from biological, but they still treat them “as if” they are alive, considering them as social others in the roles of a friend or a mentor (Calvert, 2021).

3 Children’s Digital Companions in the Market

What kinds of children’s digital companions may be used by children or are already used by them? We address this question by finding out children’s digital companions which can be purchased by end consumers. We assume the adoption of children’s digital companions to be influenced by market offerings. Prior to the panel discussion, we conducted a market analysis with two objectives: (1) to explore the market offerings of children’s digital companions for children and (2) to understand the value propositions of different types of children’s digital companion. By no means do we intend the overview to be exhaustive. We initially searched only within the European market, but enlarged our scope to also include the American and the Asian markets at a later stage. Our search locations range from multinational online retailers to manufacturer websites following snowball sampling. We also consulted relevant blog articles and went through their list of endorsed digital companions.

3.1 Three Types of Children’s Digital Companions

Our final list of digital companions for children consists of 30 exemplars. We analyzed their similarities and differences. These exemplars are marketed using different terms: learning robots, social robots, learning companions, smart toys, and educational robots. We also found digital learning applications with only digital embodiment. We originally excluded them from our list in order to focus on physical embodiment, but reconsidered them after our initial analysis with the goal to paint a richer picture of the market offerings. Overall, we discerned three types of children’s digital companions: programmable companions, autonomous learning companions, and augmented learning companions.

The main objective of a **programmable companion** is to help learning and teaching coding skills. The name is self-explanatory: these devices can be programmed using simple codes. They then demonstrate or execute the codes through movements, expressions, speech, and sound. Examples of programmable digital companions are Beebot (https://www.b-bot.de) and Robobloq (https://www.robobloq.com). Beebot has a bee-like appearance with yellow undertone and black stripes. Children can program Beebot's movement using the arrow buttons on its back. Beebot also comes with selection of mats and props with obstacles to be overcome with appropriate movement programs. When used simultaneously, Beebots can recognize and greet each other. These programmable companions are considered objects by children.

Autonomous learning companions are designed to provide children with not only social companionship (e.g., spending time and playing together), but also mentorship (e.g., learning language and social skills). These companions can recognize children's speech and respond appropriately. Some can even identify gestures and react accordingly. Some also comes with additional learning contents which can be purchased to complement the basic contents. Most importantly, these companions have physical embodiment. Examples of digital learning companions are Winky (https://heywinky.com) and Moxie (https://embodied.com). While Winky resembles a puppy, Moxie resembles a human-like cartoon character. Moxie's educational goal focuses on social and emotional development and it comes with a mobile-based application for parents. Winky, on the other hand, supports children in developing their cognitive and motoric skills. Winky is also programmable and comes with a mobile-based application for children, from which they can access Winky's learning and leisure contents. These companions are considered social others by children.

Finally, **augmented learning companions** are similar to embodied learning companions, except that they are only digitally embodied, represented by digitally animated characters. Some follows the internet-of-things approach with haptic physical interface for children's input. Plugo (https://www.playshifu.com/plugo) is an example of visual learning companions using augmented reality. Plugo consists of a mobile-based application, a gamepad (sensor mat), and various physical learning kits. The learning kits target different skills, from language and grammar to playing music. The gamified learning instructions are shown in the dedicated application. The application can detect what children do with the physical learning kits and provide real-time feedback on their progress. These learning companions are still considered objects by children.

Table 1. Three Types of Children's Digital Companion

Type	Purpose	Defining Characteristic	Example	Relationship
Programmable companion	Children learn how to code and see how their codes are executed by their digital companions.	Programmable, responsive to instruction, physical embodiment	 Beebot	Children instruct, their companions follow. The companions are objects.
Autonomous learning companion	Children learn skills (including social skills) through their interaction with the digital companions.	Two-way communicability with different modalities, physical embodiment, and add-on learning contents	 Moxie	Children and their companions interact as almost equals. The companions are social others.
Augmented learning companion	Children learn skills by completing the exercises guided by the digital companions.	Pre-programmed instruction, digital embodiment, physical interface for input, add-in learning contents	 Plugo	The companions instruct, children follow. The companions are objects.

3.2 Three Layers of a Digital Companion

Each digital companion can be analytically divided into three layers. The outermost layer is its appearance, either physical embodiment or digital embodiment. The middle layer characterizes its behavior, including communication modalities. We call the innermost layer its inner function, encompassing its underlying design logics which, in turn, have bearing on the other layers. The more we peel the layers, the further we go beyond the appearance and the better can we understand a children's digital companion. Figure 1 portrays the three layers.

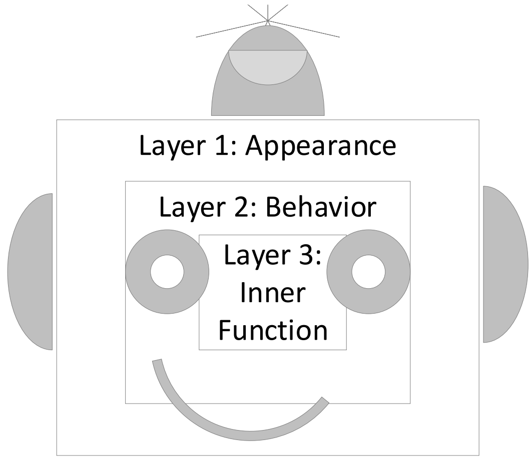

Figure 1. Three Layers of Children's Digital Companion

The appearance layer shows either physical embodiment or visual appearance of children's digital companion. Our analysis of the market offerings shows three common forms of children's digital companions. Some children's digital companions come in animal form: Winky like a puppy and Beebot looks like a bee. Some others come in humanoid form, such as Moxie and Misa. The rest of them have specific shapes which correspond to inorganic objects, such as ball or truck.

The behavior layer demonstrates the way a children's digital companions completes its tasks. This layer is also about the modalities a children's digital companions can use to express itself and communicate with children. Some children's digital companions are restricted to verbal communication, such as speech, text, and a combination of both. Others have a broader range of modality, including gesture, facial expressions, and other social cues. The interaction direction also differs. Programmable companions tend to follow one-way communication, in which they receive instructions in the form of codes and execute them. The learning companions can manage two-way communication. They can understand the content of children's speech, social cues, and other inputs and, in turn, respond accordingly.

The inner function layer points to the underlying design logics of a digital companion. These design logics define its level of adaptivity. At the one end, a digital companion can be designed to learn from the data it accumulates over time. At the other end, it can be designed to perform a set of predefined mechanisms if some conditions are fulfilled. Moxie, for instance, has a high adaptivity. It can converse fluently with children and learn from the conversation contents over time. Moxie also adapts its gestures and movements based on the mood of the conversation. Plugo, on the other hand, has a lower adaptivity compared to Moxie. Although it can detect what children do with the physical learning kits, its responses are rather repetitive. In addition to adaptivity, the inner function layer is also about agency, that is, the extent of which a digital companion demonstrates autonomy. Beebot, for instance, is low in autonomy, since it only executes the movements programmed by children. Winky and Moxie demonstrate a high degree of autonomy, in the sense that they seem to function independently as social companions.

3.3 Summing up the Insights

The market analysis contributes some useful insights for the preparation of our discussion. Among the insights are the following key points. First, we should be aware of the different terms used to refer to children's digital companions on the market. This insight provides a strong justification for our use of the overarching term. Second, children's digital companions differ in appearance, behavior, and inner function. Finally, we can distinguish between programmable companion, embodied learning companion, and visual learning companion. The most complex one to understand are autonomous learning companions. They are probably the most interesting ones for IS research.

4 Emerging Discussion Topics

4.1 Putting Ourselves into the Children's Shoes

We still do not know much about how and why children can benefit from their digital companion. But skepticism exists about the extent to which we can really understand their perspectives. Today's children are digital natives. Can we, digital immigrants, put ourselves into their shoes? The idea of digital native versus digital immigrant were introduced by Mark Prensky in 2001 and it has since been adopted by policymakers and researchers. On the other hand, the idea has also received several criticisms. Some point to the anecdotal nature of the idea and its missing empirical evidence (e.g., Margaryan et al., 2011). Others argue that there is more to being a digital native than biological age, pointing to variations among individuals and cultures, as well as access to digital technologies (e.g., Gallardo-Echenique et al., 2015). Context is also important, leading to a unifying concept to refer to children's interaction with digital technologies in learning: the 21st century student (Creighton, 2018).

As researchers, we are trained to collect and analyze data in order to understand the lifeworld of others. Even if we do not belong to a particular community or phenomenon, we still have the skills and instruments to empathize and at the same time objectively regard a phenomenon. We can consider the works of archaeologists. Therefore, it does not necessarily require a digital native to appreciate and understand how digital natives perceive and interact with their digital companions.

4.2 Moving Beyond Simplistic Measures of "Screen Time"

The last 30 years has seen increasing attention on the impact of "screen time" on the cognitive development of children. On the negative side, there have been claims that more time spent using technology such as television and other mass media for children impair cognitive development, reduce cognitive competencies, and compete with more developmentally productive activities (Ponti et al., 2017), excessive use of digital media may have negative physical, psychological, social and neurological adverse consequences (Lissak, 2018). On the positive side, this time may enrich, allowing children to vicariously experience and witness places and events far beyond their normal experiences (Anderson et al., 2017). In the context of this study on children's digital companions however, it is clear that there are a number of shortcomings and gaps in the extant literature, and that currently held temporal assumptions regarding children's use of technology may not necessarily hold as we move to technology as a digital companion.

First, existing literature over-simplifies temporal concepts usually focusing on "screen time". According to current literature, 'screen time' can be defined as the duration of time that is spent with any screen such as phones, video games, televisions, computers, laptops and tablets (Ponti et al., 2017). So, for example, we see simple recommendations emerging from these studies such as limit a child's use of a technology to X hours per day or Y number of hours before bed (Lissak, 2018; Parent et al., 2016). This over-simplification of time is not surprising and is in fact a concern raised by research (cf. Orlikowski & Yates, 2002; Shipp & Jansen, 2021). The concept of time *is an inherently complex, multi-faceted, subtle concept and is by nature socially embedded.* While IS researchers are quick to highlight the importance of development speed and dynamism, and continually refer to the fluid organisational and social world that software is developed for, they can be slow to address the polymorphous, complex and nuanced nature of time as a concept. Despite a strong consensus that richer conceptualisations of time are required, time remains theoretically elusive in contemporary organisation and management studies (e.g., Ancona et al., 2001; Reinecke & Ansari, 2015; Shipp & Jansen, 2021) and IS research (e.g., Orlikowski & Yates, 2002; Shen et al., 2015), often included only as a 'hidden dimension' and almost always over-simplified. The interactive nature of a children's digital companion means that more nuanced temporal concepts of time are required that consider not just the total time spent interacting with the companion, but also the frequency of interactions, the extent to which these interactions interrupt other activities such as dinner time, play time or 'quality time' spent with family. The rhythm of interactions may also impact the effects of the interactions.

Second, existing studies typically refer to the child's personality in terms of their preference for watching digital devices versus playing, learning or some other activity (Lissak, 2018). However, studies now need to consider that the digital companion may have a temporal personality of its own that may affect the interactions with the child. This is unlike most extant research which has only focused on television and more recently touchscreen devices (Lissak, 2018). For example, a companion may initiate interaction if left unattended for a period of time, or may be programmed to have different tolerance levels for delays of certain types of activity. Current studies assume it is the child that initiates engagement, and that it is only their tolerances for interruptions, delays or other temporal characteristics that affect the interaction and its impact.

Third, the emergence of digital companions may change currently held assumptions about the age of a child and their use of technology. Although we know that young infants and toddlers are using touch screen devices, we know little about their comprehension of the content that they encounter on them. What is known is quite general, i.e. for children less than 2 years old, television viewing has mostly negative associations, especially for language and executive function (Anderson et al., 2017). For preschool-aged children, television viewing has been found to have both positive and negative outcomes (Anderson et al., 2017). As we enter an age of bi- or multi-directional interaction and digital companionship we can learn much more about this comprehension. Also, one would expect that this digital companion-based comprehension will be improved or at least different from one-directional interaction with a television.

4.3 Being Cautious about Children's Digital Companions

We miss the bigger picture of children's interaction with their digital companions. Opinions about these digital companions tend to be polarized, each focusing only on the bright side or the dark side of them. The brighter side points to the potentials for improved information access and digital skills. Using digital companions, children can access global knowledge base and receive relevant, pre-filtered information. One can expect children to develop digital skills with interacting with their digital companions, in the manner of learning by doing. Some digital companions are designed to help children to learn social and self-regulation skills (e.g., Moxie). The learning aspect of children's digital companions sounds promising.

In contrast, the dark side calls for caution. We are familiar with the ongoing discussion on data privacy and monetization of personal information, two topics which should also be considered in the case of children's digital companions. Some regulations do acknowledge the importance of parental governance in protecting children's and teenagers' data privacy (e.g., Article 8 of the European Union General Data Protection Regulation (EU GDPR) requires parental consent for users under 16 years old). On the other hand, some of the most advanced children's digital companions on the market need their use data for them to learn and adapt (i.e., process the data) to individual preferences (see section 3.2). Without the use data, these digital companions cannot perform at their best. Adding to the complexity is the monetization of personal information, such as through personalized recommendation for consumption. Our market analysis shows how some digital companion providers rely on after-purchase sales of add-on learning contents. It is imaginable that the business model would also rely on personalized recommendation based on use data.

Still, we need to advance the discussion by finding a middle way between these two poles through the tradition of scientific knowledge accumulation. We can start by addressing the claims about digital companion's benefits in children's learning, the claims which our market analysis showed to be the unique selling proposition of the majority of providers. Here we need to make sense of interdisciplinary studies with focus on specific micro tasks. A recent study found that digital games inhibit children's self-talk for self-regulation during play, which may, in turn, have implications for executive function development (Bochicchio et al., 2022). Other studies associated the interaction with social isolation and lack of wellbeing. Moreover, we know little about children's knowledge retention when learning with a digital companion. Anecdotal evidence suggests that retention is low: children forget the answer almost as soon as they received it.

We also need to dive deeper into children's learning processes and strategies when using digital companions. Imagine asking how many people live in Switzerland. A digital companion would directly answer "8,654,622 people according to…" (cf. Google Voice Assistant). A classic search engine would show a population graph comparing Switzerland to Austria and Sweden, a summary of the country, flag and map, and other related links (cf. Google Search). While the two approaches provide good answers, the classic search engine allows for serendipity for exposure to random information which may turn out to be useful later. Which one is better? IS researchers can contribute to this collective sensemaking by combining insights on digital companions (the technologies) with insights on children's learning (the users and their social context).

4.4 From Trusted to Trustworthy Digital Companions

Trust is another important aspect we can look deeper into. Do children trust their digital companions? Should they trust them? Should we prepare our children for a trustful interaction with digital companions? If we talk about autonomous digital companions for children, we talk about social robots. Studies show that children do not only trust social robots, but they also attribute mental states (e.g., intelligence, feelings) to them and see them as social beings (e.g., could be a friend) (Kahn et al., 2014). Interaction forms emotional ties, pointing to the potentials for humanoid robots to serve as trusted friends and mentors (Calvert, 2021). Children expect their digital learning companions to show relevant knowledge and competence, emphatic reactions, more movements, and other behaviors similar to those of a friend or a mentor (Tettegah & Noble, 2015). Cayla Doll (https://myfriendcayla.co.uk) could even influence children to change their judgements about moral statements, but not to disobey an instruction (Williams et al., 2018).

Another factor influencing trust in digital companions is the *uncanny valley effect*, a hypothesized relation between an artifact's degree of anthropomorphism and how humans emotionally respond to the artifact, that state that near but not fully matching humanoid features cause eerie feelings in humans. Also, the more movement the artifact displays, the more emotions are amplified. This opens up for a plethora of questions of relevance for use and design of children's digital companions: is generation Z not affected by the uncanny valley effect, are children less susceptible to near-but-not-perfect anthropomorphism? This calls for new, ethically crafted and carefully designed experiments in children-digital companion interaction research, a research agenda to which IS researchers could bring valuable knowledge to extant studies in adjacent fields such as psychology and learning.

Finally, we need to unpack the "black box" of this phenomenon. The more complex are the models used for customizing children's digital companions, the less control can be exercised over their reasoning. Based on the small part of the world that can be formalized, the model will always be limited, fragmented and biased. How can we ensure that the children's digital companions are not only trusted but also trustworthy? Ethical issues abound; will progress in children's digital learning companions leave behind children of weaker socioeconomical groups as well as minorities for which particular language models are less economically viable to develop? Just as other digital artifacts, the business models of the manufacturers and retailers call for a transparent design process. Mentioned above, the issues of privacy and integrity of user data may influence trust in children's digital companions. In the age of data deluge, user data is the new golden currency. Does the answer lie in participatory design by multiple companies or multiple stakeholders involved in a transparent design process, employing value sensitive design (Umbrello & van de Poel, 2021)?

4.5 Digitalizing Learning and Personalizing Learning with Digital Companions

The idea of digitalization of learning has been gaining prominence in recent years. It was probably triggered by the COVID-19 pandemic and sustained by the availability of potentially useful digital technologies. The goal is to provide learners with more targeted learning systems that track individual accomplishments, set goals, and customize learning programs. Furini, et al. (2022) proposed digital twins and artificial intelligence as the pillars of personalized learning models. These authors used digital trace data to construct digital replica of the learners, making them their digital twins. These digital twins can then provide useful insights as to how to support the physical twins (the actual learners). One can analyze the digital twins to understand learning patterns, strengths, weaknesses, and other relevant variables. The ultimate idea is to personalize learning experience and progress. Digital twins can also help to anticipate potential health issues even before the onset of symptoms (Bruynseels et al., 2018).

Some of the more sophisticated children's digital companions seem to follow a similar idea. While the less sophisticated digital companions show lower adaptivity, others are particularly designed to learn from their interaction with children and adjust their mechanisms and responses accordingly (see our discussion on inner function layer in section 3.2). The downside of this idea—echoing previous discussion in section 4.3—is that we still do not know much about the side effects of the algorithms. Creating digital twins of children-learners requires a substantial period of monitoring. Moreover, the algorithms need to be trained, making the interaction between digital companions and children prone to trial and errors. What kind of errors are possible in this case and how do they impact children? Digitalization and personalization of learning also lead to dependency to the associated digital technologies, such as digital twins and digital companions. How much dependency is still acceptable? We need to accumulate knowledge to address these questions.

These examples imply the necessity of an integrative approach to understanding how children interact with their digital companions. We need to understand the underlying algorithms, their ethical consequences, and children's way of thinking and behaving. More importantly, we need to view the interaction as a sociotechnical phenomenon and the digital companions as an IS artifact.

4.6 Designing Children's Digital Companions as Sociotechnical Systems

Designing digital companions begins with an appreciation of the sociotechnical nature of their interactions with the children (Sarker et al., 2019). Focusing only on the technical features and functionalities would not help us to design trustworthy and ethical digital companions. Blackboxing the artifact to focus on their use aspects by children would not be useful, either. Such an approach would provide us with only myopic insights, leaving us wondering about how to improve the use aspects (e.g., enhance the benefits or avoid some risks) through specific changes in the digital companions. IS research needs a unified conceptualization of children's digital companions as IS artifacts with social, technical, and information components (Chatterjee et al., 2021), which are designed with specific values to contribute to the achievement of predefined economic, humanistic, or societal goals (Sarker et al., 2019) and may, in turn, lead to unintended consequences (Stahl & Markus, 2021). Being emerging technologies, we still do not know all their intended and unintended consequences. We are still confronted by imaginations and future expectations (Suchman, 2019). On a brighter note, IS researchers are equipped with design knowledge, skills, and methodologies to improve the emerging technologies.

Designing digital companions in general comes with many challenges (Moore & Arar, 2018). Digital companions require strong natural language processing (NLP) capabilities as well as appropriate knowledge about the domain of interest captured in their dialog models. In particular, studies on children's psychology, social behavior, and learning models need to be consulted to gain insights into what companionship means for the children, from their point of view (Calvert, 2021). Besides this inner structure of digital companions, their appearance (e.g., with regards to social cues (Feine et al., 2019) needs to be designed under consideration of the user, task, and context. Furthermore, design decisions with regards to the inner and outer structure of digital companions should be critically reflected upon from an ethical point of view, not only in terms of moral agency of the digital companion but also in terms of the moral patience of the child (e.g., being abusive to the companion) (e.g., Coeckelbergh, 2020). Understanding and considering these challenges strongly impacts user's interaction with digital companions.

Further challenges arise when designing digital companions for children. Compared to adults, it is much harder to involve children in the development process. However, involving children in the design and development of digital companions is a key success factor. For example, children may use a different language in their conversations with digital companions compared to adults. Thus, it may be required to build NLP models as well as dialog models specifically targeted for children. Furthermore, not enough is known about how specific design features of digital companions' impact children under consideration of task and context. Both aspects require the collection of data, both, conversational data to train NLP models and build dialog models as well as empirical data from children to better understand the impact of specific appearance design features. Finally, from an ethical point of view compared to adults it may be even more challenging to involve children in discussing and resolving ethical issues.

5 Concluding Remarks and an Agenda for IS Research

Children's digital companions are gradually entering our everyday lives. They may be less sophisticated than the fully autonomous Klara (Ishiguro's artificial friend character), but they can already provide children with social companionship and mentorship. This report offers four main contributions. First, we unpack the notion of children's digital companion using prior works on relational artifact, intelligent agent, and embodied conversational agent. Second, we present and analyze three types of children's digital companions which can be purchased on the market and unpack them into appearance, behavior, and inner function layers. Third, we create an awareness about what children's digital companions might be capable of, in good and bad ways.

Finally, we discuss four important emerging topics while appreciating diverse and even contradicting perspectives. The four emerging topics cover multiple aspects of children's interaction with their digital companions: the use aspect, the temporal aspect, the trust and ethical aspect, and the design aspect. In the spirit of crafting a research agenda for interdisciplinary IS research, we propose some possible research questions for each topic, as shown in Table 2. There is indeed a lot at stake, because this phenomenon concerns children's development and social prowess. We hope our report can ignite a spark of interest among fellow IS researchers to better understand the digital companions of our future generation and design them for the better.

Table 2. An IS Research Agenda for Children's Digital Companion

Emerging topics	**Research questions**
The temporal aspect: Current studies over-simplify temporal aspects, such as "duration-based screen time".	What is missed from simply examining the duration of 'screen time' or in this case companion time? How is "companion time" different from "screen time? What effect does the frequency and rhythm of digital companionship activity have? How does the temporal personality of the digital companion affect use and consequences of that use? Does the age of the child change the use and consequences of the companion and how do design features need to adapt for variations in child age?
The use aspect: Good or bad? The opinions tend to be polarized. We need to accumulate scientific knowledge.	How are the impacts of digital companions different from traditional media and touchscreen devices? Does children's use/misuse differ from that of adults? How do children's use of digital companions impact their language, cognition, and social skills? Which strategies do children apply when learning with digital companions?
The trust and ethical aspect: Established constructs can explain why children trust their digital companions, but not whether they are really trustworthy.	Should children trust/be taught to trust their digital companions? Should parents trust/be taught to trust children's digital companions? How can we ethically research child-digital companion interaction? What consequences come from living with and trusting children's digital companions? How can we ensure that children's digital companions evolve in ways that is positive; both for children and for society at large? How trustworthy are children's digital companions really? How can we ensure that digital companions and children treat each other morally?
The personalized learning aspect: Collecting digital trace data can help to personalize learning. But what are the side effects?	How much personalization is good for children's learning? How do digital companions really learn from their interaction with children and vice versa? Artificial intelligence also has a learning curve. How can we minimize its negative impacts on children?
The design aspect: Focusing on specific design features is not fruitful. We need a more holistic, sociotechnical approach.	How can we effectively conceptualize children's digital companions as sociotechnical IS artifacts? How do we design children's digital companions as sociotechnical artifacts? How can we anticipate even the seemingly unknowable negative consequences of our design? How can multimodal social cues be designed and optimized to allow for a more intuitive interaction? How can we involve children early on in our design efforts?

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