The Responsible Implementation of Artificial Intelligence in Childcare

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Abstract. Artificial intelligence has increasingly become part of the daily lives of today's generation. However, it is still debated how AI applications affect children when they interact with them from an early age. Parents, children and society as a whole benefit when childcare practices lead to healthy outcomes later in life. However, for many (possible) AI applications in childcare it is unclear if their effects promote positive outcomes for children or not. Therefore, the authors argue that there should be some responsibility when deploying AI in childcare, to ensure the effects of AI on the development of children are overwhelmingly positive. AI applications should be safe, accepted, trusted, and closely aligned with human values. To this end, the authors give a broad overview of the current home, education, and healthcare applications while keeping the social and emotional effects in mind. To analyze if these AI applications are designed and implemented in a responsible way, the guidelines of Floridi et al. were used to give an idea of where improvements in current and future applications can be made. This assessment does not cover all human rights and ethical perspectives on AI. Nevertheless, it focuses on the responsibility of AI application and how guardians, teachers, and medical practitioners should incorporate it into childcare.

Keywords: Artificial Intelligence · Childcare · Responsible Implementation.

1 Introduction

The question of how we should live with Artificial Intelligence (AI) systems has long been a part of our popular culture. Already in the 1950s, American writer Asimov wrote how a human-like robot with artificial intelligence should be developed in his book 'I, Robot' [8]. Although even then, Asimov foresaw the potential problems that could arise between human-robot communication.

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He implemented 'Three laws'[1] that respect the AI system's moral and ethical implications and, therefore, their treatment of humans. To this day, Asimov's three laws are often still influential in books or films throughout science fiction and maybe even influence scientists who develop AI systems [8].

Nowadays, the development of Artificial intelligence has enormously advanced, and AI systems have become part of our daily lives. However, for today's generation, the role of AI systems has been ever-increasing; To give you an idea, today's children have never known a time before smartphones. This recent progress left the authors the question, how affects these children when living with AI applications from an early age? AI has, for example, introduced new teaching systems and learning methods in the educational sector. UNESCO, for instance, published in 2019 a working paper about the policy of AI education and showed concerns about discrimination, limitations and privacy [84]. Moreover, smart toys pose risks to children's security and privacy in a home and are, therefore, banned in Germany [50]. There is also the rise of social robots used in the healthcare sector [2]. Yet, the general use of AI systems does, however, bring some societal and ethical concerns. To give a further illustration, nowadays, most people have at least read something about an AI system that discriminated unfairly [21]. Or, as O'Neil wrote in her book 'Weapons of Math destruction', AI can make life-impacting decisions in a non-transparent way [58]. This prompted the authors of this paper to investigate the state of AI applications in childcare and their (possible) effects on children. Therefore, we deduct the following research question for this paper: To which degree can AI systems in childcare be responsibly implemented, to ensure mainly positive effects from their interaction?

2 Background

In this part, we present necessary background information that we use to judge the responsibility of AI systems in childcare. This includes current looks on childcare, responsible AI, and current applications of AI technology in childcare.

2.1 Current Looks on Childcare

One of the most important factors to judge the responsibility of AI systems is the expectation towards the settings they are used in. Therefore, in this section, we present the current looks on childcare as a basis for further analysis.
It is difficult to give a singular definition of what is seen as good childhood development because childhood development goals differ per region and culture. However, it is possible to generally define what kind of practices lead to healthy

[1] First Law: A robot may not injure a human being, or, through inaction, allow a human being to come to harm. Second Law: A robot must obey orders given it by human beings, except where such orders would conflict with the First Law. Third Law: A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

outcomes later in life. Of course, different societies have different expectations of children. In some societies, a child of 8 years old is already expected to help provide for the family or assist with household chores, while in other societies, they are expected to play and learn. This difference in expectation of children's behavior causes a difference in desired competencies children are expected to develop [14]. According to Pamar et al. the main factors determining what is seen as good childhood development by society are: "the physical and social settings of daily life, customs and practices of care and parent psychology" [60].

However, some general goals of childhood development exist across cultural differences. These can be seen as independent of children's expected behaviors of children because every parent can be assumed to want their child to succeed, be it in their societal context. These general goals of childhood development are readiness to learn, success in school, and healthy outcomes later in life [7]. All three goals can be achieved best through nurturing care. This consists of a stable environment for children in which their health and nutritional needs are met, they are protected from threats and get the chance to develop and learn through stimulating and emotionally supportive interactions [13]. Responsibility to provide this care falls on parents, and other people surrounding the child depending on the family structure of children. There are countless factors influencing the quality of nurturing care ranging from maternal health to hygiene to interaction with the child, such as talking or singing. These factors can be divided into five topics: health, education, nutrition, child protection, and social protection [13]. Even though the kind of success later in life may differ across cultures, if all the child's needs in these five categories are met, the child will develop optimally and has a better chance at achieving this success [7].

There are many known ways to intervene in the factors that influence childhood development to improve the child's nurturing care. Literature suggests that successful and sustainable interventions should be built on existing healthcare and education platforms and should involve the children's different caregivers to provide the child with the level and type of care it needs throughout its life [13]. Examples of these interventions are education about proper infant nutrition and providing high-quality pre-school education programs and materials. Some interventions in childhood development, including the use of AI systems, will be discussed in section 2.3.

2.2 Responsible AI

To decide what applications of AI are responsible, one first has to understand what responsible AI is. In this section, it is described what AI systems are. Following that, the understanding of responsible AI in literature is presented and questions to evaluate responsibility of AI systems are described. These questions will be used to assess responsible implementation of AI in Section 4.

The European Union describes Artificial Intelligence as the "ability of a machine to display human-like capabilities such as reasoning, learning, planning and creativity" [28]. Therefore, an AI system is a system that autonomously adapts its

behavior based on previous actions and their effects. AI systems can take the form of traditional software (e.g. virtual assistants or modern search engines) but also embodied forms like robots, autonomous cars, or drones [28]. As AI systems adapt autonomously and impact many areas of everyday life, the question arises if AI systems act responsibly. Dignum describes Responsible AI as AI that is safe, accepted and trusted. To this end, the goals, decisions and actions of these systems have to be closely aligned with human values and expectations of the system [22]. A multitude of scholars and economic actors have created frameworks and decision aids for responsible AI in the past [92,41,65,22,3]. Floridi et. al. developed the AI4People framework, which combines multiple commonly used frameworks for responsible AI [33,34]. This framework consists of five core principles, which will each be addressed below.
The first principle, **beneficence**, is characterized as the promotion of well being of humans and the planet. The well being of humans does not only include physical and emotional integrity but also dignity. Beneficence is limited to the direct benefactor and the environment affected by the system. From this principle, we derive the following question to evaluate if an AI system is beneficent:

> *Does the system promote Well-Being, preserve dignity, and sustain the planet?*

The second principle is **non-maleficence**. AI systems should not only advance the common good, but the negative consequences of AI use also have to be considered. These negative consequences can arise accidentally or deliberately. Specifically, AI systems should promote privacy and security. Therefore the following question has to be answered:

> *Does the system prevent a loss of privacy and security?*

The third principle is **autonomy**, which is characterized by the power to decide. AI systems should be designed to not impair human freedom but promote it. Humans should therefore not be forced to delegate decisions to AI systems but rather be supported by it in their decision-making. From this, we deduct the following question:

> *Is the power to decide still in the hands of humans with this AI system?*

The fourth principle is **justice**. Justice concerns the relationship of AI and citizens in society. Floridi et al. describe justice in three ways: AI should correct previous injustice, create shared benefits and prevent new injustices. An example of injustice could be unfair discrimination. Citizens should be able to thrive alongside AI while AI systems should benefit society to build a better and more just future. From this we conclude the following question:

> *Does the system promote prosperity, preserve solidarity and avoid unfairness?*

Floridi et al. name **explicability** as the fifth principle. This principle consists of two major parts. First, systems should not be opaque. A citizen that is affected by an AI system should be able to understand how this system works. The second part is accountability. Developers have to be accountable for the effects that their AI system has. From this principle, we conclude the following questions:

> *Does the system enable the previous principles through intelligibility and accountability?*

2.3 Current applications

To understand the responsibility of AI systems in childcare, we present current applications of AI systems in this section. Children can interact with AI systems on a daily basis. When they are at home, they can ask Alexa to put on their favorite song, can play AI-powered games, or their wearables can remind them that they have reached enough steps that day. They also might interact with platforms based on AI or even have a robot tutor at school. Additionally, children with special needs are sometimes diagnosed or are educated by AI-based software. A plethora of interaction possibilities between AI and children occur with both AI systems designed specifically for children, but also those that are not which children interact with anyhow. The following section will give a small overview of different interactions with AI in a child's life.

Home At home children come across most devices that are not specifically designed for them, even though versions that are adjusted for them might exist. An example of this is the Echo Dot smart home from Amazon. In 2018 they specifically released a version for children containing a rubber casing and having the ability for parental control [6,1]. The software is even being adapted to specifically pick up kids' voices, which are usually more high pitched [40,73]. Other than that, it should also be able to deal with a child's developing language and therefore understand that "Alexa" could, for example, be pronounced as "Awexa". Apart from these non-child specific applications, there are also AI applications specifically designed for children, such as toys. Nowadays, children do not only interact with toys, but the toys also interact with them. These so-called smart toys can be placed in several categories, for instance, voice or image recognition toys [52], puzzles and building games [25], and health-tracking toys or wearables [9]. Some of these toys are smart devices that are not only used at home but also in an educational environment. The earlier mentioned Alexa, for instance, can also be equipped with educational games that aim to improve learning [30]. For children there, are also devices, like the toy My Keepon made in 2011 to be attentive and understand emotive actions [12]. Or Cozmo, where its AI has reactions eerily close to the way humans display emotion and represent itself as an adorable and trustworthy companion [68].

Education The emergence of AI in education allows for multiple applications in both smart content and student engagement. Software platforms exist that focus on providing personalized education materials for areas like literacy and mathematics [47,48]. Such platforms may also use games or rewards to achieve better engagement with the subject [23,51]. For example, the Zenbo robot from the research by Weng et al. aims to promote self-regulated learning via robotic quiz games [90]. Surprisingly, AI systems are also developed to teach children about AI-related concepts and internet-of-things technology like the PopBots [91] and the Any-Cubes [72]. More physical solutions can be found for instance in courses like Physical Education. In response to the COVID-19 pandemic, Shin et al. propose Jumple, a virtual physical education classroom. It is a remote learning environment that allows students to jump and play. Positions of body parts are detected by using AI-based pose estimation technology [76]. For a long time, research has also focused on Intelligent Tutoring Systems (ITS). Such systems can provide customized instructions to its learners and aim at enhancing the learning experience of the individual [37]. This development was followed by Affective Tutoring Systems (ATS), which are supposed to take into account the affect or emotional states of the student [38]. An example of such a system was developed by Wang et al., who developed an emotional design tutoring system that aims to analyze their learning progress by collecting information on the user's emotions. When for instance negative emotions are recognized, this might indicate that the user is confused. To recognize the emotions they use AI-driven facial emotion recognition and semantic text identification techniques [89].

Healthcare In pediatrics, Socially Assistive Robots (SARs) are researched a lot like the NAO robot, which is the preferred robot in human interaction research because of its open programming platform [2]. Applications of the robot are researched in various child healthcare areas, for instance emotional support [71], screening for autism in toddlers [70], or assessment, therapy and teaching of children with autism spectrum disorder [5,94] and possibly in pediatric asthma [29]. To optimally assist in such applications, AI-driven improvements are continuously being researched, like human emotion recognition from facial expressions [49,31], speech recognition [93] and automated planning for human-robot interactions [83]. Such applications are necessary to evaluate the child's emotional state and let the robot automatically respond accordingly. Next to this, Foster et al. aim to use the NAO robot to help children cope with painful procedures. In order to realize this, they want to incorporate social signal recognition to determine what state the children are in. Using a neural-network approach like Roffo et al. [69], they aim to automatically detect states, such as emotions, intention and attitudes. Subsequently, they will use a similar AI-planning method as Petrick et al. [63], to decide on the appropriate response of the robot [35].

Besides SARs, AI also emerges in several different child healthcare areas. For young adults that suffer from anxiety or depression, a fully automated conversational agent has been designed to deliver cognitive behavior therapy. The responses of the conversational agent were determined via an AI technique called

decision trees [32]. Next to this Balasuriya et al. aim to visually impaired children to identify objects using AI and Computer Vision. Using Artificial Neural Networks, objects in the scenery are recognised and using a similar technique a description of the identified objects is generated. Via a speech recognition module, the user is able to communicate with the system [10].

3 Effects of AI in Childcare

AI systems can have multiple effects on children, positive and negative, that specifically stem from systems designed for children or not. In this section, we present common impacts of the applications discussed before. These will act as a basis for the evaluation of responsible effects in Section 4.

Typical effects of AI systems in childcare might be specific for the field of childcare, or might also be more generally applicable. For example, effects following data protection and privacy affect every age group and are therefore more generally applicable. Legislation is already being set up and debated, with the aim to minimize the risks and allow for safe implementation [24,27,26,86,18]. A difference, however, might be that, in contrast to adults, children might be unaware of their data being collected. If children are aware that they are being monitored, it might be that they change their behavior [12].

Another effect that is important to highlight, but does also not specifically result from the design of AI systems for childcare, is the possible creation of a digital divide. Disadvantaged communities might be similarly disadvantaged when the distribution or use of emerging AI technologies is concerned [85,86]. If our world becomes increasingly more dependent on AI systems, some communities, and therefore their children, are disadvantaged in the digital world. This still leaves us to address effects as a consequence of AI's specific design in childcare. These will be discussed below by walking through the positive effects first, followed by contingent negative effects.

3.1 Positive Effects of AI in Childcare

Multiple positive effects of AI in childcare have been found that influence the emotional state, social skills, learning abilities and improve their well-being as a whole. Children might benefit from a emotionally stable companion. Parents could let their own desires influence those of their children. Or a teacher struggling with personal problems might overreact to children misbehaving or making a mistake. The behavior of robots is designed to be more consistent than that of humans and could therefore possibly be designed in such a way that it promotes healthy emotional development and better parenting techniques [20]. In the design of social robots, it might be possible to avoid such influences or reactions. This could have a positive influence on children, since it can teach them how to behave in similar future situations. Borenstein et al. even argued that children could apply these techniques and behavior in the future when they become parents themselves [12].

AI systems could also teach children to interact better with other children. Björling et al. found that the addition of a social robot in a group setting, promoted human-human interactions [11]. As an example, in a group setting, a (social) robot might call the name of a child that has been excluded from the group. This can result in the group making place for the child to join and continue interactions together [44]. This can aid in both an ability to be more inclusive and a more inclusive environment as a whole. Next to this, Rafique et al. also hypothesized that it would be possible to teach children emotional intelligence while teaching them the fundamentals needed for leaning programming skills. At the end of their study they found that both emotional intelligence and understanding of programming constructs were improved in children [67].

AI systems can also impact the well-being of children positively. Relationship-building behavior of social robots can affect children's display of positive emotions, since interaction with robots as social agents could provide them with additional emotional support, similar to the feeling of belonging and acceptance a child might receive from a playmate [17]. For example, the 'Cozmo' robot uses AI to to interact with children about their interests and is able to react to a child's emotions, and children react to it similarly as they would react to a playmate [46]. Robots might also help children deal with stress originating from their environment or stress during hospitalization [11]. For example, if a child can engage with an AI powered virtual friend they can foret about being in the hospital for a while. During hospitalization of children, several positive effects have been noted on children when six types of SARs were researched; less stress and pain, a distraction from pain or treatment, and in general more smiling, relaxation and openness [54,35,80]. Additionally SARs are also used for children with autism spectrum disorder. Therapy for this is costly and time-consuming [66], and therefore it can benefit greatly from the application of SARs. It has also been found that the use of SARs might cause parents less stress, since it could relieve them of some duties if needed [78]. As for the children themselves, many studies have shown that SARs can increase the social engagement of these children with ASD and improve their social abilities [64,87,78].

AI systems can also have positive effects on formal education. Earlier studies had already shown that the use of Information and Communication Technology (ICT) in schools promotes collaboration and increases motivation through the availability of better information and shared work resources. This can result in a better understanding of the material and increase creativity in communication [43]. Where traditionally, the whole class gets the same learning material, ICT can provide material adapted to the children's learning capabilities. Following these developments, AI systems can raise the quality of education by making teaching and learning more personalized. This personalized teaching helps to increase children's engagement to increase the learning experience [55]. Next to this, the learning process can be made more interactive and make children more easily immersed in learning [4,39]. Additionally, AI systems in the classroom can also have an effect on teachers. These applications could grade work or could be

active on discussion boards, which could allow the teacher to give more individual attention to the children [36].

3.2 Contingent Negative Effects of AI

Besides positive effects we also found contingent negative effects. There exists one common effect most researchers and robotic developers are afraid of; children might anthropomorphize robots. This anthropomorphism might result in a different development of their empathy. Young children are more prone to such developments than adults because they are more eager for social connections and have less understanding of the workings of a robot. Anthropomorphism of robots may either be conscious or unconscious, of which the latter may also raise concerns about deception [74].

However, there is also a possible occurrence of trauma by embodied robots. In a study by Coeckelbergh et al., it became evident that both parents and therapists prefer the robot to look like an animal or object, but not like a human. The authors discuss that it might be the case that they are afraid that a humanoid robot might replace human-human relationships. Next to that, they are anxious that the children might become too attached to a humanoid robot and it may upset the children if they can no longer interact with it [19]. On the other hand, a child could also be traumatized by a human-like robot. A more human-like robot is appealing until a certain point; otherwise, a sensation of strangeness and eeriness could appear. This feeling is what we call the 'uncanny valley sensation' [56]. This could lead to children becoming scared as also happens when watching a movie that is not age appropriate.

Children that spend a lot of time with AI systems could also develop impaired social and emotional skills. This in turn could lead to asocial behavior or social isolation. Robots are encoded with a 'personality', and this may affect the emotional development of children. Robots do not have the ability to experience emotion in the present time genuinely. From this, the question arises if a robot can provide the level of care to children that is necessary. A child needs to see the other's emotional state when interacting, and a lack of showing empathy can therefore be criticized [79]. If children relate too consistently to robots, they might find that their love or friendship is not reciprocal. This might cause these children to lose the ability to have empathy [81].

On the other hand they might find robotic responses to be less judgmental than humans and therefore prefer their companionship [62]. Children might come to think that the robots are capable of being friends, and leaving children in total care of robots might cause an increase in the probability of psychological damage [82,75,74]. However, these kinds of negative effects are hard to prove since it is challenging to assess if empathetic development in children is really altered by social robots [61]. Some also argue that such effects will be prevented by developers of AI, since no company would want to be liable for damage to children. Therefore, the market would adapt to make responsible choices to reduce and prevent such effects [15]. However, there exist real life examples that refute this kind of argument. For example, Facebook optimized their services for

ads and screen time, even though this can cause psychological damage children [16]. Naturally, efforts are being made to hold them accountable for this. Unfortunately, doing this this is a slow process and there is no guarantee that this will be successful. Even though this might be resolved in the end, the damage might already have been inflicted.

Next to differences in emotional and social development, they are also feared in the case of morality. Because of the difference between robot-human relationships instead of human-human relationships, children might not develop the same moral responsibilities as in human-human relationships [42]. Kubinyi et al. even make a comparison with cross-fostered animals. If such an animal is brought up by a surrogate species, it will behave differently. They fear this might happen when robots raise children as well [45]. Similarly, Melson argues that children brought up by robots will be bereft of moral standing, because they are prone to develop a different understanding of humans. This is due to the fact that they are not exposed to human morals in the same way children fully brought up by humans are [53]. One might make the case that AI is imitating humans and therefore will have a similar understanding. However, it might be that programming this is too complex and therefore a much more simplified version is used.

Lastly, there could also be negative effects through goal conflicts between academic performance and overall development of children. AI systems in school, for instance, might risk a focus on measurable academic skills instead of on established curricula. On the one hand, this performance-based focus could result in a decrease in motivation, contrary to the increase in motivation that can be gained from more personalized learning [59,57]. On the other hand, it could also lead to a neglect of skills that are less measurable but equally important.

4 Evaluation and Responsible Implementation

In this chapter, we are going to evaluate the responsibility of the AI applications described in Section 2.3. As a basis for that we are going to answer the questions about the responsibility of AI systems named at the end of Section 2.2, with regards to the effects of these systems covered in Section 3. The effects will be covered using the question structure explained in Section 2.2.

> *Does the system promote Well-Being, preserve dignity, and sustain the planet?*

Dependent on the application, the use of AI systems in childcare can promote well-being. An important factor to reach this outcome is the human oversight of either supervisors, teachers or caregivers. In conjunction with this human factor, AI systems might improve well-being of children. However, when AI systems are used to fully replace humans in areas of childcare, this generally decreases well-being. This can be observed when looking at the home, educational and healthcare environment.

When AI applications are used in the home environment researchers worry that a lack of empathy shown by the AI system could lead to an underdeveloped emotional intelligence or even psychological damage. Many researchers warn that the use of AI systems in childcare in the home setting might affect children's social and moral development negatively. However, it is also argued that the use of these AI systems could promote emotional development due to the fact that they can provide consistent companionship and act in the children's interests. This is something that parents, teachers and other caregivers are not always able to provide, since they might have personal circumstances that limit them. So, if AI applications would be used to provide such stable companionship, in conjunction with parents and caregivers interacting with children to build their emotional intelligence, AI systems might be able to improve their well-being while possible negative effects are minimized. However, long term studies would have to be performed in order to confirm these suspicions.

In the educational sector the use of AI shows an increase in the quality of teaching, and thus can positively effect well-being. These applications show positive effects such as improved motivation and communication skills. Students are individuals and the educational sector could accommodate their specific needs and pre-existing strengths. AI technology can help to optimize the content and methods for each student through personalized learning. However, when AI systems fully replace teachers the well-being of the student will suffer, since AI systems are not suited for teaching children about communicating knowledge and ideas. Furthermore, excessive reliance of the teacher on AI systems such as grade predictors might prompt them to give too little or too much attention to certain students, which can lead to a decrease in the quality of education. This same effect can be seen in the students themselves; students could put in too little or too much effort in studying when relying too much on AI systems like grade predictors. This all highlights the importance of the human factor, but also shows promise for improving education with the help of AI systems.

Lastly, AI systems in healthcare are specifically designed to improve well-being by helping children with disabilities or improving their comfort and happiness during hospitalization. Since these systems do not try to take over the roles of doctors and nurses, but focus on relieving stress or assistance in therapy, well-being of users is improved. If AI systems keep being designed with the goal of improving well-being by aiding the care giver, they could be a favorable addition in healthcare.

Does the system prevent a loss of privacy and security?

The protection of privacy and security is better preserved in the healthcare and education sector than in the home situation. In healthcare there are no specific indications that these applications would cause a loss of privacy, since the applications should be initiated by a therapist, doctor, parent or caregiver. In the education sector, privacy could even be promoted when using AI systems. Students need to communicate their thoughts with teachers, which causes an inherent loss of privacy. However, if these interactions take place with an AI

systems, their privacy might be preserved to a higher degree. A downside of this comes with the question if their data and usage of the system is being tracked. If this is the case, there is a huge amount of metadata that would otherwise not have existed that results in new privacy and security risks.

In the home situation such risks are larger, because AI systems often have little transparency in their data storage method and its accessibility. Enforcing these risks, is the fact that children, who will most likely be the main users, are probably less aware of the privacy and security concerns that are accompanied by the AI systems. In both the healthcare and educational setting, the main users are mostly their teachers or caregiver, who are more likely to be aware of the risks associated.

Is the power to decide still in the hands of humans with this AI system?

In both healthcare and education, it is clear that the power to decide is still in the hands of humans. In healthcare, AI systems are still only applied and researched in supportive roles. Therefore, the power to decide is also still in the hands of humans, since they can decide to use it or not. When AI systems are applied in education, teachers are free to decide in what way they want to design their lessons. Therefore, they can choose to use AI systems or not. However, important to note here is that the teacher in this case also decides for the child. An opt-out from students or their caretakers is questionable, because of the added workload for teachers for dual lesson preparation.

Contrary to this, it is unclear if the power to decide is still in the hands of the user when AI systems in the home situation are concerned. Especially for childcare, the power to decide also depends on the level of parental supervision required from the AI systems. Without this supervision, it will probably be difficult to ensure this, since children are less aware of the workings of AI systems and therefore have more difficulty making informed decisions.

Does the system promote prosperity, preserve solidarity and avoid unfairness?

The use of AI systems could promote prosperity and preserve solidarity in all three settings. The use of AI home systems can improve children's emotional intelligence, but can also teach them new skills like programming. Through this, AI systems can promote prosperity and solidarity indirectly and it might increase children's chances later in life and make them more compassionate towards others. In education teachers assess students based on their performance but also on inherent biases [77]. These biases could be avoided by software. Students could also be less hesitant to interact with software than with a teacher. These could result in improved education and therefore also an increase in prosperity. In the healthcare setting a specific application like ASD also promotes solidarity, since it has been shown that it improves their social skills.

For all three settings it is difficult to avoid unfairness. In all cases the use of the AI systems will probably be accompanied by costs. Low income households or lesser developed countries in general might not be able to afford such

technology, increasing the risk of the possibility of a digital divide. In education specifically an additional risk at unfairness exists with applications like grade prediction. Such data could create new biases in either student or teacher and demote fairness.

> *Does the system enable the previous principles through intelligibility and accountability?*

Accountability and intelligibility are little discussed topics in all three settings. However, if AI systems are used in a supportive manner, the user could still be hold accountable. This would therefore be feasible in the healthcare and educational setting, but could be questionable in the home setting. In all cases however, it would nonetheless be imperative that the user has sufficient understanding and control over the used AI system, in order to be held accountable.

4.1 Responsible Implementation

Having evaluated the use of AI systems in the home, education and healthcare setting using the question structure from Section 2.2, it can be clarified how these systems can responsibly be implemented. In all cases, but specifically in the home and educational setting, it is imperative that teachers and parents gain insight in the workings of the system. Since they would likely be held accountable for the AI system, they need to able to make informed decisions on use and supervision. Furthermore, there are some slight differences in each setting, that could make implementation of AI systems responsible.

Home AI systems could have serious negative effects on children's well-being as many researchers have discussed. As mentioned before, Bryson [15] believes, that such a situation would not occur, since no company wants to be liable for such effects. However, it has also been exemplified that such situations have occurred and are only being remedied after the damage has been done. To aid responsible implementation, parents should frequently be involved and be able to acquire sufficient knowledge about the applications. Providers of the AI systems should also be transparent about if and how data is acquired and stored. If this information is available, parents or guardians could decide to let their child use the AI systems or not. Accountability for the system would then be the responsibility of the parent or caregiver. Nonetheless, this means that they need to be able to know how the applications function. This should therefore be realized in the application design.

Education To responsibly implement educational AI systems, explanations and additional information about the system are required, specifically focused on teachers and students. It might even be convenient to educate teachers and students on AI technology. Education of AI technology in school for teachers and students is still in its developmental phase [88]. For this reason, it is unclear

how experienced and educated teachers and students are with these applications. Teachers could misjudge their shortcomings and especially young students might also be unable to see the risks and benefits of AI systems in school. Next to education in AI technology, responsible implementation of AI systems should be in consultation with teachers and parents, as well as students. If every party is aware of the risks and benefits associated with the use of AI systems, one could prevent negative effects like bias of teachers and unmotivated students.

Healthcare Outweighing the negative effects with the positive effects is largely in the hands of the users in the case of AI systems in healthcare. Most negative effects are centered around the fact that parents, but also therapists, do not want an AI system to fully replace a therapist or doctor. This can be prevented by designing the system in such a way that it will always only be a support and not replace the user. This also immediately indicates that users are not limited by the system, since it has a supportive role, and therefore the user can decide to use it or not. Ensuring this, child healthcare could greatly benefit from AI systems, since it can save parents and caretakers time and cause them less stress. Most importantly however, children with disabilities or hospitalized children have shown improvements in their treatment and in their well-being.

5 Conclusion

In the introduction of this paper, we asked the research question:

> *To which degree can AI systems in childcare be responsibly implemented, to ensure mainly positive effects from their interaction?*

To answer these research questions, we divided the AI systems that a child interacts with into three groups. We see AI systems at home as largely irresponsible. Uses at home only offer debatable positive effects and potential downsides like underdevelopment of emotional intelligence or psychological damage. There are also privacy and security risks and fur current AI systems in the home it is debatable if the power to decide what happens with a users data is in the hand of the user. The second group of AI systems are systems in education. These systems offer largely positive effects such as leveraging pre-existing capabilities, and optimizing content for students. Systems that predict students performance or replace the teacher, on the other hand, suffer from negative effects. Furthermore, depending on the system, AI systems can promote or demote fairness, so it depends on the application if there is a positive or negative effect on fairness. It is however questionable if teachers and students are able to understand the consequences of using AI Systems. The last group is healthcare. In this group, we found the least amount of negative effects. AI systems in healthcare can augment patients care and therefore promote a patients well being. AI systems should however not replace practitioners so that the power to decide is still in a human hand. When using AI systems in childcare, it should be kept in mind that these systems are only tools. Therefore, the responsibility is dependent on how guardians, teachers, and medical practitioners incorporate it into childcare.

5.1 Limitations

This subsection will present limitations of the research, such as unexplored areas. First of all, the focus of this research was aimed at the responsible implementation of AI systems in childcare. Within this scope, a focus has been put on AI systems in the home setting, educational setting and healthcare. The scope was chosen to get a broad perspective of AI systems in childcare. However, a broad perspective comes at the cost of a less detailed analysis of each of these three settings. Therefore, it might be that not all available research in every area is taken into account. Next to this, there also exist some effects that are a general consequence of AI systems, and therefore not necessarily specific for childcare. An example of this is privacy risks concerned with the implementation of AI systems. These general consequences are not discussed in depth, but do have an influence on the responsible implementation of AI systems in childcare. Therefore, it is important to keep in mind that such consequences can have an additional impact on the overall conclusion.

Furthermore, the scope of this paper also focused on the responsible implementation of AI systems. However, this does not cover all ethical and/or human rights perspectives. Therefore, if an application is deemed responsible according to the framework used here, it could still be seen as unethical to implement. Lastly, this paper only considers the interpretation of responsible AI of the framework from Floridi et al. [34] which was selected to evaluate the AI application in this paper. Even though the chosen framework combines commonly used frameworks and is cited frequently, and is thus probably a well-accepted standard, the use of another framework might have led to slightly different results.

5.2 Outlook

Lastly, we will give a short outlook on what we (the authors) think will be the future of childcare robotics. Currently, many of AI's possible applications in childcare are not developed yet or are not applied on a broad scale. Suppose we, as a society, want to ensure responsible developments of AI in childcare. In that case, frameworks as the one used in this paper should be used as at framework within which rules and technical standards can be developed to ensure continued responsible development of AI, as was concluded by Floridi et al. If this is not done correctly, the development of AI for childcare is left to the market, which leaves the opportunity for companies to develop AI for their benefit instead of the benefit of society. However, if the development of AI in childcare is done following laws and standards that ensure responsible development, AI in childcare can assist parents, teachers and children in providing the best care and giving children more equal chances to develop into their best selves. Therefore, it is important that we, the scientific community, continue the debate about responsible AI openly and inclusively [33].

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