

Perceptions and Possibilities: Exploring 5-year-old children's Understanding of Artificial Intelligence

Jae Eun Lee Wooyong Jeun¹⁾
Baekseok University

Abstract

This study investigates how 5-year-old children perceive and understand Artificial Intelligence (AI). The participants of the study were 45 children from a private kindergarten in South Korea. The research employs drawings and small group interviews to explore the children's conceptualizations of AI. Research results were as follows. First, 73.3% of children associated AI with positive feelings. Although they generally viewed AI as a convenience in their lives, they also expressed concerns related to health and costs. Secondly, they indicated household items, smart devices, robot and machinery, personal computer and other things as images of AI. The most frequently indicated images of AI included items that they had used themselves or seen people using in daily lives. Children primarily view AI as a tool for adult convenience and entertainment, with their perceptions shaped by their developmental stage and daily interactions with technology. These findings underscore the need for a more comprehensive approach to AI education in early childhood, one that addresses ethical considerations and is tailored to children's developmental needs. This study aims to contribute to the ongoing dialogue and development of strategies for effectively introducing AI to young learners in a way that supports their growth and development.

Keywords : perception of artificial intelligence, artificial intelligence education, young children, early childhood education

Corresponding author, ¹⁾ purin1011@bu.ac.kr

Introduction

In the dynamic landscape of the digital age, children are the first inhabitants of a world deeply integrated with Artificial Intelligence (AI). AI has shifted from a figment of imagination to an everyday reality, evident in the plethora of smart devices that are part of a child's daily environment. This generation, born into the digital era, navigates a life filled with tablet PCs and AI-driven devices with an unprecedented ease. Unlike their predecessors, they don't view technology with skepticism or fear. Instead, they embrace smart toys and phones as natural extensions of their being. Commands like “Hey Siri,” “Okay Google,” and “Hey Kakao” are part of their vernacular, illustrating a future where humans and machines coexist in mutual understanding. In this post-human world, a world where there is no distinction between human and non-human (e.g., AI robots, virtual reality, internet of things etc.) (Dong, 2022), their relationship with AI and smart technologies will be inherently different, marked by an intimacy and fluency that those who encountered AI later in life might never fully experience (Lee et al., 2022).

The COVID-19 pandemic has escalated the presence of AI in our daily lives, especially within the educational sphere, prompting a worldwide surge in AI education interest. Nations are vying to lead in core AI technologies, with Korea actively embedding AI contents and skills into its educational framework to cultivate future-ready talent (Korea Foundation for the Advancement of Science & Creativity, 2019; Ministry of Education, 2020). To enhance digital proficiency, the Ministry of Education in Korea plans to integrate AI education into the curricula of kindergartens, elementary, middle, and high schools starting in 2025. It's reported that kindergartens will implement an AI-focused curriculum aligned with the Nuri curriculum², enabling students to perceive and utilize AI as an integral part of their daily lives. This does not simply mean providing smart devices, robots, or AI-driven toys to children.

² The Nuri curriculum refers to the educational program implemented in South Korea. Introduced in the early 2010s, it's designed for children from birth to age 5 and aims to provide a comprehensive and standardized educational experience for all young children regardless of their background. The Nuri curriculum focuses on holistic development, emphasizing not just cognitive skills but also all young children's physical, emotional, and social growth. It integrates play-based learning and is tailored to meet developmental milestones, seeking to create a solid foundation for lifelong learning and well-being.

What is important is that education is provided in the classroom so that children can play in a variety of ways using computers, the Internet, robots, and smart devices (Lee, 2022; Lee & Kim, 2020; Lee et al., 2022).

The formal incorporation of AI into early childhood education programs is in its initial stages, yet the creation and dissemination of AI-focused educational resources are swiftly expanding. For example, there has been a significant leap in teaching methodologies, with ICT³ technology playing a pivotal role in revolutionizing early childhood education. The shift towards child-led play and ICT-enriched educational content is not just a response to immediate needs but a step towards a future where technology and learning are inherently connected, preparing young minds for a world where AI is an integral part of life. According to Dong (2022), who examined children's digital play and learning from a post-humanist perspective, the needs to investigate new dynamics and educational potentials in the relationships between human and non-human elements in children's activities are rapidly increasing.

Historically, ICT-related research in early childhood education has predominantly focused on the application of educational robots and computers. Studies exploring the effectiveness of intelligent robots in teaching (Lee & Jung, 2012; Park et al., 2011; Yoo & Lee, 2013; Yoo et al., 2011), the experiences and emotional responses of early childhood teachers using assistant robots (Hyun et al., 2010; Kim et al., 2010), and the development and impact of curricula incorporating educational robots (Park & Kim, 2013) have been pivotal in illustrating how robotics and computer technology can enhance early learning environments. It is important to note that these studies were conducted prior to the growing interest in AI, which allowed us to explore the possibilities of using AI robots in early childhood education (Lee, 2022), and showed the promise of using AI in early childhood education. These inquiries also have laid the groundwork for understanding the multifaceted ways in which technology can support and enrich the educational experience for young learners.

Recently, there's been a notable shift towards research in software and programming education for young children. International studies from the United States, Singapore, and Sweden demonstrate that robotics and programming activities are being integrated into

³ ICT is an abbreviation for Information and Communication technology.

children's daily routines in a playful manner, tailored to their interests and developmental stages (Balanskat et al., 2018; Lee & Kim, 2020; Sullivan & Bers, 2018). These activities, designed with children's developmental needs and interests in mind, are not only enhancing logical thinking, creativity, and problem-solving skills but are also fostering communication and collaboration as children engage and share ideas with their peers (Bers, 2017, 2018; Flannery & Bers, 2013; Papadakis et al., 2016). In addition, children showed that they used metacognition during coding play by expressing their thoughts and goals, monitoring errors and performance, regulation their emotions and motivation, and evaluating the quality of learning outcomes (Han & Choi, 2023). This evolution in research reflects a broader understanding of how technology can be seamlessly and effectively integrated into early childhood education.

Building on the exploration of ICT and software activities in early childhood classroom, it's important to acknowledge the mixed reactions from educators. While there's a general positive outlook on using computers, tablets, or robots as creative learning tools, early childhood teachers often feel overwhelmed by the additional tasks these technologies introduce (Lee & Kwon, 2022). This sentiment underscores the need for a well-structured approach to integrating technology in early learning environments. Lee (2022) emphasizes this point, advocating for the development of teacher education programs specifically designed to introduce software and AI education into early childhood settings. She argues that digital competency is a critical skill that should be nurtured from a young age and that educators need systematic training to effectively impart these skills.

Reflecting a broader consensus, these prior studies advocate for enhanced education to strengthen young children's digital capabilities in anticipation of the AI era. Research predominantly focuses on the utilization of technological devices, the impact of programming activities, and the creation of comprehensive teacher education programs (Lee, 2022; Lee & Oh, 2021; Park et al., 2022; Yoo & Kim, 2021). These findings not only highlight the evolving dynamics of early childhood education in an increasingly digital world but also the imperative for well-rounded strategies that equip both educators and students to navigate and excel in this new era.

Despite the growing global interest in software or AI education and the strides being made to integrate AI technologies into early childhood classrooms, research specifically targeting

AI education for young children remains scant. The discourse surrounding the structure and objectives of AI education in early childhood is just beginning to emerge. Initial studies have started exploring the direction of early childhood AI education, understanding early childhood educators' perceptions of AI, and identifying the educational competencies required for teachers to effectively deliver AI education to young learners (Choi & Kim, 2023; J. -E. Lee, 2022; Kim, 2022; Lee & Kim, 2023; Lim & Choi, 2022; Park, et al., 2022; Pyun & Han, 2022; Su et al., 2023; Yang, 2022; Yang & Park, 2022). Yet, there is a notable gap in foundational research aimed at developing AI education content and programs specifically tailored for young children.

To introduce an AI educational content and curriculum for children in a systematic and developmentally appropriate manner, it's crucial to investigate how children perceive and interact with AI in their play and daily lives. Understanding children's perspectives and acceptance of AI will provide valuable insights into what AI education should encompass and how it should be delivered. This knowledge is key to developing an AI curriculum that resonates with and benefits the youngest learners, ensuring they are equipped for a future where AI is an integral part of life.

The purpose of this study is to understand children's perspectives on and acceptance of AI by examining their preferences and familiarity levels with AI, as well as their perceptions of AI images, providing foundational data to enhance and inform the development of AI education for this young age group. The preference and familiarity with AI is a factor often used in South Korea's national software and AI education research projects to examine how learners understand and accept AI (Korea Foundation for the Advancement of Science & Creativity, 2023). Because it is difficult to clearly distinguish between the concepts of familiarity and preference for AI at early childhood ages, researchers use these concepts interchangeably. By investigating how 5-year-old children perceive and conceptualize AI, this research seeks to uncover the images and understandings that these young minds hold about AI. The insights gained will not only contribute to a more nuanced understanding of children's interactions with AI but will also serve as a critical resource for educators and curriculum developers aiming to create effective, age-appropriate AI educational programs. The following research questions are discussed in this study:

1. What is the preference and level of familiarity with AI among 5-year-old children?
2. What are the images of AI perceived by 5-year-old children?

Method

Participants⁴

This study focused on 45 five-year-old children from D private kindergarten in a suburban city of Chungcheongnam-do, South Korea, who had previous exposure to software education or AI-related activities. This prerequisite was essential as children without such educational background might find it challenging to articulate their thoughts on AI. The selection process began by identifying kindergartens offering software and AI education. Researchers then reached out to these institutions, explaining the study's purpose and seeking their participation. From the responses, institutions willing to participate were chosen. Subsequently, from these kindergartens, 5-year-old children who had engaged in AI and programming activities were selected. This age group was specifically chosen due to their developmental readiness; at five years, children are typically able to express their ideas clearly in small groups and possess better drawing skills compared to younger children, as noted by Baturka and Walsh (1991, as cited in Graue & Walsh, 1995). The distribution of participants by class and gender is detailed in Table 1.

Table 1. *Distribution of the participants by the Gender*

Class	Boy	Girl	Total
Class 1	10	12	22 (6 groups)
Class 2	10	13	23 (6 groups)
Total	20	25	45 (12 groups)

³ Name of research participants was changed into pseudonym.

Research context

The selected research institution is a university-affiliated kindergarten that follows a national curriculum emphasizing play, life, and activities. It operates daily from 9:30 AM to 4:00 PM and has three classes for 3-year-olds, two for 4-year-olds, and two for 5-year-olds. For this study, both classes of 5-year-olds were chosen. This kindergarten is notable for its diverse software educational activities based on Korea's national play-based Nuri curriculum. Consequently, the teachers are well-versed in software education content, teaching methods, and activities. The children here are more accustomed to using ICT devices in their play compared to their peers from other institutions. This familiarity makes them better equipped to articulate their thoughts and feelings about AI.

Data Collection

The data for this research include children's drawings about AI and group interviews with children. These data were collected from March, 2023 to July, 2023. To collect children's drawings, the date and time for meeting children were scheduled with the classroom teachers. Because the process of writing down children's picture stories required help from teachers, researchers gave teachers specific guidance on how to write down picture stories. The procedure for collecting pictures is as follows. First, researchers and classroom teacher sat down with children in a large group and asked them if they had heard the words AI or artificial intelligence and what they thought about it. And we suggested that children drew the image or their impressions about AI. Children drew pictures using drawing tools such as crayons and colored pencils on white A4-sized drawing paper during the free choice activity hours, and then explained the picture story to either researchers or classroom teacher. Additional questions were asked if more explanation of the picture was needed while writing the children's story. These drawing process took one hour or less in each class.

Then, interviews with the children in small groups were conducted one or two times per week. Through consultation with classroom teacher of each class, a group was formed of 3 or 4 peers who were friendly and had similar level of participation in group activities. As a result, the children were familiar with interviews with researchers, and were able to share their opinions and thoughts about their peers' opinions in a comfortable atmosphere. Each

interview took 10-20 minutes. The free choice activity hours were used for interviews, which took place at the small group activity room familiar to young children.

The interview questions were in the semi-structured format. The examples of interview questions include “What do you think artificial intelligence, AI means?”, “Have you ever heard people saying AI or artificial intelligence?”, “Have you ever used AI or artificial intelligence? When have you used it?”, “Can you tell me when you felt ‘AI is good’?” or “Can you tell me when ‘AI is bad’?”, “If you were to create an AI, what kind of AI would you want to create?” In small group interviews with young children, it is important to structure questions appropriately for the children’s level and to specify and clarify the children’s thoughts through the process of changing and supplementing the terminology or structure of the questions by reflecting the children’s answers (Morgan et al., 2002). In this study, interview was about the overall perception of AI and topics related to children’s drawings. Since AI is an abstract concept, in order to enable conversation about them, children were asked about the concept of AI at the first interview, and if they had difficulty answering, a brief introduction was made to share basic understanding.

The specific interview procedures were as follows: researchers visited a classroom and introduced ourselves to the young children so that we would get familiar with each other. Then we moved to the interview room with the children. Before starting an interview in a group, we made small talk with them about weather, life at the kindergarten, and playing with friends to create a comfortable atmosphere. After becoming familiar with each other, children had time to introduce the pictures they had drawn about AI. Considerations were given during an interview so that young children could have enough time to answer the interview questions. When additional explanations about children’s answers were needed, follow-up interviews were conducted. After completing the interviews with children, researchers acquired information about the children’s prior experience or knowledge about AI from their classroom teachers to improve their understanding of the interview content.

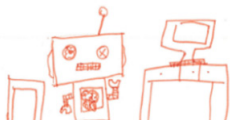
Data Analysis

Data analysis proceeded simultaneously and interactively with data collection (Glense, 2006). The strategies for analyzing data were based on the constant comparative method,

continuously analyzing each data unit against the data already gathered (Strauss & Corbin, 1998). Researchers meticulously examined both interview transcripts and drawings from each participant individually, identifying key themes. We manually coded the data, identifying developing patterns, categories, and themes. Subsequently, researchers analyzed the identified categories, comparing and contrasting the data sets while taking into account each set's specific context (Strauss & Corbin, 1998). For instance, children's drawings and interview data were initially coded into individual images such as computers, tablet PCs, smartphones, robot vacuum cleaner, and so on. Then, we searched the common patterns of the data and labeled the responses. Meanwhile, we wrote a memo for generating a preliminary list of categories like smart devices, daily necessities, and revised the preliminary list repeatedly to generate an upper category. After determining the sub-categories according to the major ones, we extracted and analyzed suitable cases for each category. The collected data was re-analyzed based on the categories.

Five categories of images of AI as perceives by 5-year-old children were used in coding interview and picture data: household items used in daily life, smart devices, robot and machinery, personal computer and other things. Interview and picture data were coded as indicating the presence of images of AI corresponding to one or more of these categories.

The following are examples of picture data coding:



Robot, tablet PC, and computer comes to mind.

(Sumin, Age 5, Girl)

In this picture, Sumin described that when thinking of AI, robots, tablet PCs, and computers come to her mind. These responses match with the categories of the smart devices and personal computers. Hence the authors coded this picture data as smart devices and personal computers. Like this, if multiple images were presented in one picture, duplicate responses were processed.

To enhance the trustworthiness of data analysis, researchers frequently asked and reviewed the participating children's understanding of what they understood during the interviews or drawing pictures. Through this, efforts were made to ensure the accuracy of analysis and

interpretation, and after completing the study, records of the researchers' analysis and interpretation were provided to the children's classroom teachers to conduct member review to confirm suitability (Merriam, 1998). And we performed joint and cross checks in the process of extracting and analyzing cases in an effort to reduce interpretation errors as much as possible. In addition, the overall data analysis process was reviewed by 2 early childhood education professors in other university and participants' classroom teachers.

Results

Preference and level of familiarity with AI among 5-year-old children

The results of analyzing preference and the level of familiarity of 5-year-old children with AI are as follows. To examine preference and the level of familiarity with AI of 5-year-old children, researchers asked them some questions. We interviewed them how they felt when they thought of AI or heard the word, AI, using pictures of three facial expressions: good, average, and bad. And we asked them to indicate their level of familiarity with AI by the size of the circle.

As a result of the analysis, 33 children (73.3%) responded that a pleasant facial expression came to mind in relation to AI. 7 children (15.6%) responded that they felt average and 5 children (11.1%) responded that they felt bad. Children easily answered questions about how they felt when they heard the word AI or thought of AI, but had difficulties answering questions about their level of familiarity with AI. They mentioned their preference for AI depending on whether they had prior experience with AI and the emotions they felt when experiencing AI.

AI tells the time and helps a lot. It tells us what time it is, the weather, and how to get there.

(Jiyun, Age 5, Girl, 12 April, 2023)

AI is like some kind of robot. AI is a convenient machine that helps us. It helps us a lot. I think that's why we're friendly with it.

(Heejin, Age 5, Girl, 3 May, 2023)

I don't know much about robots, but I seem to know them well. So I think I'm somewhat familiar with them.

(Jiseon, Age 5, Girl, 19 April, 2023)

These interviews describe children's positive feelings about AI. This was related to children's prior experiences that AI provides convenience in their life. They expressed positive feelings about AI by providing examples of things equipped with AI functions helping people.

On the other hand, these are the examples of children's negative feelings about AI.

Although robots help us a lot, I feel a little bad because AI can make my eyesight worse. I think we're a little close.

(Nakyung, Age 5, Girl, 3 May, 2023)

If I use AI too long, I think I might be a fool. And my eyes are also red.

(Juwon, Age 5, Boy, 12 April, 2023)

I felt bad because the price of the robotic vacuum cleaner was too high.

(Junghwan, Age 5, Boy, 3 May, 2023)

There used to be a "Hey Clova" in the Haneul class. My friends and I said to Hey Clova, "Play an exciting song.", and had fun. However, one friend kept hitting 'Hey Clova' on the head as a joke, so the teacher took it away, saying it could break down and cost a lot of money to repair.

(Seunghyuk, Age 5, Boy, 19 April, 2023)

These interviews show that children's negative feelings about AI was related to the expensive price and health issue of using digital devices. They perceived that the AI-driven devices are too expensive to use in daily lives. They also concerned that excessive use of digital devices can damage eyesight, which made children feel negatively about AI.

The examples above illustrate that the majority of children felt positively about AI. However, some described their negative feelings because of the price and health problems when using AI-based digital devices. Their direct and indirect experience with AI was an important factor in allowing children to perceive AI positively, neutrally, or negatively.

Images of AI perceived by 5-year-old children

Images of AI perceived by 5-year-old children were household items used in daily life (32.7%), smart devices such as cellular phones and tablet PCs (23.6%), robot and machinery (21.8%), personal computer (12.7%), and other things (9.1%) that come to mind when they think of AI. Pictures containing multiple images in one picture were treated as duplicate responses. Categorical aspects of image of AI as perceived by 5-year-old are presented in Table 2.

Table 2. *Images of AI as perceived by 5-year-old children*

Category	Household items used in daily life	Smart devices	robot and machinery	Personal computer	Other things	Total
N (%)	18 (32.7)	13 (23.6)	12 (21.8)	7 (12.7)	5 (9.1)	55 (100)

Household items used in daily life. The biggest number of 5-year-old children said that images of household goods used in daily life came to mind when they thought of or heard the word, AI. Many daily necessities that are commonly encountered in everyday life appeared in children's drawings. Children mentioned television or television remote control equipped with AI technology, AI speaker, cars equipped with AI services, robot vacuum cleaners, and air conditioners that they had used themselves or seen people using. The following pictures are representative images of children related to images of household items used in daily life.



(Left)

I drew "Hey CLOVA."

(Suhyun, Age 5, Girl)

(Right)

It's an AI mobile that wakes up sleeping people. People call it "Hey Siri."

(Heejin, Age 5, Girl)

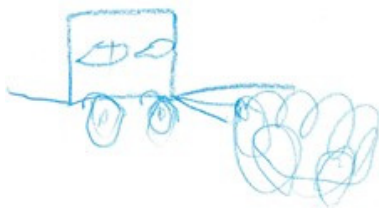


A robot vacuum cleaner that moves around and cleans alone

(Junghwan, Age 5, Boy)

Suhyun (age 5, girl) said that she can listen to children's song or fairy tales using an AI speaker, 'Hey CLOVA'. And Heejin (age 5, girl) said that she drew a picture of Siri, a cell phone's AI technology, waking up a sleeping person. Junghwan (age 5, boy) said that it reminded him of a robot vacuum cleaner that moves around the house and cleans by itself. Likewise, children recognized that AI technology helps people live conveniently. In addition, children sometimes recognized AI as the brand name of a product using AI technology or as the product itself. For example, Junsang mentioned that "I only remember LG. There was the word LG under the computer. Or even under the TV" (Junsang, Interview, 05/02/2023). Children also mentioned Apple and the iPhone produced by Apple.

Children also drew pictures and mentioned things like autonomous cars or automotive AI services installed in the cars. They recalled vehicles equipped with AI technology that they had experienced in their daily lives and self-driving cars that they had seen in advertisements.



I drew an AI car.

(Seungjun, Age 5, Boy)



I drew an AI taxi. If you tell me the AI taxi where you want to go, the taxi will take you where you want to go.

(Junhan, Age 5, Boy)

Children talked about their experiences of riding in a car equipped with a voice recognition function, such as recognizing a person's voice and giving directions or playing music they wanted to listen to. They also said that AI cars are convenient and smart because they move their own wheels without a human being driving them. As can be seen in the cases of children presented so far, AI is likely to be perceived positively by children because it makes people's lives more convenient.

Smart devices. The second images of AI as perceived by 5-year-old children were smart devices. Children mentioned smart devices such as smartphones and tablet PCs. The following pictures are representative images of children related to images of smart devices.



This is a cinnamon roll cell phone. We can listen to songs and search for things we're curious about.

(Dohee, Age 5, Girl)



It's an artificial intelligence cell phone. We can write messages and send them to people.

(Nayoung, Age 5, Girl)

Dohee (age 5, girl) said that when she wants to listen to children's song or search for something she is curious about, she uses cell phone, which she thinks is AI. And Nayoung (age 5, girl) uses smart devices to express her thoughts and communicate with others. Dain (age 5, girl, Interview, 04/26/2023) said that she thought artificial intelligence, AI was a tablet PC because there were several tablet PCs in the AI/SW classroom within the kindergarten. Children used smart devices in their daily lives to pursue enjoyment, form relationship with others, and receive help.

The smart device presented in the children's pictures was basically square in shape. This

represents the smart devices that children have experienced and seen. The picture presented below is an example of a children who mentioned that AI is something to study.



AI is somethings that must be studied with a smart pad.
I've never used AI to study, but I saw it in an advertisement.

(Jisoo, Age 5, Girl)

Likewise, some children mentioned that AI is something that has to do with learning. Even if children have never studied with AI devices, they saw TV commercials introducing AI-based educational devices that help people learn. Moreover, due to a specific Korean private education software program whose pronunciation is similar to AI, children were likely to recognize the brand name as AI.

Robot and machinery. The image of AI that participants think of appeared in the form of robots or complex, automated machines. They drew pictures related to various types of robots and automated factory machines that repeat specific tasks. Representative images related to robot and machinery drawn by children are as follows.



It's an AI robot that cleans for me, does crafts, and does everything I ask it to do.

(Yujin, Age 5, Girl)



It's an AI robot that can grab objects with tongs and suck up dust. It's a cleaning robot and also has wheels.

(Kangwoo, Age 5, Boy)



It's a robot that makes people look cool. It also makes food for people.

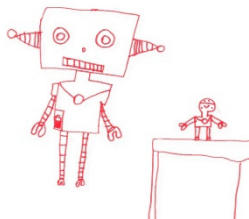
(Minjoo, Age 5, Girl)



It's a machine that makes books.

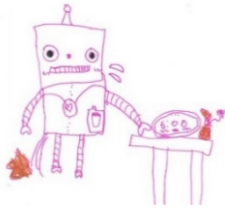
(Woojin, Age 5, Boy)

What these images have in common is that they represent a special ability that can replace what people have done so far. Children recognized that AI, represented by images like robots or machines, easily performed tasks that are troublesome or difficult for people to do, and tasks that are difficult for humans to do. While children thought that robots could take over jobs previously done by humans, they tended to draw robots that looked similar to humans. The robots children drew included body organs such as the head, arms, and legs, as well as faces, eyes, nose, and mouth, although they looked different from those of humans. Some children expressed that robots discharge excrement through metabolism similar to living things.



It's a robot that moves when controlled. People can make this robot whatever they want.

(Juhyun, Age 5, Girl)



It's an AI robot. The robot accidentally pooped.

(Eunchae, Age 5, Girl)

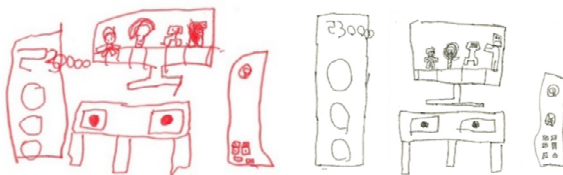
Children who recognized AI as a robot thought that robots could speak human language, move on its own, and speak English or Korean. They recognized AI as smart and even said that this was because scientists smartly created a life form called AI. While children think that AI is a robot that is smart and can do anything, they also think that the beings that run this AI are people. In other words, although they were surprised and amazed at the superior capabilities of AI, they thought that humans were the ones who created and operated AI.

Personal computer. The image of AI that children came up with sometimes takes the form of a computer. It appeared in the form of a personal computer that we commonly use, and the most common PC type was equipped with a keyboard, mouse, and monitor.



Ai is a computer.

(Jisoo, Age 5, Girl)



Playing Minecraft on
computer

(Left: Hyungsuk Age 5, Boy

Right: Jaemin, Age 5, Boy)

Children recognized AI as a computer itself. This might be due to their personal experience using a computer or seeing their parents or siblings use a computer. They were aware of the

image of AI based on the computer device itself and the functions that could be performed using the computer. Because children experienced AI using computers, they also thought that computers ran on AI. In other words, for children, computers are a medium through which they can use AI or express their thoughts through it.

Other things. In addition, 5-year-old children recognized AI as the United States and a treasure box containing AI. Children said that when they heard the word, AI, which is not made up of the Korean alphabet but made up of the letters A and I, the United States, which uses the alphabet, came to mind. Additionally, children said that America is the country that develops AI technology and has the most advanced AI technology, so when they think of AI, the United States comes to mind.



When I think of AI, America comes to mind.

(Junhyun, Age 5, Boy)

Discussion and Implication

This study aimed to understand how 5-year-old children perceive and recognize AI. To meet this goal, researchers gathered drawings from the children illustrating their thoughts on AI and conducted small group interviews. The key findings and discussions from the study are summarized below.

First, a majority of children (73.3%) associated AI with positive emotions like fun and pleasure. This aligns with previous research targeting various groups, including prospective early childhood teachers, kindergarten parents, and elementary students, which also reported predominantly positive attitudes toward AI (Hwang, 2020; Kim & Kim, 2023; Kwon & Kyun, 2018; Shim & Oh, 2011). While children generally view AI as a convenience in their lives, they did express some concerns, primarily related to health and cost, rather than the ethical

dilemmas or job displacement fears often discussed by adults. This limited scope of concern might stem from children's personal experiences with AI, which are typically as users who interact with it through voice recognition or as a tool for study, rather than as creators.

Although children could easily express their feelings about AI, they found it more challenging to articulate their understanding of it. They recognized the term 'AI' and could relate it to familiar devices and the need for electricity, but they struggled to explain how AI actually works. These findings align with those of a government-commissioned study delineating the outcomes of an AI education program implemented among elementary school students in South Korea (Korea Foundation for the Advancement of Science & Creativity, 2023). The study revealed that despite their familiarity with AI, the students exhibited a deficiency in grasping the fundamental concepts underlying AI. This indicates that while AI is a regular part of their daily lives, encountered through media and household devices, they primarily engage with it from a user's perspective. The children's interactions with AI haven't yet led them to deeply consider its functionality or their proximity to the technology.

Second, this study found that 5-year-old children's perceptions of AI can be divided into various categories, such as household items, smart devices, robots, machinery, and personal computers. Essentially, the children's images of AI were closely tied to objects they frequently encounter in their surroundings. This observation aligns with similar studies conducted among older students and prospective early childhood teachers (Hwang, 2020; Kwon & Kyun, 2018; Park & Shin, 2017; Ryu & Han, 2017; Shin et al., 2018), where AI was often visualized in forms like mechanical, human, smart computer, electronic brain, algorithm, daily product, and complex images (Hwang, 2020). The way children perceive and depict AI is influenced by their interactions with technology or TV commercial, suggesting that their experiences shape their understanding and representation of AI, often visualizing it as familiar devices like computers or tablet PCs with specific brand name.

The way children visualize AI is influenced not only by their prior experiences but also by their developmental stage. AI, a field focused on enabling computers to learn, reason, and make decisions like humans, is an abstract concept that can be challenging for young children to grasp. At five years old, children are in Piaget's preoperational stage, where understanding and representing abstract ideas like AI can be particularly difficult. Consequently, they tend to depict AI using more concrete and familiar forms from their daily lives, such as machinery,

smart devices, and personal computers, rather than abstract representations. This tendency reflects their developmental needs to relate complex concepts to tangible experiences they understand.

In the children's drawings, AI is depicted primarily as a smart device that simplifies and enhances the lives of adults, not as a direct aid or companion in their own lives. They view AI as household items like robot vacuum cleaners and Siri, which they believe can handle tedious or challenging tasks. Similarly, they see AI as capable of performing everyday tasks autonomously. This perception aligns with studies like Shin et al. (2018), where AI is often seen as a servant-like entity. However, children's views of AI as a source of fun are limited to adult-oriented activities, and they believe they need parental permission to enjoy AI's entertainment aspects. Notably, even with some background in software and AI education, the children's understanding of AI doesn't extend to seeing it as a playmate or a tool for their personal goals, with only a few recognizing its potential to assist in personal tasks like finding music or pictures. This narrow view contrasts with the natural learning-through-play characteristic of young children. AI is a part of their lives but not integrated into their play, a crucial aspect of their learning and development. To make AI a more meaningful part of their lives, children need broader, more interactive experiences with AI in their daily play and activities. Early childhood educators are key to this, requiring the ability to incorporate AI into children's learning and play effectively. Early childhood education should offer AI-related activities that encourage children to be active, creative users and producers, rather than passive consumers.

The implications of this study are multifaceted and significant for various stakeholders in early childhood education, technology development, and policy-making. First, the study highlights the need for age-appropriate AI education in early childhood curricula. Educators and curriculum developers can use the findings to design activities that introduce AI concepts in a more tangible and relatable way, aligning with children's developmental needs and interests. This might include more play-based, interactive learning experiences that make AI less abstract and more accessible to young minds. Second, understanding that children view AI primarily as a tool for adult convenience suggests that teachers need specific training to integrate AI into the classroom effectively. Professional development programs should focus on helping educators understand AI themselves and then provide them with strategies to teach

these concepts in an engaging, understandable manner for young children.

This approach will not only enable children to develop accurate understandings of AI but also empower them to engage with it more actively and effectively. AI education should go beyond just cognitive learning focused on acquiring coding skills or using AI devices without understanding. Rather, it's important to develop a curriculum that covers AI's benefits, limitations, and ethical considerations. In addition, children understand the concept of AI based on their own experiences, so research is needed to develop an educational program to help them understand the concept of artificial intelligence, AI correctly. By providing a balanced and comprehensive view of AI, early childhood education can ensure AI plays a positive and meaningful role in children's lives.

The research study provides valuable insights but, like all research, comes with certain limitations that should be acknowledged for a comprehensive understanding of its findings. This study may not reflect the broad spectrum of global childhood experiences due to its small, geographically limited sample. The research methods, primarily drawings and interviews, while child-appropriate, may not fully capture the complexity of children's thoughts on AI. Furthermore, the rapidly evolving nature of AI technology means that children's and adults' perceptions are constantly changing, potentially dating the study's findings quickly. Therefore, future research should consider a larger and more diverse sample to better represent the wide range of children's experiences with AI globally. Additionally, employing a variety of methodologies and longitudinal studies could provide a deeper understanding of how children's perceptions of AI develop over time as technology evolves. As we continue to navigate the intersection of AI and early childhood education, it is our hope that this research sparks further exploration and dialogue, guiding us toward a future where AI is integrated into children's lives in a way that is ethical, beneficial, and conducive to their growth and development.

References

Balanskat, A., Engelhardt, K., & Licht, A. H. (2018). *Strategies to include computational thinking in school curricula in Norway and Sweden-European Schoolnet's 2018 Study*

- Visit*. From
https://www.eun.org/documents/411753/817341/Computational_thinking_report_2018.pdf
- Bers, M. U. (2017). *Coding as a playground: Programming and computational thinking in the early childhood classroom*. Routledge.
- Bers, M. U. (2018). Coding and computational thinking in early childhood: the impact of ScratchJr in Europe. *European Journal of STEM Education*, 3(3), 8.
<http://dx.doi.org/10.20897/ejsteme/3868>
- Choi, H., & Kim, Y. (2023). Exploring the direction of early childhood education in the age of artificial intelligence: Delphi analysis of a group of experts. *Korean Journal of Young Children Becoming Curriculum*, 13(1), 17-38.
<http://dx.doi.org/10.26834/ksycbc.2023.13.1.17>
- Dong, P. (2022). Exploring emerging play and learning of young children in the posthuman age: Digital play. *Korean Journal of Early Childhood Education*, 42(6), 357-383. <http://dx.doi.org/10.18023/kjece.2022.42.6.015>
- Flannery, L. P., & Bers, M. U. (2013). Let's dance the "robot hokey-pokey!" children's programming approaches and achievement throughout early cognitive development. *Journal of Research on Technology in Education*, 46(1), 81-101.
<https://sites.bc.edu/devtech/wp-content/uploads/sites/113/2018/02/JRTE-robot-hokey-pokey.pdf>
- Glensne, C. (2006). *Becoming qualitative researchers: An introduction* (3rd ed.). Boston, MA: Pearson.
- Graue, M. E., & Walsh, D. J. (1995). Children in context: Interpreting the here and now of the children's lives. In J. A. Hatch (Ed.), *Qualitative research in early childhood settings* (pp. 135-154). Westport, CT: Praeger.
- Han, J. & Choi, Y. (2023). Young children's metacognition expressed during coding play. *Asia-Pacific Journal of Research in Early Childhood Education*, 17(3), 21-45.
<http://dx.doi.org/10.17206/apjrece.2023.17.3.21>
- Hwang, S. (2020). An Analysis of Pre-service Early Childhood Teachers' Perceptions of Artificial Intelligence. *Journal of Learner-Centered Curriculum and Instruction*, 20(19), 1255-1283. <http://dx.doi.org/10.22251/jlcci.2020.20.19.1255>

- Hyun, E., Park, H., Jang, S., & Yeon, H. (2010). The usability of a robot as an educational assistant in a kindergarten and young children's perceptions of their relationship with the robot. *Korean Journal of Child Studies*, 31(1), 267-282.
- Kim, D. -H. (2022). An analysis of early childhood teachers' current status and awareness of using artificial intelligence. *The Journal of Korea Open Association for Early Childhood Education*, 27(1), 167-190. <http://dx.doi.org/10.20437/KOAECE27-1-07>
- Kim, K., & Kim, M. (2023). Perception and demand of kindergarten parents for artificial intelligence (AI) education for infants. *Korean Journal of Early Childhood Education*, 25(2), 114-143. <http://dx.doi.org/10.15409/riece.2023.25.2.5>
- Kim, K., Park, S., & Kim, E. (2010). Early childhood teachers' perception on a teaching assistant robot. *The Journal of Korea Open Association for Early Childhood Education*, 15(3), 25-42.
- Korea Foundation for the Advancement of Science and Creativity (2019). *2019 AI Convergence education policy data collection*. Seoul: Korea Foundation for the advancement of science and creativity.
- Korea Foundation for the Advancement of Science and Creativity (2023). *A Study on Development Strategies through Performance Analysis of the Digital New Software.AI Camp*. Seoul: Korea Foundation for the advancement of science and creativity.
- Kwon, S., & Kyun, S. (2018). Pre-service early childhood teachers' recognition of artificial intelligence and artificial intelligence teachers. *Global Creative Leader: Education & Learning*, 8(4), 87-102. <http://dx.doi.org/10.34226/gcl.2018.8.4.87>
- Lee, B., & Kim, S. (2023). Differences in preschool children's perceptions of artificial intelligence according to their experiences with AI robots in daycare centers. *Korean J of Childcare & Education*, 19(2), 43-59. <https://doi.org/10.14698/jkce.2023.19.02.043>
- Lee, J. (2022). Designing a teacher education program model for software education for young children. *Early Childhood Education & Care*, 17(1), 119-144. <http://dx.doi.org/10.16978/ecec.2022.17.1.005>
- Lee, J. -E. (2022). Social perception of the early childhood AI (artificial intelligence) education: A news big data analysis. *The Journal of Korea Open Association for Early Childhood Education*. 27(1), 33-58. <http://dx.doi.org/10.20437/KOAECE27-1-02>
- Lee, J. -E. & Oh, S. -K. (2021). The effects of activities using artificial intelligence speakers

- on the language skill of young children. *The Journal of Korea Open Association for Early Childhood Education*, 26(5), 185-208. <http://dx.doi.org/10.20437/KOAECE26-5-08>
- Lee, J. & Jung, J. (2012). An Analysis on Early Childhood Teachers' Awareness of Robot Learning(R-learning). *Korean Education Inquiry*, 30(1), 153-171.
- Lee, J., & Kim, J. (2020). A study on early childhood software (SW) education in North European countries. *Korean Journal of Early Childhood Education*, 40(3), 229-251. <http://dx.doi.org/10.18023/kjece.2020.40.3.010>
- Lee, J., & Kwon, Y. (2022). Early childhood teachers' experience in operating the curriculum using artificial intelligence. *Korean Journal of Children's Media*, 22(1), 153-185. <https://doi.org/10.21183/kjcm.2023.03.22.1.153>
- Lee, J., Pyun, Y., & Jeun, W. (2022). *AI education meets Nuri curriculum*. Goyang: Gongdongche.
- Lim, J., & Choi, Y. (2022). Exploring the direction of Artificial Intelligence education for young children. *Korean Journal of Early Childhood Education*, 42(4), 273-296. <http://dx.doi.org/10.18023/kjece.2022.42.4.011>
- Merriam, S. B. (1998). *Qualitative research and case study applications in education*. San Francisco, CA: Jossey-Bass.
- Ministry of Education (2020). *Artificial intelligence era education policy direction department the key challenge*. Sejong: Ministry of Education.
- Park, J., & Shin, N. (2017). Students' perceptions of artificial intelligence technology and artificial intelligence teachers. *The Journal of Korean Teacher Education*, 34(2), 169-192. <http://dx.doi.org/10.24211/tjkte.2017.34.2.169>
- Park, J. -E., Hong, M., & C, J. (2022). The perception and needs analysis of early childhood teachers for development of a play-based artificial intelligence education program for 5-Year-Olds. *Journal of Industrial Convergence*, 20(5), 39-59. <https://doi.org/10.22678/JIC.2022.20.5.039>
- Park, S. -D., Chang, Y. -J., & Kim, K. -C. (2011). A study on teachers' and children's response to robots in early childhood education. *Korean Journal of Early Childhood Education*, 31(5), 253-275.
- Park, S. -M., & Kim, M. -J. (2013). A survey research on the current status of kindergarten

- teachers' use of educational robot, Genibo. *Korean Journal of Children's Media*, 12(2), 141-168.
- Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2016). Developing fundamental programming concepts and computational thinking with ScratchJr in preschool education: a case study. *International Journal of Mobile Learning and Organisation*, 10(3), 187-202. <http://dx.doi.org/10.1504/IJMLO.2016.077867>
- Pyun, Y., & Han, J. (2022). A basic study on the development of artificial intelligence education content based on Nuri curriculum. *Journal of The Korea Internet of Things Society*, 8(5), 71-76. <https://doi.org/10.20465/KIOTS.2022.8.5.071>
- Ryu, M., & Han, S. (2017). Image of Artificial Intelligence of Elementary Students by using Semantic Differential Scale. *Journal of The Korean Association of Information Education*, 21(5), 527-535. <http://dx.doi.org/10.14352/jkaie.2017.21.5.527>
- Shim, S., & Oh, J. (2011). Relation between the perspectives of robots and robot use effects and the constructivist beliefs of teachers. *Journal of Korean Council for Children & Rights*, 15(2), 227-250.
- Shin, S., Ha, M., & Lee, J. (2018). Exploring elementary school students' image of artificial intelligence. *Journal of Korean Elementary Science Education*, 37(2), 126-146. <http://dx.doi.org/10.15267/keses.2018.37.2.126>
- Strauss, A. L., & Corbin, J. M. (1998). *Basics of qualitative research: Grounded theory procedures and techniques*. Thousand Oaks: CA: Sage.
- Su, J., Ng, D. T. K., & Chu, S. K. W. (2023). Artificial intelligence (AI) literacy in early childhood education: The challenges and opportunities. *Computers and Education: Artificial Intelligence*, 4, Article 100124. <https://doi.org/10.1016/j.caeai.2023.100124>
- Sullivan, A., & Bers, M. U. (2018). Dancing robots: integrating art, music, and robotics in Singapore's early childhood centers. *International Journal of Technology and Design Education*, 28(2), 325-346. <http://dx.doi.org/10.1007/s10798-017-9397-0>
- Yang, S., & Park, E. (2022). Relationships with early childhood teachers' knowledge, beliefs, and behavioral intention toward AI in education (AIED). *Educational Theory and Practice for Infants and Young Children*, 7(1), 89-112. <http://dx.doi.org/10.20926/ETPIYC.2022.7.1.4>
- Yang, W. (2022). Artificial intelligence education for young children: Why, what, and how

- in curriculum design and implementation. *Computers and Education: Artificial Intelligence*, 3, Article 100061. <https://doi.org/10.1016/j.caeai.2022.100061>
- Yoo, G. -J., & Kim, S. -R. (2021). The effects and aspects of artificial intelligence speakers activity on children's interaction and creative problem solving skills. *The Journal of Korea Open Association for Early Childhood Education*, 26(5), 209-244.
<http://dx.doi.org/10.20437/KOAECE26-5-09>
- Yoo, K. -J., & Lee, J. -S. (2013). An effect of a free-choice activity program using intelligent robot on young children's social-emotional development. *Korean Journal of Early Childhood Education*, 33(2), 393-425.
- Yoo, K. -J., Kim, M. -K., & Lee, J. -S. (2011). Construction and effects of kindergarten free-choice activities program using an intelligent robot. *The Journal of Korea Open Association for Early Childhood Education*, 16(4), 493-520.