Communication Patterns of Fathers in Shaping Children's Science Skills in the Era of Artificial Intelligence

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Abstract:
This article analyzes fathers' communication patterns in shaping early childhood science skills in the AI era. The focus of this research problem outlines the changing dynamics of communication between fathers and children, and its potential impact on the development of children's science skills. This study aims to identify fathers' communication patterns that effectively stimulate children's science interests and abilities in the AI era. The research method was qualitative case study of 5 fathers. Data were collected through interviews, observations, and analysis of father-child interactions in the context of science learning using the Miles Huberman model and data validity using data triangulation. The results showed that father's communication focused on open-ended questions, presentation of information with a creative approach, and the use of AI technology as a learning tool can improve children's science skills. Fathers' understanding and support of technological development is also key to building children's science literacy in the AI era. These findings contribute to practical insights for parents, educators and policy makers to shape a communication environment that supports the development of children's science skills.

Keywords: father's communication patterns, science skills, Artificial Intelligence era

INTRODUCTION

In the 21st century, the development of artificial intelligence (AI) technology has permeated many aspects of human life, including education. These developments pose new challenges in preparing children for an increasingly automated and digitized world. In the midst of these dynamics, science skills become an important key to understanding what is being conveyed, building concepts in children's minds and the basis on which knowledge is formed. So the role of fathers in building communication with children is very important in supporting their development.

Science skills are a process carried out by individuals to obtain knowledge related to things that occur (facts) such as circumstances, events and properties. Science can also form an understanding related to concepts about an object, event, a situation or related to the characteristics of objects/living things such as animals, plants, etc. The development of science in early childhood proposed by Carson is everything that is considered interesting and new that children find and
provide new knowledge in order to stimulate children to think more critically. The development of science skills will help children recognize new things directly so that children can recognize life's challenges and opportunities through the experiences they gain can encourage optimal child science development. The development of science in early childhood is characterized by the child's ability to understand something systematically and has a valid or tested truth. Science skills in early childhood, namely children are able to understand the concept of cause and effect related to a situation / event or nature, children are able to understand a concept related to characteristics / shape / classification. Meanwhile, science understanding is that children have the ability to draw conclusions about what they have learned.

Early childhood is an important period in the formation of the foundation of science skills (Ariyanti, 2016; Directorate of PAUD Kemdikbud, 2020). Early childhood has great curiosity and the ability to learn quickly, making it easy to absorb information. Therefore, it is important to pay attention to how parents, including fathers, can play a role in shaping children's understanding and conceptualization of science skills. However, the role of fathers in this context is often overlooked in early childhood education research. Involving fathers in early childhood science education not only benefits children's cognitive development, but can also strengthen the emotional connection between fathers and children. By providing adequate attention and support, fathers can play an important role in fostering the next generation who are smart, creative and have a good understanding of science.

This is also revealed in the findings of this study outlining that the role of parents in shaping science skills, especially in the role of fathers is very important. Previous research revealed that the involvement of a father's active role in parenting has a major impact on child development which stimulates the development of communication skills, provides experiential teaching, good supervision, protection and emotional support and the development of learning in the field of science (Syafiqoh & Pranoto, 2022). Other research proposed by Jones et al. (2023) highlighted the importance of fathers' involvement in children's educational activities, especially in shaping science interests and skills. They found that fathers who actively engaged in science activities with their children had a positive impact on the development of children's cognitive and problem-solving abilities. In addition, a study by Smith & Brown (2022) showed that strong father role models in supporting children's science learning can influence children's perceptions of science and their interest in scientific exploration. Positive interactions between fathers and children in science contexts have also been associated with increased children's confidence in solving problems and taking intellectual risks.

In the digital age, technology presents new opportunities and challenges for children's science education. On the one hand, technology can be utilized as an engaging and interactive learning tool. On the other hand, excessive exposure to technology can disrupt children's learning and hinder the development of children's science skills. Previous research has revealed insights into the importance of fathers' roles in children's science education, but there is still limited in-depth understanding of how good father-child communication patterns build science skills in children as technology develops rapidly. Fathers can act as facilitators and guides in helping children utilize technology to learn science effectively. The development of the digitalization era that has made it easier for people to obtain various information and knowledge using Artificial Intelligence tools is a challenge for parents. Current research reveals related family communication patterns, especially the role of mothers in shaping children's abilities (Santoso et al., 2023; Shojaee et al., 2018; Yamamoto & Holloway, 2010). This research focuses on specifically exploring father's communication patterns in the context of shaping children's scientific knowledge in the era of Artificial Intelligence is still rarely found. The main difficulty faced in this research is the lack of
in-depth understanding of how father-child interactions can influence the development of children’s science skills. Thus, there is a need for more focused and comprehensive research to fill this knowledge gap.

Through this research, it is hoped to gain a deeper understanding of fathers' communication patterns in shaping early childhood science skills in the era of artificial intelligence (AI). By identifying and addressing existing knowledge gaps, it is hoped that this study will make a meaningful contribution to understanding how parents, especially fathers, can play a more effective role in supporting children's science development in an era of increasingly sophisticated technology. The main objective of this study is to thoroughly investigate fathers' communication patterns in shaping early childhood science skills in the AI era. Filling the existing knowledge gap, this study aims to analyze the verbal and non-verbal interactions between fathers and children and explore their impact on the development of children's science skills. The success of this research will help in gaining a better understanding of how to optimally utilize fathers’ roles in supporting children's science development amidst the rapid development of AI technology.

METHODS

This research used a qualitative case study method. Participants were determined through purposive sampling consisting of five fathers of young children with varying levels of involvement in their children's education and understanding of AI technology. The participants of this study totaled 5 fathers. The characteristics of the research subjects were selected based on these criteria to ensure variation in fathers' experiences and communication patterns. The informants who assisted in data collection consisted of family members involved in father-child interactions, such as mothers, siblings, or caregivers. They provided additional information about the daily interactions between fathers and children and provided different perspectives in the analysis.

Data were collected through several methods, including in-depth interviews with fathers, direct observation of father-child interactions, and content analysis of science learning materials used in the family. More details can be seen in Table 1 below.

<table>
<thead>
<tr>
<th>Table 1. Data Collection Matrix</th>
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<tbody>
<tr>
<td><strong>Observation</strong></td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td><strong>Interview</strong></td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

The research was conducted in each participant's home to obtain a more natural picture of father-child interactions. The study was conducted over a sufficient period of time to ensure quality data. The length of the study was about six months, which allowed the researcher to observe father-child communication patterns in various situations and contexts. The collected data will be analyzed using the Miles and Huberman approach. The analysis steps include data collection, data reduction, data presentation, and conclusion drawing.
The validity of the research results is guaranteed through data triangulation, namely by comparing and validating findings from various data sources such as interviews, observations, and content analysis. This is done to ensure that the research findings reflect the actual reality and have high validity.

RESULTS AND DISCUSSIONS

Results
In this study, the author focuses on exploring fathers' communication patterns in shaping early childhood science skills in the AI era. The purpose of this research is to explore the various communication strategies of fathers that are effective in stimulating children's science interests and abilities, especially in the context of rapidly developing AI technology. Through direct observation, in-depth interviews, and content analysis of science learning materials used in the family, the authors were able to detail how fathers utilize various communication strategies to guide their children in understanding science concepts. The informants used in the study are outlined in the following table:

<table>
<thead>
<tr>
<th>No</th>
<th>Father's Occupancy</th>
<th>Age</th>
<th>Child’s Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineer</td>
<td>35</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Enterpreneur</td>
<td>40</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Teacher</td>
<td>30</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>Mercants</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Office worker</td>
<td>45</td>
<td>3</td>
</tr>
</tbody>
</table>

The results of the research findings in analyzing the communication patterns applied by parents in supporting the development of scientific intelligence in early childhood, are described as follows:

Participant n1 revealed that learning today must be integrated with technology based on the age level of her child, which is 4 years old. Through the observations found by the researcher, he uses interactive applications that utilize AI technology to explain science concepts to his child. Fathers build communication with their children by asking about what learning their children want and involving their children in the selection process and allocating special time to search for appropriate learning applications. Participants also revealed that in building communication with their children, fathers spend time assisting their children to learn and build a strong foundation for science development. Participants also explained that the discussion activities related to science concepts that children discover related to new information obtained provide children’s experience in building a critical mindset towards something. Fathers can be a space for children to explore children's knowledge, fathers act as teachers and as discussion partners for children. This can improve children’s ability to understand science concepts.

Participant n2 is a father who actively uses creative approaches in science learning with his 3-year-old son. From the observations made by the researchers, it appears that n2 often presents science materials in the form of stories or games that actively involve children. This approach not only makes learning more fun for children, but also helps them understand science concepts directly. Support and praise are also used by n2 to stimulate children's motivation and confidence to continue learning and exploring new concepts. In an interview with n2, she emphasized the importance of quality time with children in developing science interests and skills. n2 sees challenges in teaching AI to young children but also sees opportunities in using interactive games and technology. As a solution, n2 plans to provide a supportive learning environment at home, including storybooks about science and technology and educational apps that introduce AI concepts.
interactively to his child. Thus, effective father communication patterns in shaping early childhood science skills in the context of AI involve using easy-to-understand language, interactive games and activities, linking concepts to real-life experiences, and providing support and praise.

Participant n3 shows strong engagement in science learning with her 5-year-old son. Observations showed that they regularly conduct simple experiments or science projects at home as part of their learning activities. n3 believes that direct involvement in science activities not only helps children understand science concepts better, but also strengthens the relationship between father and child. In the interview, n3 explained that engaging in science activities is an opportunity to bond more closely with his child while jointly exploring the wonders of science. While he recognizes the potential of AI technology in science learning, n3 prefers to focus on hands-on engagement, which he believes has a more significant impact on children's development. However, the challenges faced by n3 are not few. One of them was the difficulty in finding enough time to plan and implement science activities with her child. But with her commitment, n3 managed to overcome these challenges by incorporating science learning activities into their daily routine. She also faced the challenge of maintaining her child's interest in science learning over time. By creating variety in science activities and paying attention to individual children's interests, n3 managed to keep her child's interest high. From these observations and interviews, it appears that n3 has created a learning environment that supports and strengthens her child's science interests and abilities, while building a strong and meaningful relationship between them.

Participant n4 an entrepreneur active in the technology business, realized the importance of teaching science concepts to her 4-year-old son in the AI era. It was observed that they often conduct simple experiments or science projects at home as part of their learning activities. This activity not only provides hands-on experience of science concepts to the child, but also strengthens the relationship between n4 and her child. She acknowledged the challenge of explaining AI concepts in a simple yet informative manner. One of the drawbacks is the lack of free time to interact with her children due to her busy business life. However, n4 sees an opportunity in combining quality time with her child by introducing AI concepts through fun activities, such as building simple robots or playing educational games. As a solution, n4 plans to set aside dedicated time each week to play and learn with her child, while ensuring that the language used is easy to understand and relevant to the child's experience. Thus, n4's communication pattern with her child in shaping science skills in the AI era involves using appropriate language, interactive activities, linking concepts to real-life experiences, and providing support and praise.

Participant n5 shows great dedication in teaching science to her 3-year-old son. Through observation, it was observed that n5 often relates science concepts to everyday life when interacting with her child. She uses concrete examples from the surrounding environment to explain abstract concepts to her child, which enables her child to understand the material better. In the interview, n5 explained that one of her goals is to make science learning relevant and meaningful to her child. She shared experiences of how AI technology can be a useful tool in their learning process such as when using specialized apps that provide simulations of how weather forms or how plants grow, which can be accessed through smart devices, such activities demonstrate her awareness and deep thinking about the use of technology in children's education. n5 also talked about the challenges she faced, including difficulties in finding sufficient time to conduct learning activities with her busy work schedule, as well as challenges in finding age-appropriate learning resources and materials. However, with her commitment and creativity, n5 managed to overcome these challenges by aligning time and making learning activities part of their daily routine, as well as by conducting research to find appropriate resources. From these observations and interviews, it is evident that n5
has created a fun and relevant learning environment for her child, while utilizing AI technology as a useful tool in their learning process.

The five fathers showed diverse communication patterns in shaping their children's science skills in the era of advanced AI. Some use AI technology as a learning tool, others rely more on creative approaches, while others focus more on direct involvement in science activities with their children. Nonetheless, their awareness of the importance of using AI technologies in children's education is clear. They managed to overcome various challenges, including finding sufficient time for learning, explaining AI concepts in simple terms, and maintaining children's interest in science learning. With commitment, creativity and deep thinking about the use of technology in children's education, they have created a learning environment that is engaging and relevant to their children.

Based on the observations that have been described, it can be stated that some of the communication patterns applied by fathers in developing science skills in children are:

**Father-Child Communication Patterns**

Creating a warm and interesting atmosphere, building communication with children by creating a warm atmosphere so that children can feel comfortable to express what they think, feel and other things they do not understand. This can build personal relationships between fathers and children so that children feel valued and not pressured to express their feelings. A warm atmosphere is built by including various activities such as conducting experiments with children, creating works together, and making observations. This pattern was found in parents n1, n2, n3 and n5.

Discussion, this pattern is carried out to build two-way interactions with children that involve exchanging ideas, providing opportunities for children to choose what children are interested in, as well as question and answer activities that can build concept understanding of the activities carried out, such as through experimental activities, creating works, making observations will build interaction through questions that are solved during activities. Fathers act as friends and learning resources for children in building their thinking on the activities they do, fathers are also teachers who can answer questions raised by children, fathers can also act as examiners who can shape children's critical thinking. This was found in parents n2, n4 and n5 through activities that provide direct experience to children.

Active as a Facilitator, communication is built by providing motivation and support for the learning activities provided, when the child feels tired and gives up to complete the activity. Fathers act as people who provide positive encouragement and support for everything the child does, fathers also guide the discussion with the child in supporting the child to solve the problems found by the child.

**Discussion**

Based on the observations and interviews with the five fathers, it can be seen that fathers' communication patterns in shaping early childhood science skills show significant variations. These fathers have shown dedication and creativity in ensuring science learning becomes something interesting and meaningful for their children, despite the challenges they face. Good and effective communication patterns are those that contain good values, children can empathize and sympathize, children have honesty, children have high consistency, and open interactive communication between children and parents (Hidayah et al., 2021; Husin Husin et al., 2022; Setianingsih, 2017; Setyowati, 2013). Overall, effective father communication patterns in shaping early childhood science skills include several important aspects. The communication pattern found is a consensual communication pattern (Putri et al., 2022) which shows that the communication built is oriented towards conversation as well as compliance, this communication
pattern maintains social relationships between fathers and children that are established to remain harmonious, provides opportunities for children to choose their decisions, builds open two-way communication and provides many opportunities for children to express what they want to express. The findings also show that fathers spend time with their children to spend time together with various learning activities that develop children's science skills.

First, the use of AI technology is one of the key elements in this approach. AI enables personalized learning, provides effective feedback and improves overall teaching efficiency (Mambu et al., 2023). Fathers have utilized various apps and learning tools powered by AI technology to explain science concepts to their children in an engaging and interactive way. Besides technology, creative approaches are also an important factor in this communication pattern. Fathers use stories, games and hands-on activities to explain science concepts to their children. This approach helps children understand the material better and makes learning more fun. A father's involvement in parenting is very important for children's development (Garcia et al., 2022; Syafiqoh & Pranoto, 2022). Fathers' engagement with children is significantly associated with positive mental, cognitive, social, and physical child outcomes (Cabrera et al., 2018; Choi et al., 2021). Fathers' direct involvement in science activities with children also has a positive impact. Through simple experiments, science projects or other activities, fathers help their children to understand science concepts in a practical way. This engagement not only strengthens the relationship between fathers and children, but also increases children's interest in science.

Linking concepts to real-life experiences is also another important element in this communication pattern. Fathers use concrete examples from the surrounding environment to explain abstract concepts to their children. This is because learning abstract concepts using concrete examples is more effective than using words alone (Micallef & Newton, 2024; Rawson et al., 2015). This allows children to relate learning to their daily experiences, which makes the material more relevant and easy to understand. Despite facing various challenges, such as lack of time, difficulty in explaining AI concepts simply, or adapting learning content to children's development, fathers overcome these with commitment, creativity, and a deep awareness of the importance of science education for their children in the era of advanced AI. Thus, this pattern of communication not only helps shape their children's early science skills, but also builds a strong foundation for their future development.

CONCLUSION

Based on the results, it can be concluded that fathers' involvement in shaping early childhood science skills, especially in the era of Artificial Intelligence (AI), has a significant impact. The fathers in this study demonstrated effective communication patterns through the use of AI technology, creative approaches, hands-on engagement, and linking concepts to real-life experiences. Despite facing challenges such as lack of time and difficulty explaining AI concepts in simple terms, they overcame these with commitment, creativity, and a deep awareness of the importance of science education for children. Projected developments from the results of this study involve increasing understanding of the role of fathers, developing family education programs that utilize AI technology, and integrating science concepts with AI technology in formal or informal education curricula. Thus, future research can analyze the influence of communication patterns on children's science development abilities in an era of increasingly advanced technology.
REFERENCES


