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Critical Thinking Profile in Coding Learning for 6-Year-Old Early Childhood Education Students

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Abstract

General Background: The rapid digitalization era has positioned coding as a crucial medium for developing foundational cognitive skills in early childhood. **Specific Background:** For 6-year-old learners, visual-based coding activities offer opportunities to strengthen logical reasoning and structured problem-solving, yet empirical descriptions of their critical thinking profile remain limited. **Knowledge Gap:** Existing studies rarely document how critical thinking indicators manifest during coding activities in early childhood settings. **Aims:** This study aims to analyze the critical thinking profile of 6-year-old children engaged in coding learning at TK Tunas Harapan. **Results:** Findings showthat coding activities significantlyenhance children's analytical, evaluative, and problem-solving abilities, reflected in notable score improvements across learning cycles, although 40% of students initially demonstrated difficulties in critical thinking. **Novelty:** This research provides early evidence on how coding education concretely stimulates critical thinking in young children within rural early childhood contexts. **Implications:** The results highlight the importance of integrating developmentally appropriate coding activities into early childhood curricula to strengthen critical thinking foundations and inform future digital learning model development for PAUD.

Highlights:

- Coding learning significantly strengthens critical thinking skills in 6-year-old children.
- Visual-based coding activities help improve analysis, evaluation, and problem-solving abilities.
- Integrating coding in early childhood supports digital literacy and cognitive readiness in the

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digital era.

Keywords: Critical Thinking, Coding Education, 6-year-old Children, Digitalization, Early Childhood Education

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Introduction

Early Childhood Education (PAUD) is an effort of guidance carried out from infancy up to the age of 6, by providing various stimuli and stimulation to support their growth and development. This guidance covers various aspects, such as physical-motor skills, cognitive, language, religion, morals, socio-emotional, and art, which are tailored to the uniqueness and developmental stage of each child.[1] This period is often referred to as the "Golden Age" because it is an important phase in the development of the brain, intelligence, personality, memory, and other aspects that can potentially influence their lives in adulthood.[2] In addition, the development aims to ensure that children are better prepared to face the next stage of education, especially at the elementary school level.[3]. The rapid development of information and communication technology (ICT) has brought significant changes to various aspects of life, including the field of education.[4] In the era of the Industrial Revolution 4.0 and moving towards Society 5.0, digital skills such as programming (coding) and basic understanding of artificial intelligence (AI) have become important competencies that educators need to possess. This aligns with the need to prepare the younger generation not only to be users of technology but also capable of becoming creators of technology.[5]

Another factor is that not all teachers in early childhood education (PAUD) possess the necessary skills to effectively operate e-learning technology. 21st-century teachers are required to master TPACK (Technological, Pedagogical, and Content Knowledge), which is a framework for assessing teachers' knowledge in using technology during the learning process.[6] Technological Knowledge refers to the ability to understand various technologies and how to use them as tools, processes, or resources. There is a gap in access to technology and training, especially in underdeveloped areas. Teachers in rural areas often face limited access to technological devices and training.[7] Integrating technology into the curriculum requires significant time and effort, as well as support from various parties to ensure effective implementation. Teachers in early childhood education need to be trained to use technology effectively and integrate it in ways that support their educational objectives.[8]

In the context of early childhood education (PAUD), critical thinking can be stimulated through exploration-based learning and technology. One effective innovation is the implementation of visual-based coding games such as G Compris, which helps children understand algorithm and logic concepts concretely.[9] TK Tunas Harapan in Jarorejo Village, as an educational institution in a rural area, has begun integrating simple coding activities into daily thematic learning. These activities not only introduce children to technology but also foster critical thinking skills through the arrangement of logical commands to achieve specific goals. However, there is still limited research describing the profile of critical thinking in 6-year-old children in the context of coding learning in kindergarten-level schools.[10] Dewey describes critical thinking as a process of reflective thinking that begins with two main elements: first, the presence of doubt, confusion, or mental difficulty which serves as the starting point for thought, and second, an active effort to seek, explore, and gather information that can overcome the doubt and eliminate the confusion.[11] Based on this perspective, Dewey emphasizes that critical thinking is more oriented towards the process of inquiry rather than merely evaluation. He defines critical thinking as a form of rational thought focused on reflection, aimed at helping a person determine what should be believed or done.

In addition to these two figures, several other experts also provided views on the concept of critical thinking. They stated that critical thinking is an essential skill needed to develop students' deep thinking abilities. Lipman (1988) added that critical thinking skills help individuals make good and appropriate judgments in various situations. They emphasized that critical thinking is a form of rational thought reflected in real actions and logical decision-making. Overall, these various perspectives indicate that critical thinking is not merely an intellectual ability, but also a reflective process oriented towards rational reasoning, decision-making, and finding appropriate solutions to problems faced.[12] One of the learning approaches that is increasingly gaining attention in the field of Early Childhood Education (PAUD) is the implementation of coding games, which are educational games based on visual programming. Through applications like G Compris, children are given the opportunity to understand basic algorithm concepts, think logically, and develop problem-solving skills using a visual interface that is engaging and easy for children to understand. In this activity, children not only play, but also have the chance to design stories, arrange sequences of commands, and complete various missions in an interactive and enjoyable way.

Various studies show that the use of coding games contributes positively to the development of children's computational thinking, enhances creativity, and trains their ability to design strategies gradually to solve problems. Thus, visual programming-based games not only serve as entertainment but also as an effective educational tool to stimulate critical and logical thinking skills from an early age.[13] Strengthening critical thinking skills through coding education is a strategic step in shaping learners who are independent, creative, and able to adapt to increasingly dynamic global challenges. This effort not only focuses on mastering technological aspects but also on developing analytical thinking and problem-solving abilities from an early age. In line with this urgency, this study aims to examine and evaluate the profile of children's critical thinking skills in the context of coding education, specifically on the topic of Plants at TK Tunas Harapan.

Through the analysis process conducted, this study is expected to provide an in-depth overview of the extent to which students master elements of critical thinking in coding-based learning activities. The results of this study will later serve as an important basis for the design and development of innovative digital media that aligns with the characteristics of early childhood, thereby supporting the enhancement of critical thinking skills effectively and enjoyably in the children's educational environment.[14] In an era of rapidly advancing technology, critical thinking skills have become one of the important 21st-century competencies that need to be instilled from an early age. Learning coding is not merely intended to introduce children to the world of technology, but also serves as a means to develop logical and structured thinking skills, as well as to sharpen creativity in solving various problems. Nevertheless, to date, there is still a limited number of studies that

highlight how forms and characteristics of critical thinking emerge in coding learning activities, particularly for young children at the early childhood education level.

In line with this issue, this study focuses on providing an in-depth description of the critical thinking profile of six-year-old children in the context of coding education in the digital era. Through this study, it is expected that how children demonstrate analytical, evaluative, and simple decision-making skills during coding learning activities can be identified. The findings of this research are expected to benefit educators and early childhood education practitioners in designing more effective learning strategies to foster critical thinking skills from an early age, as well as serve as a foundation for developing a digital literacy curriculum in early childhood education. Coding Learning in Early Childhood Education Coding is an important tool for 6-year-old children to develop critical thinking and problem-solving skills. It involves creating instructions that can be used and executed by a computer, allowing children to communicate with the computer and solve problems through the creation of programs or applications. In the context of coding, this can enhance creativity, teamwork, and communication skills. The use of interactive learning methods, such as video animations, can boost children's motivation and critical thinking skills. This comprehensive, self-paced, and adaptive learning module helps children learn independently and according to their age.[15].

The relevance to digitalization The development of digital technology in today's era opens both opportunities and challenges in stimulating critical thinking skills in early childhood, particularly for 6-year-olds who are entering a very important stage of cognitive development. Effective learning must integrate digital media as a tool that can enhance children's curiosity and exploratory abilities through enjoyable and meaningful activities. According to the Director General of Early Childhood, Primary, and Secondary Education (Dirjen PAUD Dikdasmen), learning in the digital era must apply the principles of joyful, meaningful, and mindful to enable children to learn according to their developmental psychology and interests. Properly designed digital media can be an effective tool to stimulate children's critical thinking by encouraging them to observe, try, experiment, and express their opinions.

Method

This research is a preliminary study that uses a quantitative descriptive analysis approach as the main method in data processing. This study does not focus on hypothesis testing, but aims to provide an initial overview of the phenomenon under investigation. The findings of this study are expected to serve as a foundation for the development of learning tools designed to enhance students' critical thinking skills. The research was conducted at TK Tunas Harapan involving 20 children from Group B as research subjects, consisting of 9 boys and 11 girls. The instrument used consisted of five essay questions focused on the learning topic of Plants. All research procedures, from the preparation stage to data analysis, are systematically explained

This study adopts five main indicators in assessing students' critical thinking skills, namely: (1) identifying and showing differences between objects; (2) arranging patterns; (3) classifying objects based on categories; (4) providing further explanations, related to the ability to identify and understand the assumptions underlying a statement; and (5) developing strategies and tactics, seen from the ability to determine appropriate steps and interact effectively with others. The assessment process of students' critical thinking skills is conducted by referring to the answers given for each question. The highest score, which is 4 points, is awarded if the answer is considered logical, complete, and systematically organized. If the answer only meets two of the three criteria, a score of 3 is given. Meanwhile, an answer that covers only one aspect will receive 2 points, an inaccurate answer is given a score of 1, and if there is no answer at all, the score is 0. Based on this scoring system, the maximum total score that each student can achieve is 20 points. Theoretical Review: Critical Thinking in Early Childhood Critical thinking, one of the most important cognitive skills, must be developed from an early age. Observing, analyzing, hypothesizing, concluding, and evaluating are some of the main components of critical thinking. These aspects serve as important measures to assess the extent to which a child's critical thinking skills have developed. Observation is the first aspect. This is when a child has the ability to pay attention to and recognize problems or phenomena around them carefully. This ability serves as a cognitive foundation that allows the child to understand situations or objects more deeply.

Then, the aspect of analyzing is the process of breaking information into smaller parts to understand patterns, cause-and-effect relationships, or connections between components. This teaches children to organize data logically and distinguish important information from unimportant information. Furthermore, forming a hypothesis is a child's ability to make predictions or initial guesses as solutions to problems or questions that arise from observation and analysis. This stage demonstrates the child's active thinking ability and the design of testable possibilities. Concluding is the process of combining observation results, analysis, and hypotheses to make decisions, ideas, or new knowledge systematically and logically. Children are trained to link information so that they can draw accurate conclusions about the phenomena they observe. Finally, evaluation is a reflective ability in which a child assesses the validity and quality of results and considers various options. This is important to ensure that children actively engage in critical assessment and do not passively accept information.

As demonstrated by action research at PAUD Mentari, this critical thinking element can be developed through a learning approach that involves exploration, experimentation, and active stimulation activities. The research shows that environment-based experimental learning activities can significantly enhance early childhood critical thinking skills. This method develops elements of observation, analysis, hypothesis formulation, conclusion, and evaluation gradually and systematically. Children who actively participate in experimental activities not only enhance their cognitive abilities, but they also cultivate a critical attitude and a high level of curiosity, which are essential components in developing their critical thinking skills.

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The Role of Digitalization: The development of digital technology in the current era opens opportunities as well as challenges in stimulating critical thinking skills in early childhood, particularly for 6-year-olds who are entering a crucial stage of cognitive development. Effective learning must integrate digital media as a means to enhance children's curiosity and exploratory abilities through enjoyable and meaningful activities.

Results and Discussion

This study monitors the critical thinking skills of 6-year-old children in class B, which consists of 20 students. The results show that 8 of these students experienced difficulties in their critical thinking skills. Table 1 below shows the results.

Table 1. Critical Abilities of Class B Children

No.	Description	Number of Children
1	Total Children in Class B	20
2	Children with critical thinking problems	8

Table 1 shows the profile of critical thinking problems faced by students in Class B. From the table above, it can be seen that 40% of the total children in Class B exhibit difficulties or obstacles in critical thinking when participating in coding lessons. This serves as an important indicator that not all children at the age of 6 are yet able to optimally develop critical thinking skills in the context of digital learning. Results in the form of images, or data presented as pictures / schemes / graphs / diagrams / similar formats, should also follow existing rules; the title or name of the image is placed below the image, centered, and given a single-space gap from the image. If more than one line, the lines should be single-spaced.

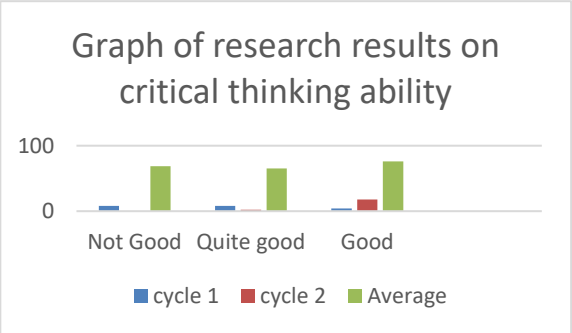

Figure 1. Research Results Chart

Based on the full-width table data showing coding scores and categories from the two cycles, the discussion of this research results can demonstrate how the data addresses the problem in the context of improving the measured skills or quality. The data indicates that most participants experienced an increase in coding scores from Cycle 1 to Cycle 2. For example, Latif experienced an increase from 60, which falls into the less satisfactory category, to 71, and others, such as Zella and Fadilla, also showed significant improvements. This indicates progress or improvement in the measured coding skills. According to learning theory and the evaluation of learning outcomes, such an increase in scores can be considered a positive result of the intervention or learning method applied. This aligns with learning models such as Horay Class Review or project-based learning, which aim to enhance students' abilities by using an active and contextual approach. According to this theory, learning outcomes will indicate potential challenges, such as uneven variations in results among participants who have lower or moderately good second cycle scores. These variations can be caused by differences in participants' motivation levels, their backgrounds, or difficulties in the material that have not been fully addressed.

Significantly increased from cycle to cycle if the appropriate learning methods are used. This study shares similarities with previous research that found that interactive learning methods and project-based learning improve learning outcomes, but differs in the context of its application. These findings also contribute to the development of science and technology by expanding empirical evidence on the effectiveness of the learning models used. Theoretically, this can change or reinforce continuous assessment and active learning theories. Overall, the findings of this study not only indicate changes in scores and categories, but also qualitatively depict the learning methods as competency development solutions that can be more broadly applied to enhance learning effectiveness. This study also identifies areas for improvement that can serve as a foundation for new theories or practices in technology and coding education. To make interpretations and follow-up designs more logical and targeted, this discussion is closely tied to the category and score data.

Table 2. Presentation of a full-page width table

No	Name	Cycle 1		Cycle 2		Average
		Coding Score	Category	Coding score	Category	
1.	Latif	60	Not good	71	Good	65,5
2.	Dedi	60	Not good	68	Pretty Good	64
3.	Zella	63	Not good	72	Good	67,5
4.	Fadilla	62	Not good	77	Good	69,5

5	Andra	62	Not good	69	Pretty Good	67
6.	Memey	80	Good	90	Good	65,5
7.	Valen	75	Good	80	Good	77,5
8.	Sherly	70	Pretty Good	73	Good	71,5
9.	Rafan	73	Pretty Good	75	Good	74
10.	Rendra	72	Pretty Good	75	Good	73,5
11.	Iqbal	65	Not good	70	Good	67,5
12.	Alia	74	Pretty Good	80	Good	77
13.	Azky	78	Good	80	Good	79
14.	Ayra	77	Baik	85	Good	81
15.	Dara	60	Not good	75	Good	67,5
16.	Sulthan	65	Not good	75	Good	70
17.	Keysha	70	Pretty Good	75	Good	72,5
18.	Izzatin	68	Pretty Good	75	Good	71,5
19.	Faris	66	Pretty Good	75	Good	70,5
20	Aqsha	70	Pretty Good	80	Good	75
	Average	68,5	Not good	76	Good	69

Conclusion

The article titled "Critical Thinking Profile in Coding Learning for 6-Year-Old Children in the Digital Era" concludes that coding learning for six-year-old children can significantly enhance their critical thinking skills. Research data shows that coding learning interventions specifically designed for early age development improve critical thinking abilities, as indicated by increased scores and categories. The results demonstrate that interactive learning and digital technologies such as coding are highly effective in boosting creativity, problem-solving, and analytical skills in early childhood. By integrating technology as a critical learning medium in today's digital era, this research opens new horizons for the development of early childhood education. A practical recommendation from this study is that educators and parents can actively incorporate coding education from an early age by using methods that align with the child's cognitive development stage, such as interactive applications and educational games. The results of this study support and encourage the development of learning models that combine cognitive elements and digital technology to stimulate critical thinking in early childhood in a more systematic way. For further research, it is recommended to investigate the relationship between coding education and the development of various cognitive and socio-emotional aspects of children in the long term. Additionally, it is suggested to test various digital learning models in broader and more diverse contexts. These conclusions and recommendations refer to the empirical data found, as well as relevant theories of critical learning and educational technology. They are intended to serve as a reference source when developing early childhood education in the digital era.

References

1. N. H. Basumbang, R. U. Djuko, and S. Rawanti, “Pengaruh Pembelajaran Berbasis Project-Based Learning terhadap Kemampuan Berpikir Kritis Anak Usia 5–6 Tahun TK Pertiwi Kecamatan Bone Kabupaten Bone Bolango,” Inovasi Pendidikan dan Anak Usia Dini, vol. 1, no. 4, pp. 23–34, 2024.
2. A. Buyalskaya, M. Gallo, and C. F. Camerer, “The Golden Age of Social Science,” Proceedings of the National Academy of Sciences of the United States of America, 2021, doi: 10.1073/pnas.2002923118.
3. N. Nurjayanti, F. D. Reskyadita, et al., “Pengenalan Coding Berbasis Game bagi Anak Usia Dini di TK Sarah Shabrina,” Proceeding Pendidikan Anak Usia Dini, no. 1, pp. 134–137, 2024.
4. I. A. Huda, “Perkembangan Teknologi Informasi dan Komunikasi (TIK) terhadap Kualitas Pembelajaran di Sekolah Dasar,” Jurnal Pendidikan dan Konseling, 2020, doi: 10.31004/jpdk.v1i2.622.
5. S. Karmila, S. Gunawan, T. Informatika, S. Informasi, and U. I. Membangun, “Koding dan Kecerdasan Artifisial bagi Guru Sekolah Dasar dan Menengah di Kabupaten dan Kota Sukabumi,” Jurnal Pengabdian kepada Masyarakat, vol. 6, no. 2, pp. 1113–1120, 2025.
6. C. Zhu, X. Xu, W. Zhang, J. Chen, and R. Evans, “How Health Communication via TikTok Makes a Difference: A Content Analysis of TikTok Accounts Run by Chinese Provincial Health Committees,” International Journal of Environmental Research and Public Health, 2020, doi: 10.3390/ijerph17010192.
7. D. Herlisya and P. Wiratno, “Having Good Speaking English Through TikTok Application,” Journal Corner of Education, Linguistics, and Literature, 2022, doi: 10.54012/jcell.v1i3.35.
8. L. K. Hanannika and S. Sukartono, “Penerapan Media Pembelajaran Berbasis TIK pada Pembelajaran Tematik di Sekolah Dasar,” Jurnal Basicedu, 2022, doi: 10.31004/basicedu.v6i4.3269.
9. E. Priyanti and H. Haryanto, “Pemanfaatan Teknologi Informasi dan Komunikasi dalam Menunjang Pembelajaran di PAUD,” Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, 2023, doi: 10.31004/obsesi.v7i4.4124.
10. Pintarharati, “Pemanfaatan Teknologi Informasi dan Komunikasi (TIK) sebagai Media Pembelajaran di Lembaga PAUD,” Pintar Harati: Jurnal Pendidikan dan Psikologi, 2023, doi: 10.36873/jph.v19i1.10147.
11. S. Ismet and S. Saridewi, “Keterampilan Teknologi Informasi dan Komunikasi Mahasiswa PGPAUD Universitas Negeri Padang,” Early Childhood: Jurnal Pendidikan, 2020, doi: 10.35568/earlychildhood.v3i1.440.
12. R. Rohita, E. Yetti, and T. Sumadi, “Kemampuan Berpikir Kritis Anak: Analisis pada Pengenalan Budaya Lebak dalam Pembelajaran di TK,” Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini, vol. 7, no. 6, pp. 6566–6578, 2023, doi: 10.31004/obsesi.v7i6.5326.
13. U. Ubaidillah, N. Setiarini, I. Budiarti, and K. Windarty, “Pengaruh Coding Game terhadap Kemampuan Problem Solving Anak Usia Dini,” Ar-Raihanah: Jurnal Pendidikan Islam Anak Usia Dini, vol. 5, no. 1, pp. 16–23, 2025, doi:

10.53398/arraihanah.v5i1.632.

14. M. Solichah, N. Istiq, and B. Purwoko, "Profil Kemampuan Berpikir Kritis dalam Pembelajaran IPA di Sekolah Dasar pada Era Digital," Jurnal Variasi, vol. 8, no. 1, pp. 9–19, 2025.
15. G. P. A. Oka and R. N. Tuga, "Pengembangan Modul Ajar Bermuatan Coding Tema Alam Semesta Subtema Bintang Anak Usia 5–6 Tahun di Kober Harapan Baru Kecamatan Aesesa Selatan Kabupaten Nagekeo," IMEDTECH: Instructional Media Design and Technology, vol. 7, no. 3, pp. 177–192, 2024, doi: 10.38048/imedtech.v7i3.308.