Coding-Based Joyful Learning Through ScratchJr in Kindergarten

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Abstract: Coding has received attention from the national education ministry in Indonesia. Most kindergarten teachers in Indonesia lack the experience to implement coding learning. Focusing on ScratchJr being the most popular free introductory block-based programming language app designed specifically for children aged five to seven, this paper explores the application of ScratchJr in kindergarten. This study explores how ScratchJr can be used as a new learning media tool in kindergarten. This paper presents a case study of a kindergarten teacher's experience in designing and implementing coding learning through ScratchJr, which is integrated with digital technology media. This study employs a qualitative case study approach to explore how early childhood learning experiences and teachers' experiences in implementing coding learning through ScratchJr in kindergarten are influenced over one week. The study participants were 20 children aged five to six years. The results of this study provide evidence that children can design, build, and program animation projects after one week of intensive ScratchJr learning. In addition, the results of the study show that teachers have successfully integrated coding learning through ScratchJr in kindergarten, which includes basic coding concepts while also involving children in efforts to develop imagination and creativity. The results of the study show the importance of applying coding learning through ScratchJr to help develop early childhood creativity in the early years. Furthermore, this study looks at preliminary evidence that the State of Indonesia will start implementing the coding curriculum in basic education. This research supports the latest policy rules of the national education ministry through the application of coding learning through ScratchJr in kindergarten.

1 INTRODUCTION

Early childhood education is education intended for children aged zero to eight years (NAEYC, 2022). This period is also called the golden age period because children experience a process of rapid growth and development, especially the brain's thinking ability, which develops by up to 80%. It is hoped that during this period, positive stimuli will be given that help children grow according to the progress of the times. Based on the results of the survey, the use of technology today is increasing, as evidenced by 92% of families having internet access at home in 2021, while this percentage level was initially only 90% in 2020. It has also increased children's access to technology and the internet (Bunce & Woolley, 2021). Researchers, educators, and practitioners agree on the importance of developing the 5Cs skills to prepare children for the challenges of the 21st century. These abilities can be taught and learned effectively by integrating digital technology media in learning that can start from the early childhood education level.

The 21st century, as it is now, is an era of very rapid technological development. Technology is developing and spreading to various sectors of life to help humans solve various things. Technology is used from various ages until children unknowingly grow up to be digital natives. Digital native is a term for children who are born and raised in the digital era (Yildiz & Guler Yildiz, 2021). Several studies have sought that children not only consume digital media, but also need to engage in positive activities, so that programs focused on STEM (Science, Technology, Engineering, Mathematics) and coding or programming have emerged (Yalçın & Erden, 2021). Whether children are aware of it or not, children use digital technology media as a daily consumption activity. Therefore, it is necessary for digital education as a provision for children to face the world. One of the efforts to realize digital education is to introduce coding learning (Unahalekhaka & Bers, 2021). Many developed and developing countries have taken policies to utilize digital technology media in the school learning curriculum,

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one way is by learning coding.

Early childhood coding is a series of cognitive processes that start from a simple stage to a higher level to solve problems by finding effective and efficient solutions or systematic such as how computer systems work (Bakala et al., 2021). Children's coding is defined as problem-solving activities by applying computer science concepts that are often associated with computational thinking skills (Terroba et al., 2021). Based on the theory of cognitive development of the Bloom taxonomy, the computational thinking ability of the debugging aspect and the design process is at the highest level, namely, vacuuming and creating.

The debugging process for children tries to find the right solution to the problem by conducting several experiments. Children's design process tries to work according to their imagination (Critten et al., 2022). The results of the study stated that children who were given coding learning were able to solve problems more creatively and had higher levels of cognitive skills, such as analysis and evaluation, which were more developed compared to children who were not given coding learning (Gerosa et al., 2022). Learning coding is an important skill today, because through coding learning children can develop abilities based on the knowledge and experience gained to reach the optimal stage of development. The selection of technology tools and interactive media must be adjusted to the child's developmental age, individual readiness and interests, and appropriate in the context of the family and community culture will determine how effectively technology can be used as a coding learning medium (Singhal, 2022). One of the media that can be used for learning coding in an early childhood education environment is a computer programming application called ScratchJr. The main problem faced in this context is the lack of systematic and targeted implementation in integrating coding learning as part of the early childhood education curriculum in the city of Surakarta. This research has the urgency to explore more deeply how the coding process is practiced for children aged 5-6 years. The purpose of this research was to describe the practice of the early childhood coding process, which can be used as an illustration of the implementation of coding learning in an early childhood education by utilizing a technology program called ScratchJr.

The results show that children aged 5-6 years have limited ability to understand coding, so simple features in the form of images or symbols are needed that will be easier for children to understand, such as ScratchJr (Misirli & Komis, 2023). All blocks are completely graphic-based (with no text other than numbers) to make it easier for children to use this programming language before they can read. Research proves that ScratchJr can develop computational thinking skills because children learn exploratively by trying out complex programming blocks (Çiftçi & Topçu, 2023). Other research shows that when children code with *ScratchJr*, children learn to express themselves and be creative (Zeng et al., 2023). ScratchJr also supports the joyful learning approach that is being implemented in Indonesia.

The application of the joyful learning approach is, in principle, by the recommendations of the government in Indonesia that professional teachers are obliged to create a meaningful, fun, creative, and dynamic learning atmosphere. It is more important that the learning process in early childhood education must be carried out in an inspiring, interactive manner, motivating children to participate actively, providing enough space to develop creativity and independence at the stages of child development. Joyful learning will arouse children's curiosity. If learning can be conditioned in a fun atmosphere, children will be active and creative in the learning process. Children will have the ability to organize and be themselves in the learning process. Joyful learning in it has no pressure, both physical and psychological pressure, so that a fun and non-monotonous classroom atmosphere is created. Joyful learning makes the learning process exciting and meaningful. Exciting means that learning can be enjoyed by children without any pressure. Meanwhile, meaning means that the knowledge gained by children in learning can be useful in their lives.

The fact that problem that always occurs in the field is that teachers still use boring methods, models, and strategies for early childhood. The learning methods, models, and strategies used by teachers in the implementation of learning still often come from one direction, namely, learning is only centered on the teacher without understanding the characteristics of each child. As a result, children become bored, so they are not enthusiastic about following the learning process in the classroom. To overcome these problems, professional teachers must carry out various efforts by implementing various learning strategies so that children have strong motivation in the learning process. One of the efforts that can be made by teachers in the learning process is to use joyful learning strategies. In addition, teachers also need to introduce the use of digital technology media from an early age, so coding-based learning through ScratchJr is very suitable to be applied in early childhood education. Thus, this article will shed light on the implementation of coding-based fun learning

through ScratchJr in early childhood education.

2 METHOD

This study uses a qualitative method with a case study approach to understand and explore in depth the practice of coding through ScratchJr in children aged 5-6 years. This research is a case study because it addresses the "how" question that allows for an in-depth examination of a phenomenon. This research employed a case study method, which allows people to gain a greater insight into a specific case by investigating it in depth and within its actual context (Babbie, 2010). This research is designed as qualitative research because it focuses on detailed information and phenomena in the best possible way.

Qualitative research focuses on understanding how people perceive events, describing them, and connecting meanings, rather than on the analysis of statistical data as seen in quantitative research (Christensen et al., 2014). This study aims to explore the practice of coding through ScratchJr in children aged 5-6 years, so that the qualitative research method is in accordance with this study. The data of this study were collected from 20 children aged 5-6 years in one of the early childhood education institutions in the city of Surakarta, Indonesia. All children have the same knowledge background, socioeconomic status, and ability to use technological media devices. Qualitative research argues that the depth and originality of knowledge are more important than generalizations, so it focuses on in-depth and specific data from smaller groups rather than large samples (Johnson & Christensen, 2014b). Therefore, 20 samples of children will generate data for this study. Participants were selected based on the purposive sampling method. Purposive sampling was used in this study to select information-rich cases for in-depth analysis according to the research objectives.

In this study, the coding process through ScratchJr in children aged 5-6 years was studied in depth through observation. Observation is a carefully observed activity that fosters a deep awareness of an event, situation, or place, as well as the behavior of the people in it, to obtain data and information (Gall, 2014). Observations can be categorized in various forms; some reference sources classify them into direct and indirect observations (Johnson & Christensen, 2014a), while others differentiate it into participatory and non-participatory observation (Mukherji & Albon, 2015). In this study, observation was carried out directly without intermediaries on the subject at the place where the event took place, and the researcher was with the subject being studied. In addition, observation is also carried out by actively participating directly to observe the ScratchJr coding process carried out by children aged 5-6 years, so that researchers know and get information accurately and in detail. In addition to the observation method, the documentation method is also used in this study to document the results of children's work during the coding process using ScratchJr. Therefore, observation and documentation methods are used in this study to facilitate consistency and accuracy in the data collection process.

Observation forms are a data collection tool to discover children's processes as they code in ScratchJr. Observation can foster a deep awareness of an event, situation, or place, as well as the behavior of the people in it (Mukherji and Albon, 2015). The observation form was created by the researcher and used during data collection. In addition to the observation form, the data collection tool used is documentation of children's work during the coding process using ScratchJr. Data is collected individually, and each child has between 45-60 minutes to explore and create a project using ScratchJr. During the child's exploration of ScratchJr, the child's progress in the coding process is recorded on an observation form. In addition, every documentation of the children's ScratchJr project is stored for analysis.

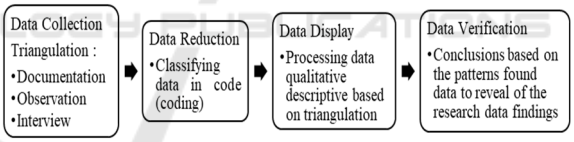

Figure 1: Data Analysis Technique.

Data from observation and documentation results were analyzed using descriptive analysis techniques. After completing the data collection process, all observation results and documentation of children's ScratchJr work are thoroughly analyzed to reveal the results of the research. This process involves encoding the data, identifying themes, and drawing conclusions based on the patterns found in the data. Due to the ethical research process, to ensure the confidentiality of participants' privacy, the analysis of children's data was abbreviated "Child" (C), followed by a number, so that it became a form of code.

3 RESULT

Joyful learning for early childhood is learning while

Table 1: Coding-Based Joyful Learning Through ScratchJr in Early Childhood Education.

No	Activity Title	Warm Up Activity	Main Activity	Concluding Activity
1.	Introducing the ScratchJr	Children observe and listen to the teacher's explanation in ScratchJr	Children try to open ScratchJr on their own	Children and teachers sit together in a circle (circle time) to discuss the activities that have been carried out, share ideas, discuss what happened, what worked, what didn't, and provide each other with feedback on the work project children's animations to make them meaningful and interesting.
2.	Create a new animation project	The teacher gives an example using blocks to create animations	Children try to create animations using different block programming	
3.	Add a background (story theme)	The teacher gives an example of how to add a background	Children add background (theme) freely according to their creativity	
4.	Add characters and make the character move	The teacher guides in adding characters based on the background and gives an example of how to make a character move by dragging and arranging blocks	Children are free to choose characters based on the theme and select blocks that are arranged to make characters move	
5.	Save animation project using children's names	The teacher gave an example of how to save the finished animation project work with the child's name	Children save the work of animation projects by typing their names	
6.	Tell the animation (display project or presentation)	The teacher invites children to share and tell of their animation and to appreciate the work of a friend's animation	Children share and tell of their animation and appreciate the work of a friend's animation project	

playing, which will invite children to be active. While playing, children are actively learning, and while learning, children are actively playing. Joyful learning for early childhood is learning while playing, which will invite children to be active. Joyful learning uses an approach that evokes feelings of fun and creativity to reduce the boredom and learning tension experienced by children. The steps of coding-based joyful learning through ScratchJr in in Table 1.

The ScratchJr used in this study was integrated with a larger exploration unit on early childhood learning as part of the kindergarten. This learning lasts about 10 hours of work over 5 days (about 2 hours per day). The implementation of this research is an intensive experience where early childhood will delve into the basic concepts of the coding process using ScratchJr for one week. During this period, early childhood in kindergarten spends one week focusing on designing, creating, and programming ideas that can help with the child's development. The researcher adjusts the learning principles that the teacher has applied in his class. Researchers provide an opportunity for children to discuss ideas about daily activities, share new ideas, and give each other feedback. The implementation used in this study is an adaptation of the curriculum created by the DevTech Research Group at Tufts University.

The learning presented in this paper provides a learning experience where children can use ScratchJr as a medium to develop a sense of competence and confidence in the ability to use technology. ScratchJr also develops creativity to create animation projects, from coming up with ideas to implementation, and ending up being able to share them with the community. The curriculum focuses on learning the basics of coding to create simple animations using a variety of programming blocks. The researcher adapted the curriculum to suit the stages of early childhood development.

The benefit of implementing the coding curriculum through ScratchJr is that teachers are able to adapt the curriculum to meet the talents, needs, and abilities of early childhood interests. Teachers are able to create a comprehensive curriculum based on coding concepts through ScratchJr and adjust the content of the curriculum according to the stages of early childhood development as a whole. The teacher follows the child or follows the direction of the class. Teachers try to plan as much learning as possible, but still leave room for flexibility, and it's a bit difficult. Teachers must be confident that this will succeed and see the coding curriculum as a learning process that is in line with the development of the 21st century, which is all digitalized. Coding through ScratchJr can provide children with the freedom to use technology in a new way and follow the mutually agreed class rules. Overall, the children feel enthusiastic and happy when doing coding through ScratchJr.

The first lesson of the programming with ScratchJr, which is divided into two sessions, is devoted to introducing ScratchJr. Instead of visiting the playground for warm-up activities, researchers showed the graphic programming blocks inside ScratchJr to the children. Then, the children with

great enthusiasm and curiosity discuss questions such as: "What is the name of this game?"; "What is the function of this block?"How to move the character?"How do I change the background of the theme?"Can I add another character?"; "How do I delete a character?" which the researcher then answered by showing directly through the ScratchJr application. This session meeting is very energetic because the child discovers something new in the classroom. Researchers introduced various forms of graphic programming blocks within the ScratchJr application to create animation projects. The researchers told the children about the functions of the various forms of programming blocks and demonstrated how they were used.

After the teacher demonstrated how to make animations using programming blocks. The next activity was that the children were asked to create an animation project using the programming blocks. ScratchJr is a storytelling programming language that allows children aged five to seven to create their own interactive stories, collages, and games. With ScratchJr, children combine graphics programming blocks to make characters move, jump, dance, and sing. Children can modify characters and add their sounds. Children display one category of instructions at a time by clicking the selector on the left. Dragging the instruction block from the palette to the script area below it activates it. Putting the blocks together will create a program that is read and played from left to right. ScratchJr asks children to create coding from left to right, just as they are learning to read and write.

After completing the animation, children have the opportunity to present their animated work to their friends, explain the animated themes that have been created, and tell the characters in the animation. Letting children speak for themselves about their work and showing what they are proud of brings joy to researchers and teachers. Children enjoy interacting with friends, and this gives them the opportunity to help develop their language and social skills. The children take turns showing their animation programs and perfecting them if they encounter problems. At the end of each activity, children have a presentation where they can communicate and share ideas from their animation projects with teachers and friends in the classroom. Children can see the work of their friends' animation projects and can give appreciation or opinions regarding their friends' animation projects. This activity provides tangible evidence that coding activities through ScratchJr can develop children's language, confidence, and social-emotional skills.

4 DISCUSSION

ScratchJr is a block-based programming language that supports children to explore great ideas in computer science, such as algorithms, debugging, modularization, control structures, and design processes in a fun and developmentally appropriate way for children (Relkin et al., 2021; Yang et al., 2022). ScratchJr introduces computational concepts such as sequencing, looping, occurrence, and operators, and engages the child in cognitive processes related to problem-solving. ScratchJr invites early childhood to engage in coding as 21st-century literacy and develop the ability to use symbols (language) to understand, generate, communicate, and express ideas or thoughts by producing products that can be shared with others (Lin et al., 2020; Tuli & Mantri, 2020). As a literacy, coding can help develop a new way of thinking, namely computational thinking, and a new way of producing animations in the coding process to help develop problem-solving skills and creativity in early childhood at work. Implementing ScratchJr in early childhood, in kindergarten, can expand the scope of concepts and basic coding. ScratchJr allows children to drag and drop blocks to create a program for each character they choose. Children combine motion blocks, sounds, and displays to program their own stories and games. Further, children can create their own stories with a maximum of four pages in each project that has a beginning, middle, and end. ScratchJr is described as a tech playground for early childhood in kindergarten. Like a playground, the environment is open and allows for child-directed exploration and the creation of projects that express the child's unique interests and individuality(Pellas, 2024; Yang et al., 2022).

ScratchJr users are encouraged to learn through experimentation and fix errors, fix bugs, and troubleshoot. ScratchJr is a block programming language that has visual properties that correspond to syntactic properties (Delacruz, 2020; Govind et al., 2020). This helps prevent syntax errors and allows young users to focus their entire attention on the project their child is working on. ScratchJr, as an introductory programming language, allows children to express themselves and develop creativity.

ScratchJr appeals to early childhood learners who enjoy the process of coding to create animation projects. Research in early childhood using ScratchJr found that children showed significant changes in attitudes and self-efficacy related to social emotional development after engaging in coding (Fidai et al., 2020; Unahalekhaka & Bers, 2021). The

programming block-based language in ScratchJr offers an open setup to create projects of any choice, while engaging with great ideas from computer science. ScratchJr encourages children to explore and practice certain aspects of programming, such as cause and effect, logical sequences, and problem-solving. ScratchJr is like a playground and invites creativity and conflict resolution, constructed according to certain cognitive mechanisms structured in such a way as to allow children to develop certain great ideas (Kyza et al., 2022; Unahalekhaka & Bers, 2022; Konstantina & Stamatios, 2024). One of the main differences between the ScratchJr programming language and other games is that the ScratchJr programming language provides a tool for children to come up with their own projects openly, and not just to play around with games that are already in development. Process of creating animations, children become programmers of animation, also being able to develop problem-solving skills.

The implementation of the coding curriculum through ScratchJr in kindergarten classrooms aims to invite early childhood to discover, explore, and develop great ideas from computer science concepts that are appropriate to their development. Seymour Papert uses the term great idea to refer to the concept of computer science as a meaningful and useful discipline (del Olmo-Muñoz et al., 2020; Metin, 2020). Bers explained seven great ideas from computer science that can be learned by every early childhood according to its development, namely algorithms, modularity, control structures, representations, hardware or software, design processes, and debugging (Saxena et al., 2020; Bakala et al., 2021). These great ideas can be connected to many curricular areas of the experience domain outside of computer science, one of which is through a coding-based curriculum. The implementation of this coding curriculum is consistent with the content proposed by the policies of the Ministry of Basic Education and national government regulations in the State of Indonesia.

The implementation of the coding curriculum through ScratchJr is suitable for children in kindergarten classrooms because it facilitates the development of language, cognitive, fine motor, social-emotional, and art skills. Children become programmers by creating their animations through the coding process and becoming storytellers by sharing stories from meaningful animation projects with their environment. The use of programming blocks is in harmony with most early childhood curricula that invite children to explore depicted characters of humans and animals (Relkin et al., 2021; Singhal, 2022). ScratchJr programming blocks can develop a child's potential to be imaginative and creative, imagining projects that can move into meaningful and engaging animations. Children can identify mistakes and complete steps to correct mistakes. Problem-solving skills are one of the most important skills that need to be emphasized in early childhood education (Yang et al., 2023; Zurnacı & Turan, 2024). In addition, ScratchJr also involves learning how to manage frustration, develop perseverance, and teamwork skills. Therefore, when teachers provide opportunities for children to do coding activities, they aim to provide support for cognitive and socio-emotional development.

The implementation of coding through ScratchJr in kindergarten, in addition to learning problem-solving strategies, also provides new ways to express oneself, such as language and art. ScratchJr offers coding activities using a variety of digital programming blocks that can develop children's self-expression through the creation of meaningful and engaging animation (Dittert et al., 2021; Critten et al., 2022). ScratchJr is an expressive medium of self-expression, similar to writing, speaking, and art. ScratchJr gives children the opportunity to express their ideas in a meaningful, creative, and expressive way in a personal way. This is in line with the understanding of programming as one of the hundred languages of children described by the popular early childhood pedagogical approach of Reggio Emilia (Gerosa et al., 2022; Bers et al., 2023). ScratchJr offers easy and challenging activities for early childhood. The implementation of ScratchJr needs to adjust to the development and cognitive abilities. Therefore, at the same age level, the study found pre-reading children and fluent readers (reading symbols) with different cognitive abilities.

Early childhood basically needs to be given stimulation and challenges to learn new things. The selection of ScratchJr for the implementation of the coding curriculum in this study was due to three different factors. First, ScratchJr is the most popular programming language for early childhood. Secondly, ScratchJr is free (can be downloaded anywhere, anytime, and by anyone). Third, ScratchJr includes abilities that expose children to great ideas in a way that is appropriate for children's development because it is designed specifically for children aged five to seven. ScratchJr provides a means to express themselves because it allows children to create stories and projects openly (Misirli & Komis, 2023; Guss et al., 2024). ScratchJr can help develop problem-solving with complex concepts such as loops. ScratchJr offers an easy-to-understand

look so that children can get started easily by simply moving one character and then move on to create complex multi-character and multi-page projects (Na et al., 2024; Zurnacı & Turan, 2024). This makes ScratchJr an ideal candidate as a medium for the implementation of coding in kindergartens.

This research answers specific needs following the national education policy in Indonesia and provides a unique learning experience for early childhood, so that it can be integrated, integrated, and adjusted according to the needs of the curriculum in kindergarten and teacher professional development. However, regardless of the choice of media, the successful implementation of a children's coding curriculum in a kindergarten classroom must be appropriate for early childhood development, provide a medium for self-expression, develop rapid problem-solving skills, and be able to provide flexible media that is easy to use for early childhood (Clarke-Midura et al., 2023; Quinn et al., 2023; Masarwa et al., 2024). It's important to note that the benefits of implementing a coding curriculum aren't limited to technology literacy. The coding curriculum can support the development of language, cognitive, physical, motor, math, socio-emotional, and art. Teaching coding also trains problem-solving skills. The problem faced by the field of learning technology education today is not whether to teach coding in early childhood, but how best to choose media or devices and curriculum that are in accordance with the stages of early childhood development in the kindergarten classroom.

5 CONCLUSIONS

The results of this case study indicate that an effective coding curriculum, implemented through ScratchJr in kindergarten, should include materials that are tailored to the stages of early childhood development as a whole, teachers who are comfortable and confident in teaching coding, and a collaborative learning environment. Based on the study's results, integrating ScratchJr into kindergarten coding does not require teachers to allocate time outside of their teaching hours. Instead, teachers use ScratchJr as a learning medium to invite children to explore the coding process in creating animation. Because early childhood learning values personal exploration and achieving goals from any path that makes sense for each child, ScratchJr offers a unique way for children to express their creativity and create new ideas. Traditional early childhood learning is typically explored through reading books, class discussions, and working on children's worksheets. Coding through ScratchJr can be another way to understand material in a new, more modern way, as it utilizes digital technology media that gives children the opportunity to create moving images in the form of meaningful and interesting animations. As technology becomes increasingly important in a global society, ScratchJr could become a new way to teach coding in kindergarten. Teachers integrate the principles of early childhood learning with the use of technology. The teacher pointed out that ScratchJr can be used as a medium that allows early childhood to learn basic concepts of simple coding. Although ScratchJr is relatively new in early childhood education, this study shows that implementing a learning curriculum that utilizes technology media can be applied in other kindergartens, provided that learning is tailored to the stages of early childhood development. Overall, the findings of this study provide early evidence that coding through ScratchJr has a positive impact on early childhood development in the cognitive, social-emotional, and creativity domains.

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REFERENCES

Babbie, E. (2010). *The practice of social research* (Twelfth). Wadsworth.

Bakala, E., Gerosa, A., Hourcade, J. P., & Tejera, G. (2021). Preschool children, robots, and computational thinking: A systematic review. *International Journal of Child-Computer Interaction*, *29*, 1–24. https://doi.org/10.1016/j.ijcci.2021.100337

Bers, M. U., Blake-West, J., Kapoor, M. G., Levinson, T., Relkin, E., Unahalekhaka, A., & Yang, Z. (2023). Coding as another language: research-based curriculum for early childhood computer science. *Early Childhood Research Quarterly*, *64*(1), 394–404. https://doi.org/10.1016/j.ecresq.2023.05.002

Bunce, L., & Woolley, J. D. (2021). Fantasy orientation and creativity in childhood: A closer look. *Cognitive Development*, *57*(December 2020), 100979. https://doi.org/10.1016/j.cogdev.2020.100979

Christensen, L. B., Johnson, R. B., & Turner, L. A. (2014). *Research methods : design, and analysis*. Pearson.

Çiftçi, A., & Topçu, M. S. (2023). Improving early childhood pre-service teachers' computational thinking skills through the unplugged computational thinking integrated STEM approach. *Thinking Skills and Creativity*, *49*(1), 1–14. https://doi.org/10.1016/j.tsc.2023.101337

Clarke-Midura, J., Lee, V. R., Shumway, J. F., Silvis, D., Kozlowski, J. S., & Peterson, R. (2023). Designing formative assessments of early childhood computational thinking. *Early Childhood Research Quarterly*, *65*(January 2022), 68–80. https://doi.org/10.1016/j.ecresq.2023.05.013

Critten, V., Hagon, H., & Messer, D. (2022). Can pre-school children learn programming and coding through guided play activities? A case study in computational thinking. *Early Childhood Education Journal*, *50*(6), 969–981. https://doi.org/10.1007/s10643-021-01236-8

del Olmo-Muñoz, J., Cózar-Gutiérrez, R., & González-Calero, J. A. (2020). Computational thinking through unplugged activities in early years of primary education. *Computers and Education*, *150*(1), 1–19. https://doi.org/10.1016/j.compedu.2020.103832

Delacruz, S. (2020). Starting from scratchjr: integrating code literacy in the primary grades. *Reading Teacher*, *73*(6), 805–812. https://doi.org/10.1002/trtr.1909

Dittert, N., Thestrup, K., & Robinson, S. (2021). The SEEDS pedagogy: Designing a new pedagogy for preschools using a technology-based toolkit. *International Journal of Child-Computer Interaction*, *27*(1), 1–12. https://doi.org/10.1016/j.ijcci.2020.100210

Fidai, A., Capraro, M. M., & Capraro, R. M. (2020). "Scratch"-ing computational thinking with arduino: A meta-analysis. *Thinking Skills and Creativity*, *38*(July), 100726. https://doi.org/10.1016/j.tsc.2020.100726

Gall, B. (2014). *Applying educational research: How to read, do, and use research to solve problems of practice* (6th ed.). Pearson. www.pearsoned.co.uk

Gerosa, A., Koleszar, V., Tejera, G., Gómez-Sena, L., & Carboni, A. (2022). Educational robotics intervention to foster computational thinking in preschoolers: Effects of children's task engagement. *Frontiers in Psychology*, *13*(1), 1–13. https://doi.org/10.3389/fpsyg.2022.904761

Govind, M., Relkin, E., & Bers, M. U. (2020). Engaging children and parents to code together using the scratchjr app. *Visitor Studies*, *23*(1), 46–65. https://doi.org/10.1080/10645578.2020.1732184

Guss, S. S., Clements, D. H., Sharifnia, E., Sarama, J., Holland, A., Lim, C., & Vinh, M. (2024). Designing inclusive computational thinking learning trajectories for the youngest learners. *Education Sciences*, *1*(1), 1–24. https://doi.org/10.3390/educsci14070733

Johnson, B., & Christensen, L. (2014a). *Educational research* (5th ed.). Sage.

Johnson, B., & Christensen, L. (2014b). *Educational research quantitative, qualitative, and mixed approaches* (5th ed.). Sage.

Konstantina, L., & Stamatios, P. (2024). Enhancing computational thinking in early childhood education through ScratchJr integration. *Heliyon*, *10*(10), e30482. https://doi.org/10.1016/j.heliyon.2024.e30482

Kyza, E. A., Georgiou, Y., Agesilaou, A., & Souropetsis, M. (2022). A cross-sectional study investigating primary school children's coding practices and computational thinking using ScratchJr. *Journal of Educational Computing Research*, *60*(1), 220–257. https://doi.org/10.1177/07356331211027387

Lin, Chien, S., Hsiao, C., Hsia, C., & Chao, K. (2020). Enhancing computational thinking capability of preschool children by game-based smart toys. *Electronic Commerce Research and Applications*, *44*(1), 1–16. https://doi.org/10.1016/j.elerap.2020.101011

Masarwa, B., Hel-Or, H., & Levy, S. T. (2024). Kindergarten children's learning of computational thinking with the "sorting like a computer" learning unit. *Journal of Research in Childhood Education*, *38*(2), 165–188. https://doi.org/10.1080/02568543.2023.2221319

Metin, S. (2020). Activity based unplugged coding during the preschool period. *Journal of Technology and Design Education*, *32*(1), 149–165. https:// doi.org/10.1007/s10798-020-09616-8

Misirli, A., & Komis, V. (2023). Computational thinking in early childhood education: The impact of programming a tangible robot on developing debugging knowledge. *Early Childhood Research Quarterly*, *65*(January 2022), 139–158. https://doi.org/10.1016/j.ecresq.2023.05.014

Mukherji, P., & Albon, D. (2015). *Research methods in early childhood an introductory guide* (2nd ed.). Sage.

Na, C., Clarke-Midura, J., Shumway, J., van Dijk, W., & Lee, V. R. (2024). Validating a performance assessment of computational thinking for early childhood using item response theory. *International Journal of Child-Computer Interaction*, *40*(1), 1–16. https://doi.org/10.1016/j.ijcci.2024.100650

NAEYC. (2022). *National Association for the Education of Young Children*. National Association for the Education of Young Children; National Association for the Education of Young Children. https://www.naeyc.org/

Pellas, N. (2024). Enhancing computational thinking, spatial reasoning, and executive function skills: The impact of tangible programming tools in early childhood and across different learner stages. *Journal of Educational Computing Research*, *0*(0), 1–30. https://doi.org/10.1177/07356331241292767

Quinn, M. F., Caudle, L. A., & Harper, F. K. (2023). Embracing culturally relevant computational thinking in the preschool classroom: Leveraging familiar contexts for new learning. *Early Childhood Education Journal*, *1*(1), 1–11. https://doi.org/10.1007/s10643-023-01581-w

Relkin, E., de Ruiter, L. E., & Bers, M. U. (2021). Learning to code and the acquisition of computational thinking by young children. *Computers and Education*, *169*(1), 104222.https://doi.org/10.1016/j.compedu.2021.104222

Saxena, A., Lo, C., Hew, K., & Wong, G. (2020). Designing unplugged and plugged activities to cultivate computational thinking: An exploratory study in early childhood education. *Asia-Pacific Education*

Researcher, *29*(1), 55–66. https://doi.org/10.1007/s40299-019-00478-w

Singhal, V. (2022). Precoding skills-teaching computational thinking to preschoolers in Singapore using unplugged activities. *Proceedings of International Conf. on Computational Thinking Education*, 86–87. https://doi.org/10.34641/ctestem.2022.452

Terroba, M., Ribera, J. M., Lapresa, D., & Anguera, M. T. (2021). Observational analysis of the development of computational thinking in Early Childhood Education - 3 years old- through a proposal for solving problems with a ground robot with programmed directionality. *Revista de Educación a Distancia*, *21*(68), 1–20. https://doi.org/10.6018/red.480411

Tuli, N., & Mantri, A. (2020). Usability principles for augmented reality based kindergarten applications. *Procedia Computer Science*, *172*(2019), 679–687. https://doi.org/10.1016/j.procs.2020.05.089

Unahalekhaka, A., & Bers, M. U. (2021). Taking coding home: analysis of scratchjr usage in home and school settings. *Educational Technology Research and Development*, *1*(1), 1–20. https://doi.org/10.1007/s11423-021-10011-w

Unahalekhaka, A., & Bers, M. U. (2022). Evaluating young children's creative coding: rubric development and testing for ScratchJr projects. *Education and Information Technologies*, *27*(5), 6577–6597. https://doi.org/10.1007/s10639-021-10873-w

Yalçın, V., & Erden, Ş. (2021). The effect of STEM activities prepared according to the design thinking model on preschool children's creativity and problem-solving skills. *Thinking Skills and Creativity*, *41*(1), 1–14. https://doi.org/10.1016/j.tsc.2021.100864

Yang, W., Ng, D. T. K., & Gao, H. (2022). Robot programming versus block play in early childhood education: Effects on computational thinking, sequencing ability, and self-regulation. *British Journal of Educational Technology*, *53*(6), 1817–1841. https://doi.org/10.1111/bjet.13215

Yang, W., Ng, D. T. K., & Su, J. (2023). The impact of story-inspired programming on preschool children's computational thinking: A multi-group experiment. *Thinking Skills and Creativity*, *47*(1), 1–12. https://doi.org/10.1016/j.tsc.2022.101218

Yildiz, C., & Guler Yildiz, T. (2021). Exploring the relationship between creative thinking and scientific process skills of preschool children. *Thinking Skills and Creativity*, *39*(1), 1–12. https://doi.org/10.1016/j.tsc.2021.100795

Zeng, Y., Yang, W., & Bautista, A. (2023). Teaching programming and computational thinking in early childhood education: a case study of content knowledge and pedagogical knowledge. *Frontiers in Psychology*, *14*(1), 1–13. https://doi.org/10.3389/fpsyg.2023.1252718

Zurnacı, B., & Turan, Z. (2024). Educational robotics or unplugged coding activities in kindergartens?: Comparison of the effects on pre-school children's computational thinking and executive function skills. *Thinking Skills and Creativity*, *53*(1), 101576. https://doi.org/ 10.1016/j.tsc.2024.101576