



Journal of Educational Sciences

Journal homepage: <https://jes.ejournal.unri.ac.id/index.php/JES>



P-ISSN
2581-1657

E-ISSN
2581-2203

Effectiveness of Coding-Based Learning on Computational Thinking, Social Skills, and Learning Motivation in Early Childhood

Dwi Wahyuningsih*, Samuel Lukas

Faculty of Education, Pelita Harapan University, Jakarta, 12930, Indonesia

ARTICLE INFO

Article history:

Received: 11 July 2026

Accepted: 28 Sept 2026

Available Online: 05 Oct 2026

Keywords:

Coding-Based Learning,
Computational Thinking,
Early Childhood Education,
Learning Motivation,
Social Skills

* Corresponding author:

E-mail: dwIW2860@gmail.com

Article Doi:

<https://doi.org/10.31258/jes.10.10.p.93-110>

This is an open access article under the [CC BY-SA](#) license.



ABSTRACT

Coding-based learning has increasingly been used in early childhood education to introduce computational thinking skills through developmentally appropriate activities. This study examined the outcomes associated with coding-based learning in computational thinking, social skills, and learning motivation among children aged 5-6 years. A quasi-experimental, nonequivalent control group design was employed. The participants were 45 children, consisting of 23 children in the experimental group and 22 children in the control group. The experimental group participated in unplugged and plugged coding-based learning activities, whereas the control group participated in regular kindergarten learning without structured coding instruction. Data were collected using hands-on computational thinking tasks and structured observation sheets for social skills and learning motivation. The findings showed a statistically significant difference in computational thinking skills between the experimental and control groups ($t(43) = 4.716$, $p < .001$). In contrast, social skills and learning motivation did not show statistically significant differences between the two groups ($p > .05$). These findings indicate that a statistically significant between-group difference was observed in computational thinking skills, whereas no statistically significant between-group differences were observed in social skills and learning motivation. Therefore, coding activities should include more intentional collaborative and motivational elements to support broader developmental outcomes.

1. Introduction

Early childhood education is a critical period for supporting holistic development, including cognitive, social-emotional, and motivational aspects. Therefore, learning experiences should be designed to stimulate children's thinking skills, social skills, and active participation in learning. One of the thinking skills that

needs to be developed from an early age is computational thinking. Computational thinking skills involve children's ability to think logically, sequentially, and systematically; recognize patterns; organize steps; select relevant information; and solve simple problems (Fraillon & Rožman, 2025). The need to strengthen logical and structured thinking is particularly relevant in the Indonesian educational context. The Programme for International Student Assessment 2022 results showed that only 18% of Indonesian students achieved Level 2 or above in mathematics, compared with the Organisation for Economic Co-operation and Development average of 69% (OECD, 2023). Although these results represent 15-year-old students rather than young children, they indicate a broader need to strengthen reasoning, pattern recognition, and structured problem-solving through appropriate stimulation from the early years.

In addition to computational thinking, social skills are an important aspect of early childhood development. Indonesia's Learning Outcomes for the Foundation Phase emphasize social and language skills for interaction, as well as emotional maturity for participating in learning environments (Anggriani et al., 2024). Children need opportunities to communicate, cooperate, manage emotions, and participate effectively in classroom activities. Learning motivation also requires attention in early childhood education. The Learning Outcomes for the Foundation Phase identify a positive perception of learning as one of the foundational abilities that should be developed before children enter primary education (Anggriani et al., 2024). Children aged 5-6 years therefore need positive, enjoyable, challenging, and meaningful learning experiences that encourage them to focus, take initiative, attempt unfamiliar tasks, and persist when facing difficulties. Early childhood learning should consequently consider not only the achievement of learning outcomes but also children's active involvement in the learning process.

Preliminary observations of routine learning activities at XYZ Kindergarten revealed several discrepancies between the competencies expected of children aged 5-6 years enrolled in Group B, the final kindergarten level in Indonesia, and the behaviors demonstrated during classroom activities. Observations indicated challenges in children's sequencing and problem-solving abilities, peer interaction during group activities, and persistence when completing challenging learning tasks. These observed discrepancies indicate the need for a learning strategy that is structured, concrete, enjoyable, and appropriate for the developmental characteristics of children aged 5-6 years. Coding-based learning was therefore selected as the intervention in this study because it can be implemented through play-based activities involving sequencing, pattern recognition, problem-solving, collaboration, and active participation. In early childhood education, coding-based learning does not aim to train children to become professional programmers. Instead, it introduces ways of thinking and solving problems through activities suited to children's developmental levels.

Coding-based learning can be implemented through unplugged and plugged activities using age-appropriate games, sequencing tasks, ScratchJr, or educational robots. These activities allow children to arrange instructions, recognize patterns, test solutions, and revise their actions. The use of interactive learning media and

digital learning tools has also been reported to support students' cognitive engagement, digital literacy, and learning outcomes in various educational contexts (Khasyyatillah & Osman, 2025; Wahyuni et al., 2025). Previous studies have indicated that coding-based learning can support the development of computational thinking skills in young children, including sequencing, problem-solving, algorithmic thinking, and debugging skills (Bati, 2022; Bers, 2018). The use of coding games, educational robots, and tablet-based applications can also create interactive learning environments that support children's computational thinking skills development (Kalyva, 2024; Yang, 2024). These findings suggest that coding-based learning can be aligned with the characteristics of young learners when activities are concrete, playful, meaningful, and appropriately scaffolded.

Coding-based learning may also provide opportunities for developing social skills and learning motivation. Coding activities can be designed as exploratory and collaborative tasks in which children work with peers, share materials and roles, communicate ideas, test solutions, correct errors, and complete tasks together. Başaran et al. (2024) found that coding activities supported children's collaboration and communication, which may contribute to social development and engagement in learning. However, the development of social skills cannot be assumed to occur merely because children participate in group activities. It may depend on the quality, intensity, and consistency of the social interactions embedded in the learning design. Similarly, coding-based learning may encourage learning motivation because it allows children to make choices, receive immediate feedback, experience challenges, and revise unsuccessful solutions. Previous studies in the *Journal of Educational Sciences* have also shown that technology-assisted learning media can support learning motivation and learning outcomes when the media are interactive and relevant to learners' needs (Edwana et al., 2023; Ratnasari et al., 2022). However, further investigation is needed to determine whether similar motivational effects occur among kindergarten children.

The selection of coding-based learning as the intervention was also based on the educational context of XYZ Kindergarten. XYZ Kindergarten has implemented coding activities through unplugged and plugged activities; however, participation remains optional. This condition provides a relevant context for comparing children participating in coding-based learning with those receiving regular kindergarten learning activities without structured coding instruction. Despite increasing interest in coding at the early childhood level, empirical research on its implementation and effectiveness in Indonesia remains limited. Existing Indonesian studies have mainly examined contextual unplugged coding and computational thinking, while fewer have investigated coding-based learning through both unplugged and plugged activities (Fitriyah et al., 2023). Research on coding has also been conducted more frequently at the primary and secondary school levels than in preschool settings (Critten et al., 2022; Threekunprapa & Yasri, 2020). Moreover, previous studies have predominantly focused on computational thinking skills or programming concepts, while relatively few have simultaneously examined cognitive and non-cognitive outcomes.

It therefore remains unclear whether the benefits of coding-based learning extend beyond computational thinking skills to children's social skills and learning motivation, particularly in the Indonesian early childhood education context. Bers (2021) described coding as a playground that provides children with opportunities to learn, explore, create, and develop different ways of thinking. From this perspective, developmentally appropriate coding-based learning may not only stimulate computational thinking skills but may also provide opportunities for social interaction and active engagement in learning. Although coding-based learning has been implemented as an optional extracurricular activity at XYZ Kindergarten, its effectiveness in improving computational thinking, social skills, and learning motivation among children aged 5-6 years has not been empirically examined within a single research design. Unlike previous studies that primarily focused on computational thinking skills or programming concepts, this study simultaneously examines cognitive, social, and motivational outcomes. Therefore, this study aims to examine the effectiveness of coding-based learning in improving computational thinking, social skills, and learning motivation among children aged 5-6 years enrolled in Group B at XYZ Kindergarten in Tangerang City, Indonesia. It was hypothesized that children participating in coding-based learning would demonstrate higher posttest scores across the three measured outcomes than children receiving regular kindergarten learning activities.

2. Methodology

Research Design

This study employed a quantitative approach using a quasi-experimental method with a nonequivalent control group design. A quasi-experimental design was selected because group membership was based on the children's pre-existing enrollment in the optional coding extracurricular program, and random assignment was not possible in the school setting. This design enabled the researcher to compare changes between an experimental group and a control group before and after the intervention (Creswell & Creswell, 2018). The experimental group participated in coding-based learning, whereas the control group continued participating in regular kindergarten learning activities without structured coding instruction. Both groups completed pretest and posttest measurements for computational thinking, social skills, and learning motivation. The coding-based learning intervention was conducted for 16 weeks and included both unplugged and plugged activities. The unplugged activities used concrete media and physical games, while the plugged activities involved simple digital and robotic learning tools such as ScratchJr and Code and Go Robot Mouse.

Participants

The participants were children aged 5-6 years enrolled in Group B, the final kindergarten level in Indonesia, at XYZ Kindergarten in Tangerang City. The sample consisted of 45 children, including 23 children in the experimental group and 22 children in the control group. The experimental group consisted of children

who had enrolled in the optional coding extracurricular program, whereas the control group consisted of children who did not enroll in the program and continued participating in regular classroom learning. Before the intervention, the children in the experimental group had not previously participated in coding-based learning activities. Group membership was therefore based on the children's existing extracurricular enrollment rather than random assignment by the researcher. Participants were selected using quota sampling based on the school's existing group structure and learning conditions. The identities of the school and participating children were anonymized to maintain institutional and participant confidentiality.

Intervention Procedure

The coding-based learning intervention was conducted for 16 weeks, with one session per week. Each session lasted approximately 60 minutes. The intervention combined unplugged and plugged coding activities designed for children aged 5-6 years. The activities were implemented progressively, beginning with simple tasks involving one or two instructions and continuing with more complex tasks involving several sequential steps. Each session consisted of an introduction, demonstration, guided practice, and an individual or small-group activity. The teacher introduced the task, demonstrated the learning media, guided the children when they experienced difficulties, and encouraged them to test and revise their solutions. The intervention was facilitated by the coding teacher using the same learning plan and activity sequence for each session. To maintain consistency, the activities were conducted using prepared lesson plans, standardized learning materials, and observation guidelines. The control group continued participating in regular kindergarten learning activities without receiving structured unplugged or plugged coding instruction.

Learning Media and Tools

The coding-based learning activities used a combination of digital and non-digital media. These media were selected to provide developmentally appropriate opportunities for children aged 5-6 years to practice sequencing, direction, pattern recognition, spatial reasoning, debugging, and problem-solving skills. The learning media and tools used during the intervention are presented in Table 1.

Table 1. Coding-Based Learning Media and Tools

No.	Learning Media and Tools	Description
1	ScratchJr	Block-based app for creating simple animations and stories through visual commands.
2	Tangram	Puzzle-based media for developing spatial reasoning, pattern recognition, trial-and-error strategies, and problem-solving skills.
3	Colour Direction	A board game using color and direction clues to plan steps, follow rules, and solve movement challenges.
4	Code and Go Robot Mouse	Robot for sequencing, direction commands, prediction, and debugging in maze tasks.

Instrument

Data were collected using performance-based assessment and structured observation. Computational thinking skills were measured through hands-on problem-solving activities. The indicators were decomposition, pattern recognition, abstraction, and algorithmic thinking. Social skills and learning motivation were measured using structured observation sheets completed by two observers to improve objectivity. Social skills consisted of communication, emotion regulation, teamwork, and problem-solving. Learning motivation consisted of intrinsic and extrinsic motivation indicators. Each item used a four-point rating scale. Before data collection, the instruments were tested for validity and reliability. Indicator validity was examined using the Pearson product-moment correlation at a 1% significance level. An indicator was considered valid when the calculated correlation coefficient was positive and exceeded the critical correlation coefficient. Instrument reliability was assessed using Cronbach's alpha. The validity and reliability results of the instruments are presented in Table 2.

Table 2. Instrument Validity and Reliability Results

Variable	Indicator	Items	Pearson correlation coefficient	Cronbach's alpha
Computational thinking	Decomposition	3	.99	.98
	Pattern recognition	2	.98	
	Abstraction	2	.99	
	Algorithmic thinking	3	.99	
Social skills	Communication	5	.92	.93
	Emotion regulation	5	.91	
	Teamwork	5	.92	
	Problem-solving	5	.91	
Learning motivation	Intrinsic motivation	6	.99	.76
	Extrinsic motivation	4	.92	

Note. Reliability coefficients are shown once for each variable.

The validity results showed that all indicators demonstrated acceptable validity coefficients based on the Pearson correlation analysis. The correlation coefficients for computational thinking ranged from .98 to .99, those for social skills ranged from .91 to .92, and those for learning motivation ranged from .92 to .99. These results indicate that all indicators met the validity criteria and were appropriate for measuring their respective variables. The reliability results showed acceptable to high internal consistency. The Cronbach's alpha coefficients were .98 for computational thinking, .93 for social skills, and .76 for learning motivation. These results indicate that the instruments had adequate reliability and were suitable for use in the pretest and posttest data collection.

Data Collection

The research procedure consisted of three main stages: pretest, treatment, and posttest. During the pretest stage, both groups were assessed using the same instruments to identify their initial levels of computational thinking, social skills, and learning motivation. During the treatment stage, the experimental group participated in coding-based learning activities for 16 weeks, whereas the control group continued participating in regular kindergarten learning activities without structured coding instruction. During the posttest stage, both groups were reassessed using the same instruments to identify changes following the intervention. Computational thinking skills were assessed through hands-on activity tasks during the pretest and posttest. In these activities, children were asked to complete play-based problem-solving tasks related to sequencing, pattern recognition, selecting relevant information, and arranging simple steps.

The computational thinking skills score was obtained from children's performance on the hands-on tasks using the computational thinking assessment rubric. Social skills and learning motivation were assessed by two teachers using standardized observation sheets. Before data collection, the two observers participated in a briefing to establish a shared understanding of the indicators, scoring criteria, and observable behaviors for each rating category. This briefing was conducted to minimize differences in interpretation when applying the observation sheets during the assessment process. Both observers assessed each child independently during the same observation sessions. For social skills and learning motivation, each observer assigned item scores independently using the same four-point rating scale. The item scores were then summed to obtain the total score from each observer. The final score used in the statistical analysis was calculated by averaging the total scores from both observers for each child. This procedure was applied consistently to both pretest and posttest observation data using the following formula:

$$\text{Final score} = (\text{Observer 1 score} + \text{Observer 2 score}) / 2.$$

Data Analysis

Before the main hypothesis testing was conducted, baseline comparability between the experimental and control groups was examined using the pretest scores. This step was conducted because the study used a quasi-experimental nonequivalent control group design in which random assignment was not possible. The pretest comparison was used to determine whether statistically significant differences existed between the two groups before the intervention. Although no statistically significant baseline differences were detected for the three outcome variables, differences in mean pretest scores remained for some variables. Therefore, the pretest results were interpreted as information about the baseline condition of the groups rather than as evidence of complete equivalence. The posttest comparison was selected to evaluate the observed outcome levels of the experimental and control groups after the intervention, consistent with the study objective of examining differences in outcomes following participation in the coding-based learning intervention. This approach retained the original nonequivalent group

structure and allowed the post-intervention outcomes of the two existing groups to be directly compared. However, because the groups were not randomly assigned, posttest comparisons cannot completely rule out the influence of pre-existing group differences or other uncontrolled factors. Accordingly, the posttest findings were interpreted as observed between-group differences following the intervention rather than as definitive evidence that the intervention caused the observed differences. When the data met the parametric assumptions, an independent-samples *t*-test was used. When the data did not meet the normality assumption, the Mann–Whitney *U* test was applied. Because the research hypotheses were directional, the main hypothesis tests were conducted as one-tailed tests, with the level of statistical significance set at $\alpha = .05$, following quantitative data analysis procedures for experimental and quasi-experimental research (Creswell & Creswell, 2018).

The use of one-tailed tests was determined based on the directional hypotheses stated before data analysis. For the observational measures, an additional inter-observer reliability analysis was conducted using the intraclass correlation coefficient (ICC) to examine the agreement between the two observers. A two-way random-effects model with absolute agreement was used to examine the agreement between the two observers. Because the final observational scores used in the main analysis were calculated by averaging the ratings of the two observers, ICC (2,2) was used to evaluate the reliability of the average ratings. The reliability analysis was conducted separately for social skills and learning motivation at pretest and posttest. This additional reliability analysis did not alter the final observational scores or the statistical procedures used in the main analysis.

3. Results and Discussion

Implementation of Coding-Based Learning Intervention

This section describes the implementation of the coding-based learning intervention to provide contextual information about the treatment before presenting the statistical findings. The experimental group participated in coding-based learning for 16 weeks, with one session each week. The intervention combined unplugged activities, such as sequencing games, direction games, tangram activities, and color direction activities, with plugged activities using ScratchJr and Code and Go Robot Mouse. Each session included an introduction, teacher demonstration, guided practice, and individual or small-group activities. During the activities, children were encouraged to arrange steps, recognize patterns, follow directions, test solutions, identify errors, and revise their actions. These activities were designed to provide children with opportunities to practice computational thinking processes, including sequencing actions, recognizing patterns, planning solutions, and modifying strategies when encountering errors. Meanwhile, the control group continued participating in regular kindergarten learning activities without structured coding instruction.

Data Sources and Scoring Procedure

Before presenting the descriptive and inferential statistical results, the sources of data and the final scores used in the analysis were clarified. Computational thinking skills were measured through hands-on activity tasks, whereas social skills and learning motivation were measured using structured observation sheets completed by two observers. The scoring procedure for each variable, including the process of obtaining the final scores used in the analysis, is summarized in Table 3. For observational measures, the reported scores represent the average scores obtained from the two observers for each child. As shown in Table 3, the final scores used for analysis were obtained through the specified scoring procedures for each variable. For observational measures, scores from the two observers were combined to obtain the final score for each child.

Table 3. Data Sources and Final Scores Used in the Analysis

Variable	Data Collection Technique	Scoring Source	Final Score Used in Analysis
Computational thinking skills	Hands-on activity tasks	Children's performance assessed using a computational thinking rubric	Performance score from hands-on tasks
Social skills	Structured observation sheet	Observer 1 total score and Observer 2 total score	Average of Observer 1 and Observer 2 scores
Learning motivation	Structured observation sheet	Observer 1 total score and Observer 2 total score	Average of Observer 1 and Observer 2 scores

Inter-Observer Reliability

Because social skills and learning motivation were assessed independently by two observers, an additional inter-observer reliability analysis was conducted to examine the consistency of the observers' ratings. The analysis used the intraclass correlation coefficient (ICC) with a two-way random-effects model and absolute agreement. Because the final observational scores used in the main analysis were calculated by averaging the scores from the two observers, the ICC for average ratings, ICC (2,2), was reported. The reliability analysis was conducted separately for the pretest and posttest scores of social skills and learning motivation. The results are presented in Table 4. As shown in Table 4, the consistency between the two observers varied across variables and assessment occasions. Social skills showed higher inter-observer agreement at pretest than at posttest, whereas learning motivation showed lower agreement, particularly at posttest. These findings indicate that inter-observer agreement varied across variables and assessment occasions, with particularly low agreement for learning motivation at posttest. Nevertheless, the final scores used in the main statistical analysis remained the average scores of the two observers, consistent with the scoring procedure described in the Methodology.

Table 4. Inter-Observer Reliability Results

Variable	Assessment	Number of Observers	ICC (2,2)
Social skills	Pretest	2	.842
Social skills	Posttest	2	.508
Learning motivation	Pretest	2	.613
Learning motivation	Posttest	2	.136

Descriptive Results

The descriptive results show changes in the experimental and control groups from pretest to posttest across the three variables. The mean and standard deviation scores of computational thinking, social skills, and learning motivation for both groups are presented in Table 5. As shown in Table 5, the experimental group demonstrated a larger increase in computational thinking skills compared with the control group. Social skills increased in both groups, with the experimental group showing a higher posttest mean than the control group. Learning motivation also increased in both groups, although the control group obtained a slightly higher posttest mean. These descriptive patterns indicate different levels of change across the three outcome variables between the two groups. The largest between-group difference in posttest mean scores was observed for computational thinking skills, whereas the differences in social skills and learning motivation were smaller.

Table 5. Descriptive Statistics Results

Variable	Group	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD
Computational thinking	Experimental	26.04	4.88	35.00	3.57
	Control	25.14	5.18	29.77	3.87
Social skills	Experimental	38.39	6.70	60.43	6.17
	Control	41.48	5.67	58.14	5.86
Learning motivation	Experimental	21.52	3.93	30.11	2.19
	Control	22.80	3.34	30.48	2.54

Before hypothesis testing, the pretest comparison, homogeneity of variances, and posttest data distribution were examined. The pretest comparison was conducted to determine whether statistically significant differences existed between the experimental and control groups before the intervention, considering that this study used a quasi-experimental nonequivalent control group design without random assignment. The results of the pretest comparison, assumption tests, and statistical test decisions are presented in Table 6. As shown in Table 6, no statistically significant differences were detected between the experimental and control groups in computational thinking skills, social skills, or learning motivation, as all p-values were greater than .05. However, differences in mean pretest scores were present for some variables; therefore, the pretest results were interpreted as information about the baseline condition of the groups rather than as evidence of complete equivalence. The posttest scores were subsequently compared to examine the observed outcome levels of the experimental and control groups following the intervention, consistent with the study objective. Because the groups were not

randomly assigned, the posttest differences were interpreted as observed between-group differences after the intervention rather than as definitive evidence of a causal treatment effect.

Table 6. Pretest Comparison, Assumption Test Results, and Statistical Test Decision

Variable	Pretest Comparison	Pretest Homogeneity	Experimental Posttest Distribution	Control Posttest Distribution	Statistical Test
Computational thinking	$p = .450$ not significant	Yes	Normal	Normal	Independent-samples <i>t</i> -test
Social skills	$p = .948$ not significant	Yes	Not normal	Normal	Mann-Whitney <i>U</i> test
Learning motivation	$p = .876$ not significant	Yes	Normal	Normal	Independent-samples <i>t</i> -test

Inferential Statistical Results

The inferential statistical results were used to examine whether differences existed between the experimental and control groups after the intervention. The analysis showed a statistically significant difference in computational thinking skills, whereas no statistically significant differences were found in social skills and learning motivation. The detailed statistical results for the three variables are presented in Table 7. As shown in Table 7, the experimental group obtained a higher posttest score in computational thinking skills than the control group, and the difference was statistically significant. However, no statistically significant differences were found between the experimental and control groups in social skills and learning motivation. Although the experimental group showed a higher posttest mean in social skills, the difference was not statistically significant. Similarly, both groups showed changes in learning motivation, but the posttest difference between the groups was not statistically significant.

Table 7. Results of Statistical Analysis

Variable	Statistical Result	One-tailed <i>p</i> -value	Decision
Computational thinking	$t(43) = 4.716$	$< .001$	Significant
Social skills	$U = 278.5$	.279	Not significant
Learning motivation	$t(43) = -0.52$	.700	Not significant

Discussion

The discussion of the findings was based on the data sources and scoring procedure, inter-observer reliability results, descriptive statistics, pretest comparison, assumption tests, and inferential statistical results presented in Tables 3, 4, 5, 6, and 7. Computational thinking skills were measured through hands-on activity tasks, whereas social skills and learning motivation were measured using structured

observation sheets completed by two observers. The descriptive results indicated higher mean scores at posttest than at pretest in both groups across the three variables, although the experimental group showed a higher posttest mean in computational thinking skills than the control group. The pretest comparison showed that no statistically significant baseline differences were detected between the two groups, while the inferential results showed a statistically significant between-group difference only in computational thinking skills. The interobserver reliability results also showed varying levels of agreement across the observational measures and assessment occasions. Thus, under the conditions of this quasi-experimental study, a statistically significant between-group difference was observed only in computational thinking skills, whereas no statistically significant between-group differences were found for social skills and learning motivation. Although no statistically significant baseline differences were detected, differences in mean pretest scores remained for some outcome variables; therefore, the posttest findings should be interpreted as observed between-group differences following the intervention, rather than as evidence of complete baseline equivalence or definitive causal effects.

The experimental group demonstrated significantly higher posttest performance in computational thinking skills than the control group. This result is consistent with the concept that computational thinking skills involve the ability to decompose problems, recognize patterns, abstract relevant information, and arrange algorithmic steps (Wing, 2006). Coding-based learning activities provide opportunities for children to practice these components. When children arrange command cards, plan routes, move a robot through a maze, or create simple sequences in ScratchJr, they engage in activities that involve ordered and logical thinking. These activities give children opportunities to work with clear sequences and to revise their actions when errors are identified. The result is consistent with previous studies indicating that coding and programming activities can support the development of computational thinking skills in early childhood (Lee & Junoh, 2019; Relkin et al., 2021; Turan & Aydoğdu, 2020). Bers (2018, 2021) argued that coding can become a meaningful playground when children use it to create, explore, and express ideas. Similarly, Louka and Papadakis (2024) reported that ScratchJr integration can enhance computational thinking skills in early childhood education. Studies on ScratchJr and robotics also show that young children can develop early programming concepts when activities are concrete and age-appropriate (Bers et al., 2022; Louka & Papadakis, 2024; Portelance et al., 2016). In this study, the significant between-group difference in computational thinking skills was observed following an intervention that used varied learning media that involved sequencing actions, solving spatial problems, identifying patterns, and debugging errors. A related study also reported that computational thinking-oriented learning modules can support students' computational thinking development (Khasyyatillah & Osman, 2025).

The results also indicate that no statistically significant between-group difference was observed in social skills between the coding-based learning and regular kindergarten groups. Although the experimental group showed an increase in its mean score, the between-group difference was not statistically significant. This

suggests that the potential contribution of coding-based learning to social skills may depend on how explicitly collaboration is structured. Coding activities can create opportunities for peer interaction, but social skills require repeated practice in communication, emotional regulation, teamwork, and conflict resolution across various contexts (Nangle et al., 2020). If the activity focuses primarily on solving a coding task, children may practice the cognitive demands of the task more intensively than the social behaviors embedded in the activity. The non-significant result for social skills should also be interpreted cautiously because the children were grouped based on existing extracurricular enrollment rather than random assignment. Although the pretest comparison indicated that the groups were relatively comparable, possible differences in children's prior social experiences, peer interaction patterns, and classroom habits could not be fully controlled. In addition, social skills were measured using structured observation sheets, so children's social behavior may have varied depending on the activity context, peer group, and classroom situation. The absence of a significant difference suggests that group-based coding activities alone may not be sufficient to support the development of social competence. Teachers need to intentionally design collaborative roles, discussion routines, peer assistance, and reflection activities. For example, children can be assigned roles such as direction planner, command arranger, tester, and checker. They can also be guided to explain their ideas, listen to peers, take turns, and resolve differences using simple classroom language. Without this intentional structure, coding activities may remain cognitive tasks rather than social learning experiences.

The results also show that no statistically significant between-group difference was observed in learning motivation between the coding-based learning and regular kindergarten groups. This finding can be understood through self-determination theory, which explains that motivation is influenced by autonomy, competence, and relatedness (Ryan & Deci, 2020). Coding-based learning may attract children's attention because it involves games, robots, and digital media. However, sustained motivation requires more than novelty. This is consistent with studies showing that learning media may support motivation when they provide meaningful interaction, clear learning support, and engaging learning experiences, rather than merely functioning as attractive digital tools (Edwana et al., 2023; Ratnasari et al., 2022). Children need to feel successful, receive appropriate feedback, make choices, and experience meaningful interaction with teachers and peers. In this study, the coding-based learning activities may have provided engaging learning experiences. However, this may not have been sufficient to generate a statistically significant between-group difference in learning motivation. The result for learning motivation should also be considered in relation to the 16-week intervention period and the nature of motivation as a developmental and contextual variable. Motivation in early childhood may develop gradually through repeated learning experiences, teacher support, peer interaction, and opportunities for children to experience autonomy and competence. Therefore, the 16-week intervention period and the use of structured observation sheets may not have been sufficient to capture stable and contextually varied changes in children's learning motivation. An important consideration in interpreting the learning motivation findings is the relatively low inter-observer agreement at posttest. The ICC (2,2) for learning motivation at

posttest was .136, indicating very low agreement between the two observers. This finding suggests that the observational measurement of learning motivation at posttest was less consistent than the other observational assessments. Consequently, the non-significant between-group difference in learning motivation should be interpreted with caution. The low inter-observer agreement may have limited the precision with which differences between the groups could be detected. However, the low ICC does not by itself explain or establish the absence of a statistically significant difference. Rather, it represents an important measurement limitation that should be considered when interpreting the learning motivation findings. Future studies should use more clearly operationalized behavioral indicators, more extensive observer training, and additional sources of evidence to strengthen the reliability of learning motivation assessment in early childhood settings.

The findings suggest that cognitive outcomes may be more closely aligned with the structured task demands of coding activities than the broader social and motivational outcomes examined in this study. Computational thinking skills are closely related to the task structure of coding itself, while social skills and learning motivation are influenced by broader classroom climate, teacher-child interaction, peer relationships, reinforcement patterns, and children's individual characteristics. Therefore, coding-based learning should not be assumed to produce similar outcomes across all developmental domains. Instead, it should be integrated with child-centered pedagogy, collaborative learning, teacher scaffolding, and reflective activities to support more holistic learning experiences. This study contributes to the literature by providing empirical evidence from the Indonesian ECE context. Previous systematic reviews have emphasized the need for more research on how computational thinking skills can be implemented effectively in early childhood education and how learning outcomes can be measured (Bati, 2022; Bers et al., 2022; Su & Yang, 2023). The present study responds to this need by examining three variables simultaneously: computational thinking, social skills, and learning motivation. The findings suggest that children who participated in coding-based learning demonstrated higher computational thinking skills compared with children in the control group. However, statistically significant differences were not found for social skills and learning motivation, indicating that additional pedagogical design may be needed to strengthen the potential contribution of coding-based learning to social and motivational outcomes.

The practical implication of this study is that early childhood teachers can use coding-based learning as a strategy to provide opportunities for children to practice logical and systematic thinking. However, if teachers also aim to improve social skills and learning motivation, the learning design should include explicit collaborative tasks, peer discussion, role sharing, and consistent positive reinforcement. Therefore, the design of coding-based learning should consider not only the media used but also the learning model, interaction pattern, and task structure, as previous studies have shown that learning outcomes are influenced by how learning media and models are implemented in classroom practice (Khayyirah et al., 2024; Wahyuni et al., 2025). Coding activities should be presented as playful and meaningful challenges rather than isolated technical tasks. In this way, coding-

based learning can become part of a broader developmentally appropriate curriculum that supports cognitive, social, and motivational growth.

Limitations

This study has several limitations. First, it was conducted in one kindergarten with a limited number of participants; therefore, the findings should be generalized with caution. Second, the 16-week intervention may not have been long enough to capture stable changes in social skills and learning motivation. Third, social skills and learning motivation were measured using structured observation sheets, and children's behavior may vary across activities and classroom situations. Fourth, group membership was based on enrollment in an optional extracurricular program rather than random assignment. Therefore, possible differences in children's initial interest, parental support, or other background characteristics could not be completely excluded. Future studies should involve larger samples from multiple schools, longer intervention periods, and mixed-methods approaches to provide a more comprehensive understanding of coding-based learning in early childhood education.

4. Conclusion

This study concludes that coding-based learning was associated with improved computational thinking skills among children aged 5-6 years enrolled in Group B at XYZ Kindergarten in Tangerang City, Indonesia. The findings indicate that coding-based learning provided children with opportunities to practice logical, systematic, and sequential thinking through developmentally appropriate activities. However, no statistically significant between-group differences were observed for social skills and learning motivation. These findings suggest that coding-based learning may be more closely associated with cognitive outcomes, particularly computational thinking, than with the social and motivational outcomes examined in this study. To promote more holistic development, coding-based learning should incorporate intentional collaboration, peer interaction, teacher scaffolding, and motivational support. Future research should involve larger samples from multiple schools, longer intervention periods, and qualitative approaches to further explore how coding-based learning can support both cognitive and non-cognitive development in early childhood education.

Acknowledgment

The authors express sincere gratitude to XYZ Kindergarten in Tangerang City for granting permission and providing support during the research process. The authors also thank the teachers, children, and observers who contributed to the implementation of the intervention and data collection. The authors state that artificial intelligence (AI) based tools were used only to assist grammar correction and academic language refinement. The research ideas, data analysis, interpretation, and conclusions remain the original work and responsibility of the authors.

References

- Anggriani, F., Sumule, I. W., Narpaduhita, D., Chasanah, A. M., Yuliantina, I., Mursitolaksmi, L. R., Maisura, R., & Anggraeni. (2024). *Panduan Capaian Pembelajaran Fase Fondasi*. Badan Standar, Kurikulum, dan Asesmen Pendidikan.
- Başaran, M., Metin, Ş., & Vural, Ö. F. (2024). Meta-thematic Synthesis of Research on Early Childhood Coding Education: A Comprehensive Review. *Education and Information Technologies*, 29(16), 20795–20822. <https://doi.org/10.1007/s10639-024-12675-2>
- Bati, K. (2022). A Systematic Literature Review Regarding Computational Thinking and Programming in Early Childhood Education. *Education and Information Technologies*, 27(2), 2059–2082. <https://doi.org/10.1007/s10639-021-10700-2>
- Bers, M. U. (2018). Coding and Computational Thinking in Early Childhood: The Impact of ScratchJr in Europe. *European Journal of STEM Education*, 3(3). Article 08. <https://doi.org/10.20897/ejsteme/3868>
- Bers, M. U. (2021). *Coding as a playground: Programming and computational thinking in the early childhood classroom* (2nd ed.). Routledge.
- Bers, M. U., Strawhacker, A., & Sullivan, A. (2022). *The State of the Field of Computational Thinking in Early Childhood Education*. (OECD Education Working Papers No. 274). OECD Publishing. <https://doi.org/10.1787/3354387a-en>
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- 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>
- Edwana, N., Islami, N., & Zulirfan, Z. (2023). Development of Android-Assisted Sound Wave Experiment Devices as an Effort to Improve High School Students' Motivation and Physics Learning Outcomes. *Journal of Educational Sciences*, 7(4), 598–608. <https://doi.org/10.31258/jes.7.4.p.598-608>
- Fitriyah, Q. F., Saputri, L. R., & Aljawad, H. I. (2023). Praktik Unplugged Coding Berbasis Daily Lives dalam Meningkatkan Computational Thinking pada Anak Usia Dini. *Jurnal Pendidikan Anak*, 12(2), 176–185. <https://doi.org/10.21831/jpa.v12i2.57349>
- Fraillon, J., & Rožman, M. (Eds.). (2025). *IEA International Computer and Information Literacy Study 2023: Assessment Framework*. Springer Nature Switzerland. <https://doi.org/10.1007/978-3-031-61194-0>
- Kalyva, G. E. (2024). Study on The Implementation of The CAL (Coding as Another Language) Curriculum in Early Childhood Education. *Advances in Mobile Learning Educational Research*, 4(2), 1224–1241. <https://doi.org/10.25082/AMLER.2024.02.015>
- Khasyyatillah, I., & Osman, K. (2025). The Development of CT-S Learning Module on the Linear Motion Topic to Promote Computational Thinking.
-

-
- Journal of Educational Sciences*, 3(3), 270–280.
<https://doi.org/10.31258/jes.3.3.p.270-280>
- Khayyirah, S., Islami, N., & Zulhelmi, Z. (2024). Effectiveness of the STAD-Type Cooperative Learning Model Assisted by Baamboozle Game to Improve Students' Cognitive Learning Outcomes. *Journal of Educational Sciences*, 8(2), 294–301. <https://doi.org/10.31258/jes.8.2.p.294-301>
- Lee, J., & Junoh, J. (2019). Implementing Unplugged Coding Activities in Early Childhood Classrooms. *Early Childhood Education Journal*, 47(6), 709–716. <https://doi.org/10.1007/s10643-019-00967-z>
- Louka, K., & Papadakis, S. (2024). Enhancing Computational Thinking in Early Childhood Education Through ScratchJr Integration. *Heliyon*, 10(10), e30482. <https://doi.org/10.1016/j.heliyon.2024.e30482>
- Nangle, D. W., Erdley, C. A., & Schwartz-Mette, R. A. (Eds.). (2020). *Social Skills Across the Life Span: Theory, Assessment, and Intervention*. Academic Press. <https://doi.org/10.1016/C2018-0-01560-1>
- OECD. (2023, December 5). *PISA 2022 Results (Volume I and II) – Country Notes: Indonesia*. https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/indonesia_c2e1ae0e-en.html
- Portelance, D. J., Strawhacker, A. L., & Bers, M. U. (2016). Constructing The ScratchJr Programming Language in The Early Childhood Classroom. *International Journal of Technology and Design Education*, 26(4). <https://doi.org/10.1007/s10798-015-9325-0>
- Ratnasari, L. T., Mariatun, I. L., & Arief, Z. (2022). Development of Instagram-Based Learning Media to Increase Learning Motivation of Tenth Grader in Economics Subjects at SMA Ar-Raudhah. *Journal of Educational Sciences*, 6(3), 332–340. <https://doi.org/10.31258/jes.6.3.p.332-340>
- Relkin, E., De Ruiter, L. E., & Bers, M. U. (2021). Learning to Code and The Acquisition of Computational Thinking by Young Children. *Computers & Education*, 169, 104222. <https://doi.org/10.1016/j.compedu.2021.104222>
- Ryan, R. M., & Deci, E. L. (2020). Intrinsic and Extrinsic Motivation from a Self-Determination Theory Perspective: Definitions, Theory, Practices, and Future Directions. *Contemporary Educational Psychology*, 61, 101860. <https://doi.org/10.1016/j.cedpsych.2020.101860>
- Su, J., & Yang, W. (2023). A Systematic Review of Integrating Computational Thinking in Early Childhood Education. *Computers and Education Open*, 4, 100122. <https://doi.org/10.1016/j.caeo.2023.100122>
- Threekunprapa, A., & Yasri, P. (2020). Unplugged Coding Using Flowblocks for Promoting Computational Thinking and Programming Among Secondary School Students. *International Journal of Instruction*, 13(3), 207–222. <https://doi.org/10.29333/iji.2020.13314a>
- Turan, S., & Aydoğdu, F. (2020). Effect of Coding and Robotic Education on Pre-School Children's Skills of Scientific Process. *Education and Information Technologies*, 25, 4353–4363. <https://doi.org/10.1007/s10639-020-10178-4>
- Wahyuni, R., Firdaus LN, F. L., Putra, R. A., Linggasari, M. N., Wulandari, P. A., & Fadilah, M. (2025). Project-Based Learning (PjBl) Green Pedagogy E-Module in Improving Creative Thinking and Digital Literacy. *Journal of Educational Sciences*, 9(2), 876–885. <https://doi.org/10.31258/jes.9.2.p.876-885>
-

- Wing, J. M. (2006). Computational Thinking. *Communications of the ACM*, 49(3), 33–35. <https://doi.org/10.1145/1118178.1118215>
- Yang, W. (2024). Coding With Robots or Tablets? Effects of Technology-Enhanced Embodied Learning on Preschoolers' Computational Thinking and Social-Emotional Competence. *Journal of Educational Computing Research*, 62(4), 718–740. <https://doi.org/10.1177/07356331241226459>

How to cite this article:

Wahyuningsih, D., & Lukas, S. (2026). Effectiveness of Coding-Based Learning on Computational Thinking, Social Skills, and Learning Motivation in Early Childhood. *Journal of Educational Sciences*, 10(10), 93-110.
