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# Coding-Based Learning as a Pedagogical Space for Fostering Critical Thinking and Socio-Religious Values in an Islamic Elementary School

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## *Abstract*

Digital transformation in elementary education requires the integration of cognitive competence development and socio-religious character formation. Within the framework of multicultural and multireligious education, technology should not merely function as an instructional tool, but as a contextual and reflective space for value internalization. This study aims to analyze the contribution of coding-based learning using the Code.org platform to the development of students' critical thinking skills and the emergence of socio-religious values in an Islamic elementary school. This research employed a mixed-method approach with a convergent parallel design. Quantitative data were collected through learning analytics obtained from the teacher dashboard, while qualitative data were gathered through structured classroom observations. The participants consisted of nine third- and fourth-grade students who completed twenty-eight challenges in the 2021 Express Course. The findings indicate that 55.6 percent of students achieved a very high level of critical thinking, while 44.4 percent achieved a high level. The mean dashboard score was 319.4 out of a maximum of 400. Coding activities also facilitated the authentic emergence of cooperation, responsibility, patience, discipline, and respect during collaborative problem-solving processes. The study highlights that coding-based learning can function as an integrative pedagogical space bridging digital literacy and character education within a multicultural and multireligious educational framework.

***Keywords:*** *Coding-Based Learning; Critical Thinking; Socio-Religious Values; Multicultural Education; Islamic Elementary School*

## *Introduction*

Rapid technological advancement has reshaped elementary education in both cognitive and value-oriented dimensions. Twenty-first-century education requires not only technological competence but also the development of critical thinking and socio-religious awareness necessary for living in plural societies. Multicultural and multireligious education emphasizes learning environments that cultivate ethical awareness, tolerance, and social responsibility (Nashrulloh et al., 2024).

In Islamic elementary schools, the integration of religious values is an inherent component of the educational process. Religious education functions not only as normative instruction but also as a reflective space for character development through contextual practice (Annur et al., 2023; Taabudilah et al., 2023). Ilham et al. (2023) argue that value internalization in Islamic education strengthens students' holistic character formation.

Meanwhile, coding education has increasingly been introduced at the elementary level as a means of developing computational thinking, including decomposition, abstraction, algorithmic reasoning, and debugging (Liao et al., 2024; Kastner-Hauler et al., 2022). However, existing studies primarily emphasize technical and cognitive outcomes, while the integration of socio-religious values remains underexplored.

Block-based programming environments such as Scratch and Code.org engage students in iterative problem-solving processes that require reflection and self-regulation (Fagerlund, 2021; Stewart & Baek, 2023). Such processes may serve as meaningful contexts for character formation, particularly in value-oriented educational settings.

Therefore, this study investigates how coding-based learning can foster critical thinking while simultaneously facilitating the emergence of socio-religious values within a multicultural and multireligious educational context in an Islamic elementary school.

## *Methodology*

### Research Design

This study employed a mixed-method approach using a convergent parallel design. Quantitative and qualitative data were collected simultaneously, analyzed separately, and then integrated during the interpretation phase to obtain a comprehensive understanding of the research problem. This design enabled data triangulation and enhanced the validity of the findings (Artikel, 2025).

### Research Context and Participants

The research was conducted within an extracurricular coding program at an Islamic elementary school. The participants consisted of nine third- and fourth-grade students who completed the 2021 Express Course on the Code.org platform.

### Learning Activities

Coding instruction was implemented using the 2021 Code.org Express Course. Students were assigned to complete twenty-eight coding challenges involving block-based programming structures such as sequencing, loops, and conditional logic.

Each challenge required students to analyze the problem, construct a logical solution, test their program, and revise their code when errors occurred. The instructional process emphasized independent problem-solving while also encouraging peer interaction within a structured learning environment.

### *Research Instruments*

#### Critical Thinking Indicators

Students' critical thinking skills were measured using learning analytics obtained from the Code.org teacher dashboard. Five indicators were operationalized within the coding context.

| No | Critical Thinking Indicator | Operational Description | Code.org Data Source |
|---|---|---|---|
| 1 | Problem Analysis | Ability to understand the solution requirements of each challenge | Number of completed challenges |
| 2 | Logical Inference | Accuracy in arranging code blocks logically | Success rate / completion rate |
| 3 | Evaluation (Debugging) | Ability to identify and correct errors | Number of attempts |
| 4 | Reflective Reasoning | Willingness to attempt alternative solutions after failure | Retry patterns |
| 5 | Self-Regulation | Consistency in completing tasks independently | Progress consistency |

Critical thinking is defined as a systematic mental process involving analysis, evaluation, and rational conclusion-making in solving problems.

#### Critical Thinking Scoring Criteria

Dashboard scores were converted into four levels of critical thinking. The maximum dashboard score was 400.

| Score | General Criteria |
|---|---|
| 1 | Does not demonstrate critical thinking indicators |
| 2 | Demonstrates indicators with frequent errors |
| 3 | Demonstrates indicators accurately with minor errors |
| 4 | Demonstrates indicators consistently and independently |

| Score | Criteria |
|---|---|
| 1 | Unable to correct errors |
| 2 | Corrects errors with intensive assistance |
| 3 | Corrects errors with minimal guidance |
| 4 | Corrects errors independently |

#### Dashboard Interpretation Rubric

| Dashboard Completion | Interpretation | Score |
|---|---|---|
| ≥ 90% | Excellent analysis and inference | 4 |
| 70–89% | Good | 3 |
| 50–69% | Moderate | 2 |
| < 50% | Low | 1 |

| Number of Attempts | Interpretation | Score |
|---|---|---|
| 1–2 attempts | Excellent evaluation | 4 |
| 3–4 attempts | Good | 3 |
| 5–6 attempts | Moderate | 2 |
| > 6 attempts | Low | 1 |

### Observation of Socio-Religious Values

Socio-religious values were measured through structured classroom observation during coding sessions.

| No | Social and Religious Values | Observed Behavioral Indicators |
|---|---|---|
| 1 | Collaboration | Students help classmates who experience difficulties in completing coding challenges. |
| 2 | Responsibility | Students complete the assigned coding tasks without abandoning them. |
| 3 | Perseverance | Students continue trying and do not give up easily when the program encounters errors. |
| 4 | Respect | Students appreciate differences in their classmates' abilities and do not underestimate others' work. |
| 5 | Discipline | Students follow the established rules and procedures during coding activities. |

| Score | Category | Description |
|---|---|---|
| 1 | Not observed | Behavior does not appear |
| 2 | Occasionally observed | Behavior appears with guidance |
| 3 | Observed | Behavior frequently appears independently |
| 4 | Highly observed | Behavior consistently appears and becomes exemplary |

### Data Collection and Analysis Procedures

Quantitative data were automatically collected from the Code.org teacher dashboard after students completed assigned coding challenges. Qualitative data were gathered through direct classroom observation conducted by the teacher-researcher during extracurricular sessions.

Quantitative data were analyzed using descriptive statistics including mean, percentage, and categorical distribution to describe students' critical thinking profiles. Qualitative data were analyzed thematically to identify recurring patterns related to socio-religious values. The integration of both data sources provided a comprehensive interpretation of how coding-based learning supports critical thinking and character development.

### Ethical Considerations

Ethical principles were applied throughout the research. Student participation was voluntary, and identities were anonymized to ensure confidentiality. Institutional permission was obtained from the school administration, and data were used solely for research purposes.

## *Results and Discussion*

### Critical Thinking Score Distribution

The highest dashboard score was 399 out of 400.

| Score Range | Percentage | Critical Thinking Level | Score Range |
|---|---|---|---|
| 320–400 | 80–100% | Very High | 320–400 |
| 240–319 | 60–79% | High | 240–319 |
| 160–239 | 40–59% | Moderate | 160–239 |
| < 160 | < 40% | Low | < 160 |

This rubric is defensible, simple, and consistent with descriptive studies.

**Student Critical Thinking Profile Based on Code.org Dashboard Data**

| No | Student | Dashboard Score | Level |
|---|---|---|---|
| 1 | Student 1 | 326 | Very High |
| 2 | Student 2 | 263 | High |
| 3 | Student 3 | 365 | Very High |
| 4 | Student 4 | 270 | High |
| 5 | Student 5 | 302 | High |
| 6 | Student 6 | 331 | Very High |
| 7 | Student 7 | 259 | High |
| 8 | Student 8 | 399 | Very High |
| 9 | Student 9 | 362 | Very High |

Very High: 5 students (55.6%)
High: 4 students (44.4%)
Moderate/Low: 0 students
The mean dashboard score was 319.4, indicating an overall high performance level.

**Observasi Social and Religious Values**

| Student | Cooperation | Responsibility | Patience | Respect | Discipline | Notes |
|---|---|---|---|---|---|---|
| Student 1 | 3 | 4 | 3 | 4 | 3 | Notes Helps friends when they have errors |
| Student 2 | 4 | 3 | 4 | 3 | 4 | Patiently repeats coding |
| Student 3 | 3 | 3 | 4 | 4 | 3 | Very polite when asking questions to the teacher |
| Student 4 | 4 | 3 | 4 | 3 | 3 | Always prays when solving coding problems |
| Student 5 | 3 | 3 | 3 | 4 | 4 | Always arrives on time for coding lessons |
| Student 6 | 4 | 4 | 4 | 3 | 3 | Enjoys solving coding problems with friends |
| Student 7 | 3 | 4 | 3 | 3 | 3 | Likes sharing coding knowledge when friends are having difficulties |
| Student 8 | 4 | 3 | 4 | 3 | 3 | Never gives up on solving coding problems |
| Student 9 | 4 | 4 | 4 | 3 | 3 | Takes responsibility for the group in solving coding problems |

Students who achieved a very high level of critical thinking also tended to demonstrate positive socio-religious values such as patience and responsibility, particularly when revising solutions after repeated coding errors.

Students' critical thinking skills were analyzed using learning analytics data obtained from the Code.org teacher dashboard. The dashboard score represents students' overall progress in completing challenges in the 2021 Express Course, with a maximum score of 400. These scores were then categorized into four critical thinking levels: Very High, High, Moderate, and Low.

**Students' Dashboard Scores and Critical Thinking Levels**

| No | Student | Dashboard Score | Critical Thinking Level |
|---|---|---|---|
| 1 | Student 1 | 326 | Very High |
| 2 | Student 2 | 263 | High |
| 3 | Student 3 | 365 | Very High |
| 4 | Student 4 | 270 | High |
| 5 | Student 5 | 302 | High |
| 6 | Student 6 | 331 | Very High |
| 7 | Student 7 | 259 | High |
| 8 | Student 8 | 399 | Very High |
| 9 | Student 9 | 362 | Very High |

**Very High:** 5 students (55.6%)
**High:** 4 students (44.4%)
**Moderate/Low:** 0 students

The mean dashboard score was **319.4**, indicating an overall high level of performance. The absence of moderate or low categories suggests strong engagement and accessibility of coding activities for all participants.

**Narrative Analysis of Critical Thinking Outcomes**

The findings indicate that students demonstrated high to very high levels of critical thinking during coding-based learning activities. Of the nine participants, five students (55.6%) were categorized at the very high level, while four students (44.4%) were categorized at the high level. No students fell into the moderate or low categories.

Students classified in the very high category exhibited strong abilities in problem analysis, logical solution construction, and independent code revision when errors occurred. They were able to complete most challenges with minimal assistance, reflecting well-developed self-regulation and reflective reasoning skills. In contrast, students in the high category were generally capable of completing the challenges independently but required additional attempts during the debugging process, particularly when confronted with more complex logical structures.

This discussion connects the empirical findings with relevant theoretical perspectives and positions coding-based learning not merely as a technical activity, but as a pedagogical medium that strengthens cognitive skills alongside social and religious values.

**1. Coding-Based Learning and the Development of Critical Thinking**

The results show that most students achieved high to very high levels of critical thinking. This suggests that coding-based learning through the Code.org platform provides meaningful opportunities for elementary school students to develop critical thinking skills through authentic problem-solving activities.

The integration of Scratch into various subject areas through programming activities has been shown not only to function as a coding lesson but also to enhance learning outcomes and computational thinking skills (Stewart & Baek, 2023).

In each coding challenge, students were required to understand the problem, construct logical sequences, test solutions, and revise programs when errors occurred. This process aligns with the core components of critical thinking, namely analysis, inference, evaluation, and self-regulation. Thus, coding

activities function not only as technical exercises but also as structured learning experiences that promote reflective and systematic thinking.

According to Irwan and Aslan (2024), the Merdeka Curriculum provides broad opportunities to develop critical thinking skills through flexible and student-centered learning approaches. This curriculum encourages exploration, experimentation, and inquiry-based learning, enabling students to engage in deeper and more reflective thinking processes. Emphasis on project-based learning, problem-solving, and group discussions helps students develop analytical, evaluative, and creative abilities from an early age.

These findings also support the view that visual programming environments are appropriate for elementary school students, as they allow experiential learning without the cognitive burden of complex programming syntax. Furthermore, combining block-based programming with physical computing devices has been identified as a promising approach for enhancing computational thinking skills in elementary classrooms (Kastner-Hauler et al., 2022).

**2. Coding as a Medium for Self-Regulation and Persistence**

High dashboard scores also reflect students' ability to regulate their learning processes, particularly when facing repeated errors during debugging. The iterative nature of coding encourages students to remain persistent, attempt alternative solutions, and reflect on their mistakes.

Kurniawan et al. (2023) emphasize that mathematical process skills and learning persistence are key indicators of student success. A lack of persistence and process skills may hinder effective knowledge acquisition. Within the coding context, persistence and patience emerged as essential dispositions that support higher-order thinking.

In this sense, coding-based learning serves as a medium for cultivating perseverance and resilience. These dispositions are integral to critical thinking, as higher-level cognitive processes depend not only on intellectual capacity but also on students' willingness to engage in sustained and challenging thinking activities.

**3. Integration of Social Values in Coding Activities**

In addition to cognitive development, observational data revealed that coding activities fostered positive social values, such as cooperation, mutual assistance, and respect for differences in ability. When encountering difficulties, students' interactions tended to be collaborative rather than competitive.

In Scratch-based learning environments, solutions can be shared and remixed as forms of collaboration, enabling students to receive feedback and gain new ideas from others. During programming activities, students also begin to recognize that previously created code structures can be reused in new projects, introducing them to concepts of patterns and generalization (Fagerlund, 2021).

These findings indicate that coding-based learning can function as a social learning space that encourages students to support one another in problem-solving. In heterogeneous classrooms, such practices align with multicultural education principles that emphasize mutual respect, cooperation, and inclusive learning environments.

**4. Religious Values in the Context of an Islamic Elementary School**

Within the context of an Islamic elementary school, values such as responsibility, discipline, patience, and respect play a central role in character education. The findings reveal that these values emerged naturally during coding activities, without explicit moral instruction.

Taabudilah et al. (2023) demonstrate that Islamic religious education not only focuses on doctrinal understanding but also strengthens social and ethical values within community life. Coding tasks require students to complete assignments responsibly, follow established procedures, and remain patient when facing difficulties. Such behaviors are consistent with Islamic educational principles that emphasize character formation through habituation and authentic practice.

Therefore, coding-based learning can be viewed as a contextual and relevant medium for integrating technology education with character and religious education.

### 5. Implications for Multicultural and Multireligious Education

The findings carry significant implications for multicultural and multireligious education. Although the study was conducted in an Islamic school context, the social and religious values observed are universal and transferable to diverse educational settings.

Nashrulloh et al. (2024) found that integrating religious and multicultural education strengthens elementary students' character by embedding values such as equality, unity, justice, kinship, tolerance, and peace within curriculum and instructional practices.

Coding-based learning enables students from diverse backgrounds to learn together, collaborate, and develop mutual respect. When designed appropriately, educational technology can serve as a bridge between twenty-first-century skill development and the reinforcement of humanistic values central to multicultural and multireligious education.

Technology-assisted learning media should therefore cultivate character values, not only as a means of delivering instructional content but also as vehicles for moral development (Guru et al., 2026).

### 6. Research Limitations

This study has several limitations. The relatively small number of participants and the focus on extracurricular activities limit the generalizability of the findings. Additionally, critical thinking was measured through learning analytics data, which may not fully represent students' critical thinking abilities beyond the coding context.

Nevertheless, these limitations do not diminish the value of this study as a contextual exploration providing in-depth insights into the potential of coding-based learning to support critical thinking development and socio-religious value formation among elementary school students.

## *Conclusion and Implications*

### Conclusion

This study examined the implementation of coding-based learning through the Code.org platform in an elementary school extracurricular program and its contribution to students' critical thinking skills and socio-religious values. The findings indicate that most students achieved high to very high performance levels in completing coding challenges, reflecting the development of analytical thinking, logical reasoning, and self-regulation throughout the learning process.

Beyond cognitive development, the learning activities also facilitated the emergence of positive socio-religious values, including cooperation, responsibility, patience, discipline, and respect. These values developed naturally through student interaction, particularly during problem-solving and debugging activities, without explicit moral instruction. This suggests that coding-based learning can serve as a meaningful context for character education when it is thoughtfully designed and implemented.

Overall, the study demonstrates that coding education at the elementary level is not limited to the development of technical skills. Rather, it supports holistic learning that integrates cognitive growth with the formation of social and religious character.

### *Implications*

The findings of this study carry important implications for educational practice, institutional policy, and future research.

From a pedagogical perspective, coding-based learning using visual programming platforms such as Code.org can be effectively integrated into elementary education to foster critical thinking while simultaneously supporting character education. Teachers are encouraged to view coding activities not merely as technical exercises, but as opportunities to cultivate perseverance, collaboration, and ethical behavior.

From an institutional perspective, schools—particularly those with multicultural and multireligious orientations—may consider integrating coding programs into both curricular and extracurricular activities as a strategy to align digital literacy with socio-religious values. Such integration has the potential to create inclusive and collaborative learning environments that promote both twenty-first-century competencies and humanistic values.

From a research perspective, this study highlights the potential of learning analytics data as an alternative approach for examining students' cognitive processes within authentic learning contexts. Future research is recommended to involve larger participant samples, diverse school settings, and expanded mixed-method designs to gain deeper insights into the long-term impact of coding-based learning on critical thinking development and character formation.

### *Author Contributions*

Eka Prasetya Rahmawan conceptualized and designed the study, conducted the literature review, collected and analyzed the quantitative and qualitative data, and drafted the manuscript Wuri Wuryandani contributed to the development of the research methodology, provided critical revisions to the analysis and discussion sections, and offered substantial feedback on the interpretation of the findings. Firmansyah supervised the overall research process, refined the theoretical framework related to multicultural and multireligious education, and reviewed and approved the final version of the manuscript.

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