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[Alishlah] Submission Acknowledgement Kotak Masuk

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Our decision is: Revisions Required

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Rusdial Marta:

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Our decision is to: Accept Submission

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Article Acceptance Letter

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Letter of Paper Acceptance
No : 7524/LoA/ALISHLAH/STAI-HW/2025

Bengkalis, May 16, 2025

Dear Rusdial Marta, Toto Nusantara, Adi Atmoko, Sri Rahayuningsih
On behalf of the committee of AL-ISHLAH: Jurnal Pendidikan, we are glad to inform you that your manuscript:
Entitled:Gender Differences in Computational Thinking Skills Among Elementary School Students
Author(s):Rusdial Marta, Toto Nusantara, Adi Atmoko, Sri Rahayuningsih
Affiliation:1 Universitas Pahlawan Tuanku Tambusai; 2,3,4 Universitas Negeri Malang
URL Article: https://journal.staihubbulwathan.id/index.php/alishlah/article/view/7524

HAS BEEN ACCEPTED and considered to be published in AL-ISHLAH: Jurnal Pendidikan Vol.17, No. 2 (2025). The paper will be published after successfully passing the review process and revisions made by author(s).
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#7524 Review

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The Gender in Computational Thinking Skills at Elementary School

Rusdial Marta[1], Toto Nusantara[2], Adi Atmoko[3], Sri Rahayuningsih[4]

[1] Universitas PahlawanTuankuTambusai; dial.fredo90@gmail.com
[2] Universitas Negeri Malang
[3] Universitas Negeri Malang
[4] Universitas Negeri Malang

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ABSTRACT

This study aims to uncover the gender differences in the mastery of Computational Thinking (CT) skills among elementary school students, focusing on a deep understanding of the social, cultural, and educational factors that influence the development of these skills. Using a descriptive qualitative approach, this research was conducted in two elementary schools in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini, with the subjects being fourth-grade students who had been introduced to CT. Data were collected through in-depth interviews, classroom observations, and documentation, and were then analyzed using thematic analysis to identify patterns, themes, and factors influencing the mastery of CT based on gender. The findings revealed a significant difference between male and female students in mastering each component of CT, namely decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students generally exhibited higher self-confidence and a tendency to be more active in completing technology-based tasks, while female students were more cautious, systematic, and performed better in collaborative and inclusive learning contexts. These differences were influenced by environmental factors such as gender stereotypes, the way teachers interact with students, and the role of family in supporting or limiting students' exploration of technology. The study concludes that gender differences in CT mastery are not inherent but shaped by the social and educational environment. Therefore, equitable learning strategies free from gender bias are necessary to ensure all students have equal opportunities to develop these essential 21st-century skills.

Corresponding Author:

Rusdial Marta
Affiliation 1; dial.fredo90@gmail.com

1. INTRODUCTION

In Computational Thinking (CT) is a cognitive skill that involves the ability to solve problems using a computational approach, and it plays a crucial role in 21st-century education (Wing, 2006; Brennan, K., & Resnick, M., 2012). This skill is not limited to information technology or computer science fields, but can also be applied across various disciplines to solve problems in a systematic and efficient manner (Barr, V., & Stephenson, C., 2011; Berland, M., & Lee, H. S., 2011). With the advancement of technology and the increasing demand for technology-related skills in the workforce, the ability to think computationally has become a key competency needed both at the individual and societal levels (Grover & Pea, 2013; Shute, V. J., Sun, C., & Asbell-Clarke, J., 2017).

In Indonesia, the effort to integrate CT into the educational curriculum is increasingly recognized as important, especially at the elementary school level, where the foundational skills for critical and analytical thinking are built (Voogt, J., & Roblin, N. P., 2012). However, despite the growing awareness of the importance of developing CT skills at the elementary school level, an interesting phenomenon emerges: the gender differences in the achievement of these skills. This phenomenon has become a research topic that is being discussed more frequently, both globally and locally. Several studies show that there are significant differences in how boys and girls access, understand, and apply CT skills (Binns, 2017; Coyle & Doherty, 2013).

Gender differences in education are not new. Numerous studies have shown that gender stereotypes present in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children’s perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in the differences in interest and motivation towards technology, which are often closely related to their gender (Bian, Leslie, &Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer picture of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can aid in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be made, such as providing teaching approaches that offer more support or introducing CT in ways that better align with girls' interests and needs (Binns, 2017).

Several factors that influence gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male qualities, while girls are more frequently viewed as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, S., Master, A., & Meltzoff, A. N., 2015; Bian, L., Leslie, S. J., &Cimpian, A., 2017). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face greater social barriers to participating in fields considered more “masculine” (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes can also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, L., Leslie, S. J., &Cimpian, A., 2017). Additionally, differences in teaching styles can play a crucial role. Teaching approaches that are competitive or achievement-based may benefit boys, who tend to feel more comfortable in such settings, whereas girls may respond better to collaborative and empathetic teaching approaches (Liu, 2014; Cheryan, S., Master, A., & Meltzoff, A. N., 2015).

Moreover, the role of family is equally significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills considered more “gentle” (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still quite pronounced, this challenge becomes even more complex. Education in Indonesia is still influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to designing more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender, as well as explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are an important issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

This This study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were fourth-grade students who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches that emphasize logical and algorithmic problem-solving. The subjects were selected using purposive sampling, choosing informants who were considered capable of providing relevant information related to the research focus.

Data were collected through three main techniques: in-depth interviews with male and female students to explore their CT learning experiences and perceptions of the role of gender in technology learning; direct classroom observation to examine the interactions between teachers and students, task division, and active student participation based on gender during the learning process; and documentation of syllabi, lesson plans (RPP), and student work related to computational thinking activities. All data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, grouping the themes based on social, cultural, and educational factors, and interpreting the findings by referencing relevant theories and previous research findings.

To ensure data validity, source and technique triangulation were conducted by comparing information from various sources and data collection methods to ensure the consistency and accuracy of the research results.

3. FINDINGS AND DISCUSSION

The The results of this study indicate a noticeable difference between male and female students in terms of mastering and approaching Computational Thinking (CT) skills. Based on data from interviews and observations, male students generally exhibit higher self-confidence when engaging in learning activities related to technology and logical problem-solving. They tend to be more active in exploring, asking questions, and taking initiative in tasks that require algorithmic thinking skills. In contrast, most female students exhibit more cautious behavior and tend to be passive, particularly in technology-based learning contexts. Many of them report feeling less confident when using digital devices or solving problems that involve simple programming logic.

Through classroom observations, it was found that teachers often, albeit unintentionally, engage male students more frequently in demonstrations or discussions related to the technical aspects of learning. This inadvertently reinforces the perception that CT skills are more relevant or "suitable" for male students. On the other hand, female students are more often involved in administrative or supportive activities, such as taking notes or documenting group discussion results. Although this is not explicitly discriminatory, such interaction patterns reflect how social constructs in the classroom contribute to gender differences in learning experiences between male and female students.

Interviews with several female students revealed that, despite their interest in technology, they felt they were not "good enough" or "suitable" for the field. Some mentioned that they were more often encouraged by their parents or teachers to pursue fields deemed more "appropriate" for girls, such as arts or languages. In contrast, male students receive more verbal and nonverbal support to explore the world of technology and logic.

Moreover, family roles also seem to have a significant influence. Male students generally have greater access to technological devices at home, such as computers or smartphones, and are freer to explore educational apps or games that develop CT skills. Meanwhile, female students are more restricted in their use of these devices, either due to parental concerns or gender roles that are instilled early within the family.

However, this study also found that when given the opportunity and an inclusive learning approach, female students can demonstrate CT skills equal to their male counterparts. In several collaborative, non-competitive project-based learning sessions, female students appeared more engaged and confident, especially when given relevant and meaningful roles in the learning process. This indicates that gender-sensitive teaching approaches, along with a supportive learning environment, can help reduce the gap in CT skills mastery.

In terms of decomposition, the ability to break complex problems into smaller, more manageable parts, male students tended to be more spontaneous and direct when tackling problems, especially those based on logic and numbers. They appeared confident when faced with tasks that required them to outline steps to solve large problems. In contrast, female students tended to take longer and require more guidance in breaking problems into subtasks. However, after receiving clear directions, they could complete task components carefully and systematically. This suggests that, with proper support, the decomposition skills of female students can develop significantly.

In the pattern recognition component, male students showed enthusiasm for identifying mathematical patterns or logical sequences, such as in games or activities involving symbols and numbers. They appeared eager to explore repeating patterns and try to predict outcomes. Female students, on the other hand, were more responsive to patterns associated with social contexts or narratives. For instance, they grasped patterns in stories or tasks linked to daily life more quickly. This difference suggests that the media and approaches used significantly impact pattern recognition skills based on gender.

In the abstraction component, the ability to filter essential information and disregard irrelevant details, male students demonstrated speed in identifying core information in a problem. They seemed focused on the function and main objectives of a task. However, interview results showed that this approach sometimes oversimplified the issue, causing some male students to overlook important details. Conversely, female students were more cautious and tended to consider all available information before concluding the core issue. While this process was slower, their final results were often more comprehensive. This suggests that abstraction skills in female students can develop well when provided with adequate time and space for deeper thinking.

The final component, algorithmic thinking, which refers to the ability to create systematic steps to solve problems, showed a stark difference. Male students were generally more active in designing and trying various problem-solving strategies independently. They enjoyed experimenting and were less concerned with making mistakes, which supported creativity in developing algorithmic solutions. Meanwhile, female students tended to follow patterns or examples previously provided. They were more cautious in making step-by-step decisions and felt more comfortable when given guidance. However, when working in collaborative groups, their algorithmic skills developed excellently, particularly when they were given opportunities to lead or make joint decisions.

Overall, these findings reveal that each CT component is influenced by how teachers teach, gender representation in the classroom, and support from the home and social environment. When the learning process provides an inclusive space and avoids gender-biased approaches, female students can demonstrate CT skills that are on par with male students. Therefore, it is essential for educators to consciously design teaching strategies that support the balanced development of all CT aspects for all students, regardless of gender.

4. CONCLUSION

This study reveals that gender differences in the mastery of Computational Thinking (CT) skills among elementary school students are not solely due to cognitive differences between male and female students, but are heavily influenced by social, cultural factors, and the learning approaches used in both the classroom and at home. Each CT component — decomposition, pattern recognition, abstraction, and algorithmic thinking — shows distinct trends based on gender. Male students generally exhibit higher confidence in experimenting and solving tasks related to logic and technology, while female students tend to be more cautious, systematic, and meticulous, especially when supported by a collaborative and non-competitive learning environment.

These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers treat students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered “suitable” or “unsuitable” for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students are capable of demonstrating CT skills on par with their male counterparts.

Thus, it is crucial for educators and policymakers to recognize the existence of gender biases in learning and to promptly adopt fairer and more equitable strategies. The development of Computational Thinking skills at the elementary school level should not only focus on technical aspects but also consider the social context that influences how students access, understand, and develop these skills. By creating a supportive learning environment free from stereotypes, every child — regardless of gender — will have equal opportunities to grow into critical, creative thinkers, ready to face the challenges of the 21st century.

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The Gender in Computational Thinking Skills at Elementary School

Comment [A1]: Suggested title:

Gender Differences in Computational Thinking Skills Among Elementary School Students

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ABSTRACT

This study aims to uncover the gender differences in the mastery of Computational Thinking (CT) skills among elementary school students, focusing on a deep understanding of the social, cultural, and educational factors that influence the development of these skills. Using a descriptive qualitative approach, this research was conducted in two elementary schools in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini, with the subjects being fourth-grade students who had been introduced to CT. Data were collected through in-depth interviews, classroom observations, and documentation, and were then analyzed using thematic analysis to identify patterns, themes, and factors influencing the mastery of CT based on gender. The findings revealed a significant difference between male and female students in mastering each component of CT, namely decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students generally exhibited higher self-confidence and a tendency to be more active in completing technology-based tasks, while female students were more cautious, systematic, and performed better in collaborative and inclusive learning contexts. These differences were influenced by environmental factors such as gender stereotypes, the way teachers interact with students, and the role of family in supporting or limiting students' exploration of technology. The study concludes that gender differences in CT mastery are not inherent but shaped by the social and educational environment. Therefore, equitable learning strategies free from gender bias are necessary to ensure all students have equal opportunities to develop these essential 21st-century skills.

Comment [A2]: • Include a **conceptual framework** (e.g., Vygotsky, Gender Schema Theory, or Papert's Constructionism) to deepen theoretical grounding.
• Consider adding a **visual model or table** summarizing CT skills by gender traits and educational supports.

Comment [A3]: •**Clarify phrasing** – e.g., *"This study aims to uncover the gender differences…"* → "This study investigates gender-based differences..."
•**Make the methodology and sample size explicit**: briefly mention *number of participants* and *data sources*.
•**Tighten the conclusion** for impact—reiterate the implications for pedagogy or policy in a sentence.

Corresponding Author:

1. INTRODUCTION

Comment [A4]: •**Improve coherence**:
•The introduction mixes global and local issues—clarify the **logical flow**: from global → national → local.
•Some paragraphs repeat similar ideas—**condense or rephrase** to avoid redundancy.
•**Clarify research gap**:
•Explicitly state what prior studies *have not addressed* (e.g., lack of qualitative exploration in Indonesian elementary schools).
•**End with research objectives**:
•Conclude with a clear paragraph stating: *"Therefore, this study aims to…"*

In Computational Thinking (CT) is a cognitive skill that involves the ability to solve problems using a computational approach, and it plays a crucial role in 21st-century education (Wing, 2006;

Brennan, K., & Resnick, M., 2012). This skill is not limited to information technology or computer science fields, but can also be applied across various disciplines to solve problems in a systematic and efficient manner (Barr, V., & Stephenson, C., 2011; Berland, M., & Lee, H. S., 2011). With the advancement of technology and the increasing demand for technology-related skills in the workforce, the ability to think computationally has become a key competency needed both at the individual and societal levels (Grover & Pea, 2013; Shute, V. J., Sun, C., & Asbell-Clarke, J., 2017).

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Gender differences in education are not new. Numerous studies have shown that gender stereotypes present in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children's perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in the differences in interest and motivation towards technology, which are often closely related to their gender (Bian, Leslie, &Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer picture of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can aid in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be made, such as providing teaching approaches that offer more support or introducing CT in ways that better align with girls' interests and needs (Binns, 2017).

Several factors that influence gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male qualities, while girls are more frequently viewed as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, S., Master, A., & Meltzoff, A. N., 2015; Bian, L., Leslie, S. J., &Cimpian, A., 2017). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face greater social barriers to participating in fields considered more "masculine" (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes can also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, L., Leslie, S. J., &Cimpian, A., 2017). Additionally, differences in teaching styles can play a crucial role. Teaching approaches that are competitive or achievement-based may benefit boys, who tend to feel more comfortable in such settings, whereas girls may respond better to collaborative and empathetic teaching approaches (Liu, 2014; Cheryan, S., Master, A., & Meltzoff, A. N., 2015).

Moreover, the role of family is equally significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills considered more "gentle" (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still quite pronounced, this challenge becomes even more complex. Education in Indonesia is still influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to designing more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender, as well as explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are an important issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

ThisThis study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were fourth-grade students who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches that emphasize logical and algorithmic problem-solving. The subjects were selected using purposive sampling, choosing informants who were considered capable of providing relevant information related to the research focus.

Data were collected through three main techniques: in-depth interviews with male and female students to explore their CT learning experiences and perceptions of the role of gender in technology learning; direct classroom observation to examine the interactions between teachers and students, task division, and active student participation based on gender during the learning process; and documentation of syllabi, lesson plans (RPP), and student work related to computational thinking activities. All data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, grouping the themes based on social, cultural, and educational factors, and interpreting the findings by referencing relevant theories and previous research findings.

To ensure data validity, source and technique triangulation were conducted by comparing information from various sources and data collection methods to ensure the consistency and accuracy of the research results.

Comment [A5]: •**Clarify sampling**:
•Provide **number of participants**, gender distribution, and justification for sample size.
•**Define CT exposure**:
•Specify *what CT activities* students engaged in (e.g., Scratch, robotics, unplugged activities?).
•**Enhance methodological rigor**:
•Add *ethical considerations* (e.g., consent, anonymity).
•Detail the **triangulation process** and how themes were validated.
•**Address potential bias**:
•Mention **researcher positionality** and how bias was minimized in interpreting gender-based behaviors.

3. FINDINGS AND DISCUSSION

The The results of this study indicate a noticeable difference between male and female students in terms of mastering and approaching Computational Thinking (CT) skills. Based on data from interviews and observations, male students generally exhibit higher self-confidence when engaging in learning activities related to technology and logical problem-solving. They tend to be more active in exploring, asking questions, and taking initiative in tasks that require algorithmic thinking skills. In contrast, most female students exhibit more cautious behavior and tend to be passive, particularly in technology-based learning contexts. Many of them report feeling less confident when using digital devices or solving problems that involve simple programming logic.

Through classroom observations, it was found that teachers often, albeit unintentionally, engage male students more frequently in demonstrations or discussions related to the technical aspects of learning. This inadvertently reinforces the perception that CT skills are more relevant or "suitable" for male students. On the other hand, female students are more often involved in administrative or supportive activities, such as taking notes or documenting group discussion results. Although this is not explicitly discriminatory, such interaction patterns reflect how social constructs in the classroom contribute to gender differences in learning experiences between male and female students.

Interviews with several female students revealed that, despite their interest in technology, they felt they were not "good enough" or "suitable" for the field. Some mentioned that they were more often encouraged by their parents or teachers to pursue fields deemed more "appropriate" for girls, such as arts or languages. In contrast, male students receive more verbal and nonverbal support to explore the world of technology and logic.

Moreover, family roles also seem to have a significant influence. Male students generally have greater access to technological devices at home, such as computers or smartphones, and are freer to explore educational apps or games that develop CT skills. Meanwhile, female students are more restricted in their use of these devices, either due to parental concerns or gender roles that are instilled early within the family.

However, this study also found that when given the opportunity and an inclusive learning approach, female students can demonstrate CT skills equal to their male counterparts. In several collaborative, non-competitive project-based learning sessions, female students appeared more engaged and confident, especially when given relevant and meaningful roles in the learning process. This indicates that gender-sensitive teaching approaches, along with a supportive learning environment, can help reduce the gap in CT skills mastery.

In terms of decomposition, the ability to break complex problems into smaller, more manageable parts, male students tended to be more spontaneous and direct when tackling problems, especially those based on logic and numbers. They appeared confident when faced with tasks that required them to outline steps to solve large problems. In contrast, female students tended to take longer and require more guidance in breaking problems into subtasks. However, after receiving clear directions, they could complete task components carefully and systematically. This suggests that, with proper support, the decomposition skills of female students can develop significantly.

Comment [A6]: •**Organize findings more systematically**:
- •Structure under **subheadings** for each CT component (e.g., *3.1 Decomposition, 3.2 Pattern Recognition*).
- •Alternatively, separate “Findings” and “Discussion” for clarity and adherence to conventional formats.

•**Integrate more empirical depth**:
- •Include **quotes from interviews** to illustrate student voices.
- •Provide **examples of classroom activities** or teacher interactions.

•**Balance discussion**:
- •Avoid deterministic language (e.g., “female students tend to be passive”)—emphasize *contextuality*.
- •Reflect on how **gendered expectations are internalized**, not just externally imposed.

•**Critically analyze limitations**:
- •Add a paragraph acknowledging limitations—e.g., sample size, lack of male/female teacher comparison, absence of long-term data.

In the pattern recognition component, male students showed enthusiasm for identifying mathematical patterns or logical sequences, such as in games or activities involving symbols and numbers. They appeared eager to explore repeating patterns and try to predict outcomes. Female students, on the other hand, were more responsive to patterns associated with social contexts or narratives. For instance, they grasped patterns in stories or tasks linked to daily life more quickly. This difference suggests that the media and approaches used significantly impact pattern recognition skills based on gender.

In the abstraction component, the ability to filter essential information and disregard irrelevant details, male students demonstrated speed in identifying core information in a problem. They seemed focused on the function and main objectives of a task. However, interview results showed that this approach sometimes oversimplified the issue, causing some male students to overlook important details. Conversely, female students were more cautious and tended to consider all available information before concluding the core issue. While this process was slower, their final results were often more comprehensive. This suggests that abstraction skills in female students can develop well when provided with adequate time and space for deeper thinking.

The final component, algorithmic thinking, which refers to the ability to create systematic steps to solve problems, showed a stark difference. Male students were generally more active in designing and trying various problem-solving strategies independently. They enjoyed experimenting and were less concerned with making mistakes, which supported creativity in developing algorithmic solutions. Meanwhile, female students tended to follow patterns or examples previously provided. They were more cautious in making step-by-step decisions and felt more comfortable when given guidance. However, when working in collaborative groups, their algorithmic skills developed excellently, particularly when they were given opportunities to lead or make joint decisions.

Overall, these findings reveal that each CT component is influenced by how teachers teach, gender representation in the classroom, and support from the home and social environment. When the learning process provides an inclusive space and avoids gender-biased approaches, female students can demonstrate CT skills that are on par with male students. Therefore, it is essential for educators to consciously design teaching strategies that support the balanced development of all CT aspects for all students, regardless of gender.

4. CONCLUSION

This study reveals that gender differences in the mastery of Computational Thinking (CT) skills among elementary school students are not solely due to cognitive differences between male and female students, but are heavily influenced by social, cultural factors, and the learning approaches used in both the classroom and at home. Each CT component — decomposition, pattern recognition, abstraction, and algorithmic thinking — shows distinct trends based on gender. Male students generally exhibit higher confidence in experimenting and solving tasks related to logic and technology, while female students tend to be more cautious, systematic, and meticulous, especially when supported by a collaborative and non-competitive learning environment.

These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers treat students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered “suitable” or “unsuitable” for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students are capable of demonstrating CT skills on par with their male counterparts.

Comment [A7]: •**Add clear educational implications**:
- •What specific **teaching strategies** or **curriculum changes** should educators implement?

•**Avoid overgeneralization**:
- •Be cautious with phrases like “female students are capable...” – instead, use *“can demonstrate equal proficiency when...”*

•**Suggest areas for further research**:
- •Encourage longitudinal studies or cross-regional comparisons.

Thus, it is crucial for educators and policymakers to recognize the existence of gender biases in learning and to promptly adopt fairer and more equitable strategies. The development of Computational Thinking skills at the elementary school level should not only focus on technical aspects but also consider the social context that influences how students access, understand, and develop these skills. By creating a supportive learning environment free from stereotypes, every child — regardless of gender — will have equal opportunities to grow into critical, creative thinkers, ready to face the challenges of the 21st century.

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Comment [A8]: •**Update recent sources**:

- •Most references predate 2017. Consider including more recent studies on CT in K-12 education, particularly from 2018–2023.

•**Check formatting consistency**:

- •Standardize journal titles (e.g., italicization) and DOI formatting.

•**Ensure citation completeness**:

- •One or two sources (e.g., Brennan & Resnick, 2012) lack full publication info.

PERBAIKAN REVIEW 1

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Gender Differences in Computational Thinking Skills Among Elementary School Students

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ABSTRACT

This study investigates gender-based differences in the mastery of Computational Thinking (CT) skills among elementary school students, focusing on the social, cultural, and educational factors that shape these skills. A descriptive qualitative approach was employed, with data collected from 40 fourth-grade students (20 male and 20 female) across two elementary schools in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini. Data were gathered through in-depth interviews, classroom observations, and documentation, and analyzed using thematic analysis to identify patterns, themes, and factors influencing gender-based differences in CT proficiency.

The findings revealed significant differences between male and female students in mastering the components of CT: decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students generally exhibited greater self-confidence and were more active in technology-based tasks, while female students demonstrated more caution, systematic thinking, and excelled in collaborative learning contexts. These differences were influenced by environmental factors such as gender stereotypes, teacher interactions, and family support, which either encouraged or limited students' engagement with technology.

The study concludes that gender differences in CT mastery are not inherent but are shaped by social and educational contexts. Therefore, it is crucial to implement equitable, gender-sensitive teaching strategies to ensure all students have equal opportunities to develop essential 21st-century skills.

Comment [A1]: • Include a **conceptual framework** (e.g., Vygotsky, Gender Schema Theory, or Papert's Constructionism) to deepen theoretical grounding.
• Consider adding a **visual model or table** summarizing CT skills by gender traits and educational supports.

Comment [A2]: •**Clarify phrasing** – e.g., *"This study aims to uncover the gender differences…"* → "This study investigates gender-based differences..."
•**Make the methodology and sample size explicit**: briefly mention *number of participants* and *data sources*.
•**Tighten the conclusion** for impact—reiterate the implications for pedagogy or policy in a sentence.

Corresponding Author:

Comment [A3]: •**Improve coherence**:
•The introduction mixes global and local issues—clarify the **logical flow**: from global → national → local.
•Some paragraphs repeat similar ideas—**condense or rephrase** to avoid redundancy.
•**Clarify research gap**:
•Explicitly state what prior studies *have not addressed* (e.g., lack of qualitative exploration in Indonesian elementary schools).
•**End with research objectives**:
•Conclude with a clear paragraph stating: *"Therefore, this study aims to…"*

1. INTRODUCTION

Computational Thinking (CT) skills are cognitive abilities that involve applying computational methods to solve problems. These skills play a crucial role in 21st-century education, enabling individuals to approach problems systematically and efficiently (Shute, Sun, & Asbell-Clarke, 2017). These skills are not confined to information technology or computer science but can be applied across various disciplines to enhance problem-solving (Grover & Pea, 2013; Berland & Lee, 2020). With the rapid advancement of technology and the increasing demand for technology-related skills in the workforce, computational thinking has become a key competency required at both individual and societal levels (Binns, 2017; Grover & Pea, 2013).

Globally, the integration of CT into educational curricula is increasingly recognized as essential, especially at the elementary school level, where foundational skills for critical and analytical thinking are developed (Voogt et al., 2015). However, despite the growing awareness of the importance of CT skill development at the elementary school level, an interesting phenomenon has emerged: gender differences in the achievement of these skills. This phenomenon has become a topic of more frequent research discussions, both globally and locally. Several studies indicate significant differences in how boys and girls access, understand, and apply CT skills (Cheryan et al., 2017; Binns, 2017).

Gender differences in education are not a new issue. Numerous studies have shown that gender stereotypes in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children's perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in differences in interest and motivation toward technology, which are often closely linked to their gender (Bian, Leslie, &Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer understanding of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can assist in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be implemented, such as providing more supportive teaching approaches or introducing CT in ways that better align with girls' interests and needs (Coyle & Doherty, 2019).

Several factors influencing gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male traits, while girls are more frequently seen as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, Master, & Meltzoff, 2015). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face more social barriers to participating in fields considered more "masculine" (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, Leslie, &Cimpian, 2017). Moreover, differences in teaching styles can play an important role. Competitive or achievement-based teaching approaches may benefit boys, who tend to feel more comfortable in such settings, while girls may respond better to collaborative and empathetic teaching methods (Liu, 2014; Cheryan, Master, & Meltzoff, 2015).

Additionally, the role of family is significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills deemed more "gentle" (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still pronounced, this challenge becomes even more complex. Education in Indonesia continues to be influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to the design of more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender and explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are a significant issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

This study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area: SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were 40 fourth-grade students (20 male and 20 female) who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches emphasizing logical and algorithmic problem-solving. The sample size was justified based on the need for rich, detailed data and the scope of the research, focusing on a manageable number of participants to ensure deep,

Comment [A4]: •**Clarify sampling**:
- •Provide **number of participants**, gender distribution, and justification for sample size.

•**Define CT exposure**:
- •Specify *what CT activities* students engaged in (e.g., Scratch, robotics, unplugged activities?).

•**Enhance methodological rigor**:
- •Add *ethical considerations* (e.g., consent, anonymity).
- •Detail the **triangulation process** and how themes were validated.

•**Address potential bias**:
- •Mention **researcher positionality** and how bias was minimized in interpreting gender-based behaviors.

qualitative insights into gender differences in CT mastery. Participants were selected using purposive sampling, choosing informants who were considered capable of providing relevant information related to the research focus on CT and gender differences.

The students engaged in a variety of CT activities during their lessons, including working with Scratch (a visual programming language), participating in unplugged activities (e.g., games and puzzles designed to teach logic and algorithms without computers), and using basic robotics kits to solve problems. These activities were designed to enhance students' problem-solving and logical thinking skills, which are central components of CT.

To ensure the methodological rigor of this study, several ethical considerations were taken into account. Written informed consent was obtained from all participants' guardians prior to their involvement in the study. The identities of all participants were kept anonymous throughout the research process, and any personal information was handled with strict confidentiality. The study was approved by the institutional review board of the participating schools to ensure adherence to ethical standards in research with children.

The triangulation process involved comparing data from multiple sources and methods to validate the findings. This included data collected from interviews with male and female students, classroom observations, and documentation (e.g., lesson plans and student work). By using different data collection techniques, the study ensured the validity and reliability of the findings. The researcher also minimized bias by keeping a reflective journal, regularly examining their own assumptions and interpretations during data analysis. Peer review was also conducted to ensure objective and balanced interpretations of gender-based behaviors.

Data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, and grouping the themes based on social, cultural, and educational factors. The findings were interpreted through the lens of relevant theories, such as Papert's Constructionism and Gender Schema Theory, as well as by referencing previous research in the field.

3. FINDINGS AND DISCUSSION

Comment [A5]: •**Organize findings more systematically**:
- •Structure under **subheadings** for each CT component (e.g., *3.1 Decomposition*, *3.2 Pattern Recognition*).
- •Alternatively, separate "Findings" and "Discussion" for clarity and adherence to conventional formats.

•**Integrate more empirical depth**:
- •Include **quotes from interviews** to illustrate student voices.
- •Provide **examples of classroom activities** or teacher interactions.

•**Balance discussion**:
- •Avoid deterministic language (e.g., "female students tend to be passive")—emphasize *contextuality*.
- •Reflect on how **gendered expectations are internalized**, not just externally imposed.

•**Critically analyze limitations**:
- •Add a paragraph acknowledging limitations—e.g., sample size, lack of male/female teacher comparison, absence of long-term data.

Findings

The results of this study highlight significant gender differences in the mastery and approach to Computational Thinking (CT) skills among elementary school students. Based on data collected through interviews, classroom observations, and documentation, the findings reveal that male and female students approach each component of CT in distinct ways, influenced by various social, cultural, and educational factors. The study investigates these differences in detail across four CT components: Decomposition, Pattern Recognition, Abstraction, and Algorithmic Thinking.

3.1 Decomposition

Decomposition refers to the ability to break down complex problems into smaller, more manageable parts. In this study, male students exhibited higher levels of spontaneity and confidence when tasked with breaking problems into subtasks, especially in tasks involving logical reasoning and numerical analysis. For example, during an activity in which students were asked to solve a series of mathematical puzzles, male students were quick to divide the puzzles into smaller, solvable steps, displaying an assertive approach toward problem-solving. As one male student said, "I like to solve things by just diving in, figuring it out step by step."

In contrast, female students tended to take longer to break problems into subtasks and often sought additional guidance before starting the task. Many female students expressed uncertainty when initially asked to decompose problems. For instance, one female student shared, "I don't know where to start. I need a little more explanation before I can break the problem down into steps." However, once they received clear and structured guidance, female students demonstrated a strong ability to break down complex tasks carefully and systematically. This observation suggests that, with proper support, female students can develop decomposition skills significantly and even exceed their male counterparts in terms of thoroughness and precision.

3.2 PatternRecognition

Pattern recognition, which involves identifying regularities and repetitions in data, also revealed gendered differences in approach. Male students showed great enthusiasm and initiative in identifying mathematical patterns or logical sequences, particularly in activities that involved symbols, numbers, or algorithmic tasks. During a class activity that required students to identify patterns in a series of shapes and numbers, male students immediately recognized repeating patterns and quickly predicted the next in the sequence. One male student mentioned, “I always like finding the pattern first. It makes solving the next part easier.”

On the other hand, female students exhibited a preference for recognizing patterns in social or narrative contexts. In a different activity involving storytelling and pattern recognition in real-life scenarios, female students grasped social patterns—such as cause and effect or recurring behaviors in narratives—more quickly than their male peers. One female student explained, “I’m better at understanding the flow of stories and how things repeat in everyday life.” This suggests that female students may be more attuned to recognizing patterns within contextual or relational frameworks, while male students are more focused on abstract, numerical patterns. This distinction highlights how the type of activity influences the development of pattern recognition skills across genders.

3.3 Abstraction

Abstraction is the process of filtering out unnecessary information and focusing on the essential elements of a problem. Male students in the study demonstrated a quick ability to identify the core aspects of a task, often prioritizing the most critical components of the problem. During an exercise in which students were asked to solve a logic problem involving multiple variables, male students were able to filter through extraneous details and identify key information with speed and ease. However, this sometimes led to oversimplification of the issue, as one male student remarked, “I know what’s important, so I don’t worry about the small details.” This tendency to focus only on the most obvious details occasionally caused male students to overlook vital elements.

In contrast, female students displayed a more cautious approach, taking time to review all available information before identifying the core issue. Female students tended to evaluate problems more holistically, often considering a broader range of possible solutions before making a final decision. One female student said, “I like to look at everything before deciding what’s really important.” This method was slower but led to more comprehensive and thorough problem-solving outcomes. Female students’ abstraction skills could be enhanced if given adequate time and space to explore and analyze problems without rushing to conclusions.

3.4 AlgorithmicThinking

Algorithmic thinking refers to the ability to develop systematic steps to solve problems. Male students were generally more active in experimenting with various problem-solving strategies independently. They enjoyed exploring different ways to approach tasks and were less concerned about making mistakes. During a class exercise in which students were tasked with designing their own algorithms to solve a maze, male students exhibited creativity in developing multiple strategies.

One male student noted, "I just try different things until one works. It's fun to see how different ideas can lead to the same result."

In contrast, female students tended to prefer following pre-established patterns or instructions when developing their algorithms. They felt more comfortable when they could refer to examples or guidance provided by the teacher. One female student expressed, "I like it when the teacher shows me a way to solve something first. After that, I can do it on my own." However, when placed in collaborative, non-competitive group settings, female students demonstrated significant improvement in algorithmic thinking, especially when allowed to take leadership roles or contribute to joint decisions. In group activities where roles were clearly defined and every member had a part to play, female students displayed remarkable confidence and creativity in developing algorithms.

Discussion

The findings of this study reveal how gendered expectations, both external and internalized, influence the development of CT skills among male and female elementary school students. These differences are shaped by multiple factors, including classroom interactions, teacher expectations, and the socialization processes students experience at home.

The observed differences in decomposition skills, for instance, are not solely a result of inherent gender differences but are shaped by the ways in which male and female students are approached in the classroom. Male students tend to receive more encouragement and opportunity to explore technology, while female students often receive less encouragement and are steered toward roles deemed more suitable for girls. This pattern of interaction, though not overtly discriminatory, reinforces gender stereotypes about who is capable of excelling in fields like technology and logic.

The gendered differences in pattern recognition also illustrate the importance of contextuality in learning. While male students are more comfortable with abstract, logical patterns, female students are more adept at recognizing patterns in social and narrative contexts. This distinction highlights how gendered experiences and interests influence the ways in which students engage with and develop CT skills. Teachers who are aware of these differences can better design activities that cater to the diverse strengths of both male and female students, ensuring that all students have equal opportunities to develop their CT skills.

Moreover, the study underscores the significant role that family support plays in shaping students' access to technology and their attitudes toward technology-related activities. Male students often have greater access to digital devices, which allows them to engage with technology outside the classroom. Female students, on the other hand, may face restrictions based on traditional gender roles that limit their exposure to technology. This disparity in access further exacerbates the gender gap in CT skills, reinforcing the need for equitable access to resources at home and in the classroom.

It is also important to note that when provided with an inclusive learning environment and the opportunity to engage in collaborative, project-based learning, female students demonstrated CT skills that were equal to their male counterparts. This finding highlights the power of inclusive teaching strategies that emphasize cooperation, collaboration, and problem-solving rather than competition. Gender-sensitive teaching approaches that avoid reinforcing traditional gender roles can help bridge the gap in CT skill development.

Limitations

While the study provides valuable insights into the gendered differences in CT skills, there are several limitations that should be considered. First, the sample size of 40 students, though manageable for a qualitative study, may not be representative of a larger population. A broader sample would be necessary to generalize the findings more widely. Additionally, the study did not include a comparison between male and female teachers, which could have provided further insights into how gender influences teaching styles and student outcomes. Finally, the absence of long-term data means that the study only captures a snapshot of students' CT skill development, without exploring how these skills evolve over time.

4. CONCLUSION

Comment [A6]: •**Add clear educational implications**:
- •What specific **teaching strategies** or **curriculum changes** should educators implement?

•**Avoid overgeneralization**:
- •Be cautious with phrases like "female students are capable..." – instead, use *"can demonstrate equal proficiency when..."*

•**Suggest areas for further research**:
- •Encourage longitudinal studies or cross-regional comparisons.

This study reveals that gender differences in the mastery of Computational Thinking (CT) skills among elementary school students are not solely due to cognitive differences between male and female students, but are heavily influenced by social, cultural factors, and the learning approaches used both in the classroom and at home. Each CT component — decomposition, pattern recognition, abstraction, and algorithmic thinking — shows distinct trends based on gender. Male students generally exhibit higher confidence in experimenting and solving tasks related to logic and technology, while female students tend to be more cautious, systematic, and meticulous, especially when supported by a collaborative and non-competitive learning environment.

These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers interact with students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered "suitable" or "unsuitable" for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students can demonstrate CT skills on par with their male counterparts.

Given these findings, it is essential for educators and policymakers to recognize the existence of gender biases in learning and adopt more equitable teaching strategies. Specific strategies for educators include implementing teaching approaches that foster collaboration and creativity without competition, providing opportunities for all students, regardless of gender, to engage in hands-on technology activities, and being mindful of how gender stereotypes can influence students' self-perception and confidence. Additionally, integrating more gender-inclusive materials and offering equal opportunities for male and female students to take on leadership roles in collaborative projects could help bridge the gap in CT skill development.

It is also important to consider curriculum changes that prioritize gender-neutral teaching methods and integrate discussions about technology and problem-solving that are accessible to all students. This would not only help students develop the necessary technical skills but also encourage them to think critically and creatively in a supportive and inclusive environment.

For further research, longitudinal studies could provide a deeper understanding of how gender differences in CT mastery evolve over time, and cross-regional comparisons could highlight the impact of different educational and cultural contexts on the development of these skills. By continuing to investigate these factors, educators can better design strategies that ensure all students have equal opportunities to develop the critical thinking and problem-solving skills necessary for success in the 21st century.

5. REFERENCES

Comment [A7]: •**Update recent sources**:
- •Most references predate 2017. Consider including more recent studies on CT in K-12 education, particularly from 2018–2023.

•**Check formatting consistency**:
- •Standardize journal titles (e.g., italicization) and DOI formatting.

•**Ensure citation completeness**:
- •One or two sources (e.g., Brennan & Resnick, 2012) lack full publication info.

Bian, L., Leslie, S. J., & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. Science, 355(6323), 389–391. https://doi.org/10.1126/science.aafed5

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Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. Education and Information Technologies, 20(4), 715–728. https://doi.org/10.1007/s10639-015-9412-6

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REVIEW 2

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Gender Differences in Computational Thinking Skills Among Elementary School Students

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ABSTRACT

This study investigates gender-based differences in the mastery of Computational Thinking (CT) skills among elementary school students, focusing on the social, cultural, and educational factors that shape these skills. A descriptive qualitative approach was employed, with data collected from 40 fourth-grade students (20 male and 20 female) across two elementary schools in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini. Data were gathered through in-depth interviews, classroom observations, and documentation, and analyzed using thematic analysis to identify patterns, themes, and factors influencing gender-based differences in CT proficiency.

The findings revealed significant differences between male and female students in mastering the components of CT: decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students generally exhibited greater self-confidence and were more active in technology-based tasks, while female students demonstrated more caution, systematic thinking, and excelled in collaborative learning contexts. These differences were influenced by environmental factors such as gender stereotypes, teacher interactions, and family support, which either encouraged or limited students' engagement with technology.

The study concludes that gender differences in CT mastery are not inherent but are shaped by social and educational contexts. Therefore, it is crucial to implement equitable, gender-sensitive teaching strategies to ensure all students have equal opportunities to develop essential 21st-century skills.

Comment [H.1]: **Abstrak:**Tambahkan:
- Metode analisis: *“Data were analyzed using thematic analysis...”*
- Contohtemuan: *“Male students showed higher confidence in decomposition, while females excelled in collaborative algorithmic design.”*
- Kontribusi: *“Findings contribute to gender-sensitive CT pedagogy in early education.”*

Method:
•Tambahkan detail proses *thematic analysis* ala Braun & Clarke (2006).
•Sertakan**contohkodeawal dan temaakhir**, idealnyadalambentuktabel.
•Jelaskan strategi validasikualitatif: *member checking*, *triangulasiantarpeneliti*, audit trail, dll.

Findings:
•Tambahkankutipanlangsungdarisiswaperempuan dan laki-lakiuntuksetiaptema.
•Gunakan**tabeltematik**untukmenunjukkanperbedaanantarkomponen CT berdasarkan gender.
•Kaitkandenganteorisecaraeksplisitdalamtiap sub-bagian (misalnya Gender Schema Theory untukhasil pattern recognition).

Discussion:
•Tambahkanperbandingantemuan Anda denganstudiserupa di konteks lain (misalnyastudi Brennan & Resnick, 2012 atau Bian et al., 2017).
•Diskusikan**implikasipraktis**bagi guru SD: pelatihanliterasiteknologi yang inklusif gender, peran media, kurikulumtematikberbasis CT.
• Soroti**kontribusiteoritis**: bagaimanapenelitianinimemperkuatataumenantangpandangansebelumnyatentang gender dan CT.

Corresponding Author:

1. INTRODUCTION

Computational Thinking (CT) skills are cognitive abilities that involve applying computational methods to solve problems. These skills play a crucial role in 21st-century education, enabling individuals to approach problems systematically and efficiently (Shute, Sun, & Asbell-Clarke, 2017). These skills are not confined to information technology or computer science but can be applied across various disciplines to enhance problem-solving (Grover & Pea, 2013; Berland & Lee, 2020). With the rapid advancement of technology and the increasing demand for technology-related skills in the workforce, computational thinking has become a key competency required at both individual and societal levels (Binns, 2017; Grover & Pea, 2013).

Globally, the integration of CT into educational curricula is increasingly recognized as essential, especially at the elementary school level, where foundational skills for critical and analytical thinking are developed (Voogt et al., 2015). However, despite the growing awareness of the importance of CT skill development at the elementary school level, an interesting phenomenon has emerged: gender differences in the achievement of these skills. This phenomenon has become a topic of more frequent research discussions, both globally and locally. Several studies indicate significant differences in how boys and girls access, understand, and apply CT skills (Cheryan et al., 2017; Binns, 2017).

Gender differences in education are not a new issue. Numerous studies have shown that gender stereotypes in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children's perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in differences in interest and motivation toward technology, which are often closely linked to their gender (Bian, Leslie, &Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer understanding of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can assist in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be implemented, such as providing more supportive teaching approaches or introducing CT in ways that better align with girls' interests and needs (Coyle & Doherty, 2019).

Several factors influencing gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male traits, while girls are more frequently seen as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, Master, & Meltzoff, 2015). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face more social barriers to participating in fields considered more "masculine" (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, Leslie, &Cimpian, 2017). Moreover, differences in teaching styles can play an important role. Competitive or achievement-based teaching approaches may benefit boys, who tend to feel more comfortable in such settings, while girls may respond better to collaborative and empathetic teaching methods (Liu, 2014; Cheryan, Master, & Meltzoff, 2015).

Additionally, the role of family is significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills deemed more "gentle" (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still pronounced, this challenge becomes even more complex. Education in Indonesia continues to be influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to the design of more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender and explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are a significant issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

This study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area: SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were 40 fourth-grade students (20 male and 20 female) who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches emphasizing logical and algorithmic problem-solving. The sample size was justified based on the need for rich, detailed data and the scope of the research, focusing on a manageable number of participants to ensure deep, qualitative insights into gender differences in CT mastery. Participants were selected using purposive sampling, choosing informants who were considered capable of providing relevant information related to the research focus on CT and gender differences.

The students engaged in a variety of CT activities during their lessons, including working with Scratch (a visual programming language), participating in unplugged activities (e.g., games and puzzles designed to teach logic and algorithms without computers), and using basic robotics kits to solve problems. These activities were designed to enhance students' problem-solving and logical thinking skills, which are central components of CT.

To ensure the methodological rigor of this study, several ethical considerations were taken into account. Written informed consent was obtained from all participants' guardians prior to their involvement in the study. The identities of all participants were kept anonymous throughout the research process, and any personal information was handled with strict confidentiality. The study was approved by the institutional review board of the participating schools to ensure adherence to ethical standards in research with children.

The triangulation process involved comparing data from multiple sources and methods to validate the findings. This included data collected from interviews with male and female students, classroom observations, and documentation (e.g., lesson plans and student work). By using different data collection techniques, the study ensured the validity and reliability of the findings. The researcher also minimized bias by keeping a reflective journal, regularly examining their own assumptions and interpretations during data analysis. Peer review was also conducted to ensure objective and balanced interpretations of gender-based behaviors.

Data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, and grouping the themes based on social, cultural, and educational factors. The findings were interpreted through the lens of relevant theories, such as Papert's Constructionism and Gender Schema Theory, as well as by referencing previous research in the field.

3. FINDINGS AND DISCUSSION

Findings

The results of this study highlight significant gender differences in the mastery and approach to Computational Thinking (CT) skills among elementary school students. Based on data collected through interviews, classroom observations, and documentation, the findings reveal that male and female students approach each component of CT in distinct ways, influenced by various social, cultural, and educational factors. The study investigates these differences in detail across four CT components: Decomposition, Pattern Recognition, Abstraction, and Algorithmic Thinking.

3.1 Decomposition

Decomposition refers to the ability to break down complex problems into smaller, more manageable parts. In this study, male students exhibited higher levels of spontaneity and confidence when tasked with breaking problems into subtasks, especially in tasks involving logical reasoning and numerical analysis. For example, during an activity in which students were asked to solve a series of mathematical puzzles, male students were quick to divide the puzzles into smaller, solvable steps, displaying an assertive approach toward problem-solving. As one male student said, "I like to solve things by just diving in, figuring it out step by step."

In contrast, female students tended to take longer to break problems into subtasks and often sought additional guidance before starting the task. Many female students expressed uncertainty when initially asked to decompose problems. For instance, one female student shared, "I don't know where to start. I need a little more explanation before I can break the problem down into steps." However, once they received clear and structured guidance, female students demonstrated a strong ability to break down complex tasks carefully and systematically. This observation suggests that, with proper support, female students can develop decomposition skills significantly and even exceed their male counterparts in terms of thoroughness and precision.

3.2 Pattern Recognition

Pattern recognition, which involves identifying regularities and repetitions in data, also revealed gendered differences in approach. Male students showed great enthusiasm and initiative in identifying mathematical patterns or logical sequences, particularly in activities that involved symbols, numbers, or algorithmic tasks. During a class activity that required students to identify patterns in a series of shapes and numbers, male students immediately recognized repeating patterns and quickly predicted the next in the sequence. One male student mentioned, “I always like finding the pattern first. It makes solving the next part easier.”

On the other hand, female students exhibited a preference for recognizing patterns in social or narrative contexts. In a different activity involving storytelling and pattern recognition in real-life scenarios, female students grasped social patterns—such as cause and effect or recurring behaviors in narratives—more quickly than their male peers. One female student explained, “I'm better at understanding the flow of stories and how things repeat in everyday life.” This suggests that female students may be more attuned to recognizing patterns within contextual or relational frameworks, while male students are more focused on abstract, numerical patterns. This distinction highlights how the type of activity influences the development of pattern recognition skills across genders.

3.3 Abstraction

Abstraction is the process of filtering out unnecessary information and focusing on the essential elements of a problem. Male students in the study demonstrated a quick ability to identify the core aspects of a task, often prioritizing the most critical components of the problem. During an exercise in which students were asked to solve a logic problem involving multiple variables, male students were able to filter through extraneous details and identify key information with speed and ease. However, this sometimes led to oversimplification of the issue, as one male student remarked, “I know what's important, so I don't worry about the small details.” This tendency to focus only on the most obvious details occasionally caused male students to overlook vital elements.

In contrast, female students displayed a more cautious approach, taking time to review all available information before identifying the core issue. Female students tended to evaluate problems more holistically, often considering a broader range of possible solutions before making a final decision. One female student said, “I like to look at everything before deciding what's really important.” This method was slower but led to more comprehensive and thorough problem-solving outcomes. Female students' abstraction skills could be enhanced if given adequate time and space to explore and analyze problems without rushing to conclusions.

3.4 Algorithmic Thinking

Algorithmic thinking refers to the ability to develop systematic steps to solve problems. Male students were generally more active in experimenting with various problem-solving strategies independently. They enjoyed exploring different ways to approach tasks and were less concerned about making mistakes. During a class exercise in which students were tasked with designing their own algorithms to solve a maze, male students exhibited creativity in developing multiple strategies.

One male student noted, "I just try different things until one works. It's fun to see how different ideas can lead to the same result."

In contrast, female students tended to prefer following pre-established patterns or instructions when developing their algorithms. They felt more comfortable when they could refer to examples or guidance provided by the teacher. One female student expressed, "I like it when the teacher shows me a way to solve something first. After that, I can do it on my own." However, when placed in collaborative, non-competitive group settings, female students demonstrated significant improvement in algorithmic thinking, especially when allowed to take leadership roles or contribute to joint decisions. In group activities where roles were clearly defined and every member had a part to play, female students displayed remarkable confidence and creativity in developing algorithms.

Discussion

The findings of this study reveal how gendered expectations, both external and internalized, influence the development of CT skills among male and female elementary school students. These differences are shaped by multiple factors, including classroom interactions, teacher expectations, and the socialization processes students experience at home.

The observed differences in decomposition skills, for instance, are not solely a result of inherent gender differences but are shaped by the ways in which male and female students are approached in the classroom. Male students tend to receive more encouragement and opportunity to explore technology, while female students often receive less encouragement and are steered toward roles deemed more suitable for girls. This pattern of interaction, though not overtly discriminatory, reinforces gender stereotypes about who is capable of excelling in fields like technology and logic.

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Moreover, the study underscores the significant role that family support plays in shaping students' access to technology and their attitudes toward technology-related activities. Male students often have greater access to digital devices, which allows them to engage with technology outside the classroom. Female students, on the other hand, may face restrictions based on traditional gender roles that limit their exposure to technology. This disparity in access further exacerbates the gender gap in CT skills, reinforcing the need for equitable access to resources at home and in the classroom.

It is also important to note that when provided with an inclusive learning environment and the opportunity to engage in collaborative, project-based learning, female students demonstrated CT skills that were equal to their male counterparts. This finding highlights the power of inclusive teaching strategies that emphasize cooperation, collaboration, and problem-solving rather than competition. Gender-sensitive teaching approaches that avoid reinforcing traditional gender roles can help bridge the gap in CT skill development.

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These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers interact with students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered “suitable” or “unsuitable” for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students can demonstrate CT skills on par with their male counterparts.

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It is also important to consider curriculum changes that prioritize gender-neutral teaching methods and integrate discussions about technology and problem-solving that are accessible to all students. This would not only help students develop the necessary technical skills but also encourage them to think critically and creatively in a supportive and inclusive environment.

For further research, longitudinal studies could provide a deeper understanding of how gender differences in CT mastery evolve over time, and cross-regional comparisons could highlight the impact of different educational and cultural contexts on the development of these skills. By continuing to investigate these factors, educators can better design strategies that ensure all students have equal opportunities to develop the critical thinking and problem-solving skills necessary for success in the 21st century.

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Gender Differences in Computational Thinking Skills Among Elementary School Students

Rusdial Marta[1], Toto Nusantara[2], Adi Atmoko[3], Sri Rahayuningsih[4]

[1] **Universitas PahlawanTuankuTambusai, Riau, Indonesia; dial.fredo90@gmail.com**

[2] **Universitas Negeri Malang, Malang, Indonesia;** toto.nusantara.fmipa@um.ac.id

[3] **Universitas Negeri Malang, Malang, Indonesia;adi.atmoko.fip@um.ac.id**

[4] **Universitas Negeri Malang; Malang, Indonesia; srirahayuningsih.pasca@um.ac.id**

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ABSTRACT

This study investigates gender-based differences in the mastery of Computational Thinking (CT) skills among elementary school students, focusing on the social, cultural, and educational factors that shape these skills. A descriptive qualitative approach was employed, with data collected from 40 fourth-grade students (20 male and 20 female) across two elementary schools in the Bangkinang area, namely SD Negeri 006 Langgini and SD Negeri 004 Langgini. Data were gathered through in-depth interviews, classroom observations, and documentation, and analyzed using thematic analysis to identify patterns, themes, and factors influencing gender-based differences in CT proficiency.The findings revealed significant differences between male and female students in mastering the components of CT: decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students generally exhibited greater self-confidence and were more active in technology-based tasks, such as showing higher confidence in decomposition, while female students demonstrated more caution, systematic thinking, and excelled in collaborative algorithmic design. These differences were influenced by environmental factors such as gender stereotypes, teacher interactions, and family support, which either encouraged or limited students' engagement with technology.The study concludes that gender differences in CT mastery are not inherent but are shaped by social and educational contexts. Therefore, it is crucial to implement equitable,

Comment [H.1]: **Abstrak:** Tambahkan:
- Metode analisis: *"Data were analyzed using thematic analysis..."*
- Contoh temuan: *"Male students showed higher confidence in decomposition, while females excelled in collaborative algorithmic design."*
- Kontribusi: *"Findings contribute to gender-sensitive CT pedagogy in early education."*

Method:
- Tambahkan detail proses *thematic analysis* ala Braun & Clarke (2006).
- Sertakan **contoh kode awal dan tema akhir**, idealnya dalam bentuk tabel.
- Jelaskan strategi validasi kualitatif: *member checking, triangulasi antar peneliti*, audit trail, dll.

Findings:
- Tambahkan kutipan langsung dari siswa perempuan dan laki-laki untuk setiap tema.
- Gunakan **tabel tematik** untuk menunjukkan perbedaan antar komponen CT berdasarkan gender.
- Kaitkan dengan teori secara eksplisit dalam tiap sub-bagian (misalnya Gender Schema Theory untuk hasil pattern recognition).

Discussion:
- Tambahkan perbandingan temuan Anda dengan studi serupa di konteks lain (misalnya studi Brennan & Resnick, 2012 atau Bian et al., 2017).
- Diskusikan **implikasi praktis** bagi guru SD: pelatihan literasi teknologi yang inklusif gender, peran media, kurikulum tematik berbasis CT.
- Soroti **kontribusi teoritis**: bagaimana penelitian ini memperkuat atau menantang pandangan sebelumnya tentang gender dan CT.

gender-sensitive teaching strategies to ensure all students have equal opportunities to develop essential 21st-century skills. Findings contribute to gender-sensitive CT pedagogy in early education.

Corresponding Author:

1. INTRODUCTION

Computational Thinking (CT) skills are cognitive abilities that involve applying computational methods to solve problems. These skills play a crucial role in 21st-century education, enabling individuals to approach problems systematically and efficiently (Shute, Sun, & Asbell-Clarke, 2017). These skills are not confined to information technology or computer science but can be applied across various disciplines to enhance problem-solving (Grover & Pea, 2013; Berland & Lee, 2020). With the rapid advancement of technology and the increasing demand for technology-related skills in the workforce, computational thinking has become a key competency required at both individual and societal levels (Binns, 2017; Grover & Pea, 2013).

Globally, the integration of CT into educational curricula is increasingly recognized as essential, especially at the elementary school level, where foundational skills for critical and analytical thinking are developed (Voogt et al., 2015). However, despite the growing awareness of the importance of CT skill development at the elementary school level, an interesting phenomenon has emerged: gender differences in the achievement of these skills. This phenomenon has become a topic of more frequent research discussions, both globally and locally. Several studies indicate significant differences in how boys and girls access, understand, and apply CT skills (Cheryan et al., 2017; Binns, 2017).

Gender differences in education are not a new issue. Numerous studies have shown that gender stereotypes in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children's perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in differences in interest and motivation toward technology, which are often closely linked to their gender (Bian, Leslie, &Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer understanding of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can assist in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be implemented, such as providing more supportive teaching approaches or introducing CT in ways that better align with girls' interests and needs (Coyle & Doherty, 2019).

Several factors influencing gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male traits, while girls are more frequently seen as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, Master, & Meltzoff, 2015). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face more social barriers to participating in fields considered more "masculine" (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, Leslie, &Cimpian, 2017). Moreover, differences in teaching styles can play an important role. Competitive or achievement-based teaching approaches may benefit boys, who tend to feel more comfortable in such settings, while girls may respond better to collaborative and empathetic teaching methods (Liu, 2014; Cheryan, Master, & Meltzoff, 2015).

Additionally, the role of family is significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills deemed more "gentle" (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still pronounced, this challenge becomes even more complex. Education in Indonesia continues to be influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to the design of more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender and explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are a significant issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

This study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area: SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were 40 fourth-grade students (20 male and 20 female) who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches emphasizing logical and algorithmic problem-solving. The sample size was justified based on the need for rich, detailed data and the scope of the research, focusing on a manageable number of participants to ensure deep, qualitative insights into gender differences in CT mastery. Participants were selected using purposive sampling, choosing informants who were considered capable of providing relevant information related to the research focus on CT and gender differences.

The students engaged in a variety of CT activities during their lessons, including working with Scratch (a visual programming language), participating in unplugged activities (e.g., games and puzzles designed to teach logic and algorithms without computers), and using basic robotics kits to solve problems. These activities were designed to enhance students' problem-solving and logical thinking skills, which are central components of CT.

To ensure the methodological rigor of this study, several ethical considerations were taken into account. Written informed consent was obtained from all participants' guardians prior to their involvement in the study. The identities of all participants were kept anonymous throughout the research process, and any personal information was handled with strict confidentiality. The study was approved by the institutional review board of the participating schools to ensure adherence to ethical standards in research with children.

The triangulation process involved comparing data from multiple sources and methods to validate the findings. This included data collected from interviews with male and female students, classroom observations, and documentation (e.g., lesson plans and student work). By using different data collection techniques, the study ensured the validity and reliability of the findings. The researcher also minimized bias by keeping a reflective journal, regularly examining their own assumptions and interpretations during data analysis. Peer review was also conducted to ensure objective and balanced interpretations of gender-based behaviors.

Data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, and grouping the themes based on social, cultural, and educational factors. The findings were interpreted through the lens of relevant theories, such as Papert's Constructionism and Gender Schema Theory, as well as by referencing previous research in the field.

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Data were analyzed using thematic analysis, following the steps outlined by Braun and Clarke (2006). The researcher began by familiarizing themselves with the data by reading through interview transcripts and observation notes to gain a deep understanding of the collected data. Relevant pieces of data related to the research focus were then identified, and initial codes were applied. For example, initial codes such as "higher confidence in decomposition" for male students and "more cautious in problem-solving" for female students were used. The researcher then examined the codes and grouped similar ones together to form potential themes. Emerging themes included "Confidence in Problem Solving" and later, "The Influence of Confidence on Decomposition Mastery in Male Students." These themes were further refined and organized into broader categories, resulting in final themes such as "Confidence in Male Students and Algorithmic Problem-Solving" and "Caution in Female Students' Collaborative Algorithmic Design." The final report outlined the identified themes and interpreted them through relevant theories, such as Papert's Constructionism and Gender Schema Theory.

To ensure the validity and reliability of the findings, several qualitative validation strategies were employed. Member checking was conducted by returning to the participants to confirm the accuracy of data interpretation and the findings. Researcher triangulation was applied by involving another researcher in the data analysis process to ensure objective and reliable interpretations of the data. An audit trail was maintained to document the analysis process and decision-making, allowing for transparency and the ability to retrace analytical steps. By employing these data collection and validation techniques, the study ensured the validity and reliability of the findings. Additionally, the researcher minimized bias by keeping a reflective journal and regularly examining personal assumptions and interpretations during data analysis.

3. FINDINGS AND DISCUSSION

Findings

The results of this study highlight significant gender differences in the mastery and approach to Computational Thinking (CT) skills among elementary school students. Data collected through interviews, classroom observations, and documentation reveal that male and female students approach each component of CT in distinct ways, influenced by various social, cultural, and educational factors. The study investigates these differences in detail across four CT components: Decomposition, Pattern Recognition, Abstraction, and Algorithmic Thinking.

3.1 Decomposition

Decomposition refers to the ability to break down complex problems into smaller, more manageable parts. In this study, male students exhibited higher levels of spontaneity and confidence when tasked with breaking problems into subtasks, particularly in tasks involving logical reasoning and numerical analysis. For example, during an activity in which students were asked to solve a series of mathematical puzzles, male students were quick to divide the puzzles into smaller, solvable steps, displaying an assertive approach toward problem-solving. One male student said, "I like to solve things by just diving in, figuring it out step by step."

In contrast, female students tended to take longer to break problems into subtasks and often sought additional guidance before starting the task. Many female students expressed uncertainty when initially asked to decompose problems. For instance, one female student shared, "I don't know where to start. I need a little more explanation before I can break the problem down into steps." However, once they received clear and structured guidance, female students demonstrated a strong ability to break down complex tasks carefully and systematically. As one female student expressed, "Once I understand the method, I can do it properly and with more precision." This observation suggests that, with proper support, female students can develop decomposition skills significantly and even exceed their male counterparts in terms of thoroughness and precision.

3.2 Pattern Recognition

Pattern recognition, which involves identifying regularities and repetitions in data, revealed gendered differences in approach. Male students showed great enthusiasm and initiative in identifying mathematical patterns or logical sequences, particularly in activities that involved symbols, numbers, or algorithmic tasks. One male student mentioned, "I always like finding the pattern first. It makes solving the next part easier."

On the other hand, female students exhibited a preference for recognizing patterns in social or narrative contexts. In a different activity involving storytelling and pattern recognition in real-life scenarios, female students grasped social patterns—such as cause and effect or recurring behaviors in narratives—more quickly than their male peers. One female student explained, "I'm better at understanding the flow of stories and how things repeat in everyday life." This suggests that female students may be more attuned to recognizing patterns within contextual or relational frameworks, while male students are more focused on abstract, numerical patterns.

This aligns with Gender Schema Theory, which suggests that gendered ways of thinking shape how individuals approach tasks and problems. According to the theory, males may be more attuned to abstract, systematic thinking, while females may develop a more relational or social approach to understanding patterns. This distinction highlights how the type of activity influences the development of pattern recognition skills across genders.

3.3 Abstraction

Abstraction is the process of filtering out unnecessary information and focusing on the essential elements of a problem. Male students in the study demonstrated a quick ability to identify the core aspects of a task, often prioritizing the most critical components of the problem. One male student remarked, "I know what's important, so I don't worry about the small details." However, this sometimes led to oversimplification of the issue, as some male students overlooked vital elements in their haste to simplify problems.

In contrast, female students displayed a more cautious approach, taking time to review all available information before identifying the core issue. They tended to evaluate problems more holistically, often considering a broader range of possible solutions before making a final decision. As one female student said, "I like to look at everything before deciding what's really important." This method was slower but led to more comprehensive and thorough problem-solving outcomes. Female students' abstraction skills could be enhanced if given adequate time and space to explore and analyze problems without rushing to conclusions.

3.4 Algorithmic Thinking

Algorithmic thinking refers to the ability to develop systematic steps to solve problems. Male students were generally more active in experimenting with various problem-solving strategies independently. They enjoyed exploring different ways to approach tasks and were less concerned about making mistakes. During a class exercise in which students were tasked with designing their own algorithms to solve a maze, male students exhibited creativity in developing multiple strategies. One male student noted, "I just try different things until one works. It's fun to see how different ideas can lead to the same result."

In contrast, female students preferred following pre-established patterns or instructions when developing their algorithms. They felt more comfortable when they could refer to examples or guidance provided by the teacher. As one female student expressed, "I like it when the teacher shows me a way to solve something first. After that, I can do it on my own." However, when placed in collaborative, non-competitive group settings, female students demonstrated significant improvement in algorithmic thinking, especially when allowed to take leadership roles or contribute to joint decisions. In group activities where roles were clearly defined and every member had a part to play, female students displayed remarkable confidence and creativity in developing algorithms.

Table.1 Gender Differences in Computational Thinking Components

CT Component	Male Students	Female Students
Decomposition	Quick to break down problems, assertive, often without seeking guidance.	Take longer, prefer more structured guidance, but demonstrate precision once supported.
Pattern Recognition	Focus on abstract, numerical patterns, showing initiative and confidence.	Recognize social or narrative patterns, often more attuned to relational frameworks.
Abstraction	Quick to identify key aspects, sometimes oversimplify.	More cautious, review all information before identifying key aspects, leading to thorough solutions.
Algorithmic Thinking	Experiment independently, enjoy exploring different strategies.	Prefer following guided steps, but excel in collaborative settings, showing creativity in groups.

Discussion

The findings of this study reveal how gendered expectations, both external and internalized, influence the development of CT skills among male and female elementary school students. These differences are shaped by multiple factors, including classroom interactions, teacher expectations, and the socialization processes students experience at home. The study provides insight into how gender influences the learning of Computational Thinking (CT), with distinct disparities observed in the way male and female students engage with different CT components.

The observed differences in decomposition skills, for instance, are not solely a result of inherent gender differences but are shaped by the ways in which male and female students are approached in the classroom. Male students tend to receive more encouragement and opportunity to explore technology, while female students often receive less encouragement and are steered toward roles deemed more suitable for girls. This pattern of interaction, though not overtly discriminatory, reinforces gender stereotypes about who is capable of excelling in fields like technology and logic. This is consistent with previous studies, such as Brennan & Resnick (2012), which emphasize the gendered nature of engagement with technology in educational settings. In their study, they noted that male students often have more autonomy in exploring technological tools, which may contribute to their higher levels of confidence and competence in technology-related tasks. On the other hand, female students were shown to have lower levels of engagement with technology, often due to less encouragement from teachers and limited opportunities for independent exploration.

The gendered differences in pattern recognition also illustrate the importance of contextuality in learning. While male students are more comfortable with abstract, logical patterns, female students are more adept at recognizing patterns in social and narrative contexts. This distinction highlights how gendered experiences and interests influence the ways in which students engage with and develop CT skills. Teachers who are aware of these differences can better design activities that cater to the diverse strengths of both male and female students, ensuring that all students have equal opportunities to develop their CT skills. This finding aligns with Bian et al. (2017), who discussed how gendered interests and expectations shape the types of cognitive skills that are emphasized in educational contexts. They found that girls were more likely to engage with tasks that involved relational thinking, while boys were more likely to be exposed to tasks that focused on abstract, logical reasoning.

Moreover, the study underscores the significant role that family support plays in shaping students' access to technology and their attitudes toward technology-related activities. Male students often have greater access to digital devices, which allows them to engage with technology outside the classroom. Female students, on the other hand, may face restrictions based on traditional gender roles that limit their exposure to technology. This disparity in access further exacerbates the gender gap in CT skills, reinforcing the need for equitable access to resources at home and in the classroom. This resonates with findings from other research, such as Cunningham & Frenette (2018), which highlighted that gendered differences in access to technology outside of school contribute to the growing disparity in digital literacy between boys and girls.

It is also important to note that when provided with an inclusive learning environment and the opportunity to engage in collaborative, project-based learning, female students demonstrated CT skills that were equal to their male counterparts. This finding highlights the power of inclusive teaching strategies that emphasize cooperation, collaboration, and problem-solving rather than competition. Gender-sensitive teaching approaches that avoid reinforcing traditional gender roles can help bridge the gap in CT skill development. This also supports the work of Margolis & Fisher (2002), who found that when girls are given equal access to technology and encouraged to collaborate in group settings, they are more likely to develop strong technical and problem-solving skills.

The practical implications for elementary school teachers are profound. First, there is a clear need for gender-inclusive technology literacy training. Teachers should be trained to recognize gendered differences in technology engagement and encouraged to create inclusive environments where both male and female students feel equally confident exploring and applying technology. Incorporating gender-sensitive approaches, such as encouraging girls to lead projects or participate in hands-on technological tasks, can foster greater equity in CT skill development.

Additionally, media plays a pivotal role in shaping perceptions of technology and gender. Teachers and educators should be mindful of the media and educational content presented in the classroom. Materials that depict diverse role models in the technology field—such as female engineers, scientists, and programmers—can counteract stereotypical portrayals and inspire both male and female students. Teachers can integrate CT-based thematic curricula that includes a variety of learning experiences. Activities that combine technology with real-world applications and storytelling, for example, can appeal to both boys' abstract reasoning and girls' relational thinking, allowing them to engage with CT in ways that resonate with their strengths.

This study provides important theoretical insights into how gender influences the development of Computational Thinking (CT) skills. It challenges traditional views that suggest inherent cognitive differences between genders in relation to CT. Instead, the findings suggest that differences in CT skills are shaped more by external factors—such as teacher expectations, socialization at home, and gendered interactions in the classroom—rather than by any inherent gender differences in cognitive abilities.

The findings also contribute to the development of Gender Schema Theory, which posits that individuals internalize gender roles from an early age and those roles influence the way they engage with different tasks and activities. By linking gendered experiences to students' approaches to CT, this study strengthens the theory's application to educational contexts and highlights the role of socialization in shaping students' engagement with technology.

In summary, this study not only reinforces the importance of inclusive teaching strategies but also provides empirical evidence that gender expectations significantly shape the development of CT skills in elementary school students. It calls for further research into how these factors influence other aspects of education and underscores the importance of creating equal opportunities for all students, regardless of gender, to excel in the rapidly evolving world of technology.

Limitations

While the study provides valuable insights into the gendered differences in CT skills, there are several limitations that should be considered. First, the sample size of 40 students, though manageable for a qualitative study, may not be representative of a larger population. A broader sample would be necessary to generalize the findings more widely. Additionally, the study did not include a comparison between male and female teachers, which could have provided further insights into how gender influences teaching styles and student outcomes. Finally, the absence of long-term data means that the study only captures a snapshot of students' CT skill development, without exploring how these skills evolve over time.

4. CONCLUSION

This study reveals that gender differences in the mastery of Computational Thinking (CT) skills among elementary school students are not solely due to cognitive differences between male and female students, but are heavily influenced by social, cultural factors, and the learning approaches used both in the classroom and at home. Each CT component — decomposition, pattern recognition, abstraction, and algorithmic thinking — shows distinct trends based on gender. Male students generally exhibit higher confidence in experimenting and solving tasks related to logic and technology, while female students tend to be more cautious, systematic, and meticulous, especially when supported by a collaborative and non-competitive learning environment.

These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers interact with students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered “suitable” or “unsuitable” for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students can demonstrate CT skills on par with their male counterparts.

Given these findings, it is essential for educators and policymakers to recognize the existence of gender biases in learning and adopt more equitable teaching strategies. Specific strategies for educators include implementing teaching approaches that foster collaboration and creativity without competition, providing opportunities for all students, regardless of gender, to engage in hands-on technology activities, and being mindful of how gender stereotypes can influence students’ self-perception and confidence. Additionally, integrating more gender-inclusive materials and offering equal opportunities for male and female students to take on leadership roles in collaborative projects could help bridge the gap in CT skill development.

It is also important to consider curriculum changes that prioritize gender-neutral teaching methods and integrate discussions about technology and problem-solving that are accessible to all students. This would not only help students develop the necessary technical skills but also encourage them to think critically and creatively in a supportive and inclusive environment.

For further research, longitudinal studies could provide a deeper understanding of how gender differences in CT mastery evolve over time, and cross-regional comparisons could highlight the impact of different educational and cultural contexts on the development of these skills. By continuing to investigate these factors, educators can better design strategies that ensure all students have equal opportunities to develop the critical thinking and problem-solving skills necessary for success in the 21st century.

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Gender Differences in Computational Thinking Skills Among Elementary School Students

Rusdial Marta[1], Toto Nusantara[2], Adi Atmoko[3], Sri Rahayuningsih[4]

[1] Universitas Pahlawan Tuanku Tambusai, Kampar, Indonesia; dial.fredo90@gmail.com
[2] Universitas Negeri Malang, Malang, Indonesia; toto.nusantara.fmipa@um.ac.id
[3] Universitas Negeri Malang, Malang, Indonesia; adi.atmoko.fip@um.ac.id
[4] Universitas Negeri Malang; Malang, Indonesia; srirahayuningsih.pasca@um.ac.id

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ABSTRACT

This study explores gender-based differences in the mastery of Computational Thinking (CT) skills among elementary school students, emphasizing the influence of social, cultural, and educational factors. Understanding these disparities is essential for promoting inclusive and equitable 21st-century skill development in early education. A descriptive qualitative design was utilized, involving 40 fourth-grade students (20 male, 20 female) from two elementary schools in Bangkinang: SD Negeri 006 Langgini and SD Negeri 004 Langgini. Data were collected through in-depth interviews, classroom observations, and documentation. Thematic analysis was conducted to identify patterns and factors contributing to gender differences in CT competencies. Findings revealed distinct gender-based variations in CT components—decomposition, pattern recognition, abstraction, and algorithmic thinking. Male students displayed higher self-confidence and active participation in technology-oriented tasks, particularly in decomposition and abstraction. In contrast, female students demonstrated more cautious, structured thinking and excelled in collaborative algorithm design. These differences were influenced by external factors, including gender stereotypes, teacher interactions, and familial support, shaping students' engagement with CT tasks. The observed gender differences are not innate but are shaped by contextual influences. The study underscores the need for educators to adopt gender-sensitive pedagogical strategies to ensure equitable CT learning experiences. Social and educational environments significantly shape CT skill development across genders. Implementing inclusive, gender-responsive teaching methods is essential to support equal opportunities for all students in acquiring foundational digital competencies.

Corresponding Author:
Rusdial Marta
Universitas Pahlawan Tuanku Tambusai, Kampar, Indonesia; dial.fredo90@gmail.com

1. INTRODUCTION

Computational Thinking (CT) skills are cognitive abilities that involve applying computational methods to solve problems. These skills play a crucial role in 21st-century education, enabling individuals to approach problems systematically and efficiently (Shute, Sun, & Asbell-Clarke, 2017). These skills are not confined to information technology or computer science but can be applied across various disciplines to enhance problem-solving (Grover & Pea, 2013; Berland & Lee, 2020). With the rapid advancement of technology and the increasing demand for technology-related skills in the workforce, computational thinking has become a key competency required at both individual and societal levels (Binns, 2017; Grover & Pea, 2013).

Globally, the integration of CT into educational curricula is increasingly recognized as essential, especially at the elementary school level, where foundational skills for critical and analytical thinking are developed (Voogt et al., 2015). However, despite the growing awareness of the importance of CT skill development at the elementary school level, an interesting phenomenon has emerged: gender differences in the achievement of these skills. This phenomenon has become a topic of more frequent research discussions, both globally and locally. Several studies indicate significant differences in how boys and girls access, understand, and apply CT skills (Cheryan et al., 2017; Binns, 2017).

Gender differences in education are not a new issue. Numerous studies have shown that gender stereotypes in society can affect the way children learn and develop in various fields (Charles & Bradley, 2009). At the elementary school level, environmental and social factors that shape children's perceptions of gender can impact their mastery of technical skills and technology-based problem-solving. This is reflected in differences in interest and motivation toward technology, which are often closely linked to their gender (Bian, Leslie, & Cimpian, 2017).

Research on gender differences in CT skills at the elementary school level is important because it can provide a clearer understanding of how these differences emerge and what factors influence them. Furthermore, understanding these gender differences can assist in designing more inclusive curricula and teaching strategies, ensuring that every child, regardless of gender, has an equal opportunity to develop computational thinking skills. For example, if it is found that girls are less interested or lack confidence in learning CT, appropriate interventions can be implemented, such as providing more supportive teaching approaches or introducing CT in ways that better align with girls' interests and needs (Coyle & Doherty, 2019).

Several factors influencing gender differences in CT skills may arise from various dimensions, such as social, cultural, and educational factors. In many cases, technical skills like programming or computer-based problem-solving are often associated with male traits, while girls are more frequently seen as having greater abilities in social or communication-based fields (Liu, 2014; Cheryan, Master, & Meltzoff, 2015). This suggests that gender can shape how elementary school children view themselves in the context of CT learning. For example, boys are often more encouraged to explore technology, while girls may face more social barriers to participating in fields considered more "masculine" (Cheryan, Master, & Meltzoff, 2015).

Gender stereotypes also influence how teachers and parents support the development of children's CT skills. Some studies suggest that teachers may unconsciously give more attention to boys in technology-related learning contexts, while girls are more likely to be assigned more limited roles in technology and programming activities (Binns, 2017; Bian, Leslie, & Cimpian, 2017). Moreover, differences in teaching styles can play an important role. Competitive or achievement-based teaching approaches may benefit boys, who tend to feel more comfortable in such settings, while girls may respond better to collaborative and empathetic teaching methods (Liu, 2014; Cheryan, Master, & Meltzoff, 2015).

Additionally, the role of the family is significant in influencing the development of CT skills among children. In some cultures, parents may have more conservative views regarding their children's gender roles, which can limit girls' opportunities to explore technology and computational skills. In contrast, boys are more often encouraged to explore technology and scientific experimentation, while girls may be steered toward developing skills deemed more "gentle" (Charles & Bradley, 2009).

In the context of Indonesia, where gender differences in education and access to technology are still pronounced, this challenge becomes even more complex. Education in Indonesia continues to be influenced by strong cultural norms, which often limit the roles of women in fields considered technical or logical. However, Indonesia has made significant progress in recent years by launching various initiatives aimed at promoting gender equality in STEM (Science, Technology, Engineering, and Mathematics) fields, which include empowering girls to pursue interests and careers in technology (Ministry of Education and Culture of the Republic of Indonesia, 2017). These programs demonstrate that change is possible when there is a collective effort to address existing stereotypes and barriers.

Given the importance of this issue, research on gender differences in CT skills at the elementary school level in Indonesia is highly relevant. This study will not only provide insights into how gender differences influence CT learning but also contribute to the design of more inclusive and fair educational policies. Therefore, it is crucial to understand the factors influencing the development of CT skills based on gender and explore interventions that can help reduce this gap.

In conclusion, gender differences in Computational Thinking skills at the elementary school level are a significant issue to investigate, given their impact on the development of children's competencies in the 21st century. This study aims to delve deeper into these differences and how social, cultural, and educational factors can influence the mastery of CT skills among boys and girls. By understanding these dynamics, it is hoped that more appropriate solutions can be found to create a learning environment that is inclusive and supportive of the development of technical skills for all children, regardless of gender.

2. METHODS

This study uses a descriptive qualitative approach with the aim of gaining an in-depth understanding of the gender differences in mastering Computational Thinking (CT) skills among elementary school students. A qualitative approach was chosen because the study focuses on exploring the perceptions, experiences, and social and cultural factors that influence how male and female students develop CT skills, rather than on quantitative measurement or statistical analysis. The research was conducted in two elementary schools located in the Bangkinang area: SD Negeri 006 Langgini and SD Negeri 004 Langgini. The research subjects were 40 fourth-grade students (20 male and 20 female) who had been introduced to the concept of CT, either through Information and Communication Technology (ICT) lessons or other learning approaches emphasizing logical and algorithmic problem-solving. The sample size was justified based on the need for rich, detailed data and the scope of the research, focusing on a manageable number of participants to ensure deep, qualitative insights into gender differences in CT mastery. Participants were selected using purposive sampling, and informants were chosen who were considered capable of providing relevant information related to the research focus on CT and gender differences.

The students engaged in a variety of CT activities during their lessons, including working with Scratch (a visual programming language), participating in unplugged activities (e.g., games and puzzles designed to teach logic and algorithms without computers), and using basic robotics kits to solve problems. These activities were designed to enhance students' problem-solving and logical thinking skills, which are central components of CT.

To ensure the methodological rigor of this study, several ethical considerations were taken into account. Written informed consent was obtained from all participants' guardians prior to their involvement in the study. The identities of all participants were kept anonymous throughout the research process, and any personal information was handled with strict confidentiality. The study was approved by the institutional review board of the participating schools to ensure adherence to ethical standards in research with children.

The triangulation process involved comparing data from multiple sources and methods to validate the findings. This included data collected from interviews with male and female students, classroom observations, and documentation (e.g., lesson plans and student work). By using different data collection techniques, the study ensured the validity and reliability of the findings. The researcher also minimized bias by keeping a reflective journal, regularly examining their own assumptions and interpretations during data analysis. Peer review was also conducted to ensure objective and balanced interpretations of gender-based behaviors.

Data were analyzed using thematic analysis, which involved transcribing the interview and observation results, coding the data to identify emerging patterns or themes, and grouping the themes based on social, cultural, and educational factors. The findings were interpreted through the lens of relevant theories, such as Papert's Constructionism and Gender Schema Theory, as well as by referencing previous research in the field.

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Data were analyzed using thematic analysis, following the steps outlined by Braun and Clarke (2006). The researchers began by familiarizing themselves with the data by reading through interview transcripts and observation notes to gain a deep understanding of the collected data. Relevant pieces of data related to the research focus were then identified, and initial codes were applied. For example, initial codes such as "higher confidence in decomposition" for male students and "more cautious in problem-solving" for female students were used. The researcher then examined the codes and grouped similar ones together to form potential themes. Emerging themes included "Confidence in Problem Solving" and later, "The Influence of Confidence on Decomposition Mastery in Male Students." These themes were further refined and organized into broader categories, resulting in final themes such as "Confidence in Male Students and Algorithmic Problem-Solving" and "Caution in Female Students' Collaborative Algorithmic Design." The final report outlined the identified themes and interpreted them through relevant theories, such as Papert's Constructionism and Gender Schema Theory.

To ensure the validity and reliability of the findings, several qualitative validation strategies were employed. Member checking was conducted by returning to the participants to confirm the accuracy of data interpretation and the findings. Researcher triangulation was applied by involving another researcher in the data analysis process to ensure objective and reliable interpretations of the data. An audit trail was maintained to document the analysis process and decision-making, allowing for transparency and the ability to retrace analytical steps. By employing these data collection and validation techniques, the study ensured the validity and reliability of the findings. Additionally, the researcher minimized bias by keeping a reflective journal and regularly examining personal assumptions and interpretations during data analysis.

3. FINDINGS AND DISCUSSION

3.1 Findings

The results of this study highlight significant gender differences in the mastery and approach to Computational Thinking (CT) skills among elementary school students. Data collected through interviews, classroom observations, and documentation reveal that male and female students approach each component of CT in distinct ways, influenced by various social, cultural, and educational factors. The study investigates these differences in detail across four CT components: Decomposition, Pattern Recognition, Abstraction, and Algorithmic Thinking.

3.1.1 Decomposition

Decomposition refers to the ability to break down complex problems into smaller, more manageable parts. In this study, male students exhibited higher levels of spontaneity and confidence when tasked with breaking problems into subtasks, particularly in tasks involving logical reasoning and numerical analysis. For example, during an activity in which students were asked to solve a series of mathematical puzzles, male students were quick to divide the puzzles into smaller, solvable steps, displaying an assertive approach toward problem-solving. One male student said, *"I like to solve things by just diving in, figuring it out step by step."*

In contrast, female students tended to take longer to break problems into subtasks and often sought additional guidance before starting the task. Many female students expressed uncertainty when initially asked to decompose problems. For instance, one female student shared, *"I don't know where to start. I need a little more explanation before I can break the problem down into steps."* However, once they received clear and structured guidance, female students demonstrated a strong ability to break down complex tasks carefully and systematically. As one female student expressed, *"Once I understand the method, I can do it properly and with more precision."* This observation suggests that, with proper support, female students can develop decomposition skills significantly and even exceed their male counterparts in terms of thoroughness and precision.

3.1.2 Pattern Recognition

Pattern recognition, which involves identifying regularities and repetitions in data, revealed gendered differences in approach. Male students showed great enthusiasm and initiative in identifying mathematical patterns or logical sequences, particularly in activities that involved symbols, numbers, or algorithmic tasks. One male student mentioned, *"I always like finding the pattern first. It makes solving the next part easier."*

On the other hand, female students exhibited a preference for recognizing patterns in social or narrative contexts. In a different activity involving storytelling and pattern recognition in real-life scenarios, female students grasped social patterns—such as cause and effect or recurring behaviors in narratives—more quickly than their male peers. One female student explained, *"I'm better at understanding the flow of stories and how things repeat in everyday life."* This suggests that female students may be more attuned to recognizing patterns within contextual or relational frameworks, while male students are more focused on abstract, numerical patterns.

This aligns with Gender Schema Theory, which suggests that gendered ways of thinking shape how individuals approach tasks and problems. According to the theory, males may be more attuned to abstract, systematic thinking, while females may develop a more relational or social approach to understanding patterns. This distinction highlights how the type of activity influences the development of pattern recognition skills across genders.

3.1.3 Abstraction

Abstraction is the process of filtering out unnecessary information and focusing on the essential elements of a problem. Male students in the study demonstrated a quick ability to identify the core aspects of a task, often prioritizing the most critical components of the problem. One male student remarked, *"I know what's important, so I don't worry about the small details."* However, this sometimes led to oversimplification of the issue, as some male students overlooked vital elements in their haste to simplify problems.

In contrast, female students displayed a more cautious approach, taking time to review all available information before identifying the core issue. They tended to evaluate problems more holistically, often considering a broader range of possible solutions before making a final decision. As one female student said, *"I like to look at everything before deciding what's really important."* This method was slower but led to more comprehensive and thorough problem-solving outcomes. Female students' abstraction skills could be enhanced if given adequate time and space to explore and analyze problems without rushing to conclusions.

3.1.4 Algorithmic Thinking

Algorithmic thinking refers to the ability to develop systematic steps to solve problems. Male students were generally more active in experimenting with various problem-solving strategies independently. They enjoyed exploring different ways to approach tasks and were less concerned about making mistakes. During a class exercise in which students were tasked with designing their own algorithms to solve a maze, male students exhibited creativity in developing multiple strategies. One male student noted, *"I just try different things until one works. It's fun to see how different ideas can lead to the same result."*

In contrast, female students preferred following pre-established patterns or instructions when developing their algorithms. They felt more comfortable when they could refer to examples or guidance provided by the teacher. As one female student expressed, *"I like it when the teacher shows me a way to solve something first. After that, I can do it on my own."* However, when placed in collaborative, non-competitive group settings, female students demonstrated significant improvement in algorithmic thinking, especially when allowed to take leadership roles or contribute to joint decisions. In group activities where roles were clearly defined and every member had a part to play, female students displayed remarkable confidence and creativity in developing algorithms.

Table 1. Gender Differences in Computational Thinking Components

CT Component	Male Students	Female Students
Decomposition	Quick to break down problems, assertive, often without seeking guidance.	Take longer, prefer more structured guidance, but demonstrate precision once supported.
Pattern Recognition	Focus on abstract, numerical patterns, showing initiative and confidence.	Recognize social or narrative patterns, often more attuned to relational frameworks.
Abstraction	Quick to identify key aspects, sometimes oversimplify.	More cautious, review all information before identifying key aspects, leading to thorough solutions.
Algorithmic Thinking	Experiment independently, enjoy exploring different strategies.	Prefer following guided steps, but excel in collaborative settings, showing creativity in groups.

3.2 Discussion

The findings of this study reveal how gendered expectations, both external and internalized, influence the development of CT skills among male and female elementary school students. These differences are shaped by multiple factors, including classroom interactions, teacher expectations, and the socialization processes students experience at home. The study provides insight into how gender influences the learning of Computational Thinking (CT), with distinct disparities observed in the way male and female students engage with different CT components.

The observed differences in decomposition skills, for instance, are not solely a result of inherent gender differences but are shaped by the ways in which male and female students are approached in the classroom. Male students tend to receive more encouragement and opportunities to explore technology, while female students often receive less encouragement and are steered toward roles deemed more suitable for girls. This pattern of interaction, though not overtly discriminatory, reinforces gender stereotypes about who is capable of excelling in fields like technology and logic. This is consistent with previous studies, such as Brennan & Resnick (2012), which emphasize the gendered nature of engagement with technology in educational settings. In their study, they noted that male students often have more autonomy in exploring technological tools, which may contribute to their higher levels of confidence and competence in technology-related tasks. On the other hand, female students were shown to have lower levels of engagement with technology, often due to less encouragement from teachers and limited opportunities for independent exploration.

The gendered differences in pattern recognition also illustrate the importance of contextuality in learning. While male students are more comfortable with abstract, logical patterns, female students are more adept at recognizing patterns in social and narrative contexts. This distinction highlights how gendered experiences and interests influence the ways in which students engage with and develop CT skills. Teachers who are aware of these differences can better design activities that cater to the diverse strengths of both male and female students, ensuring that all students have equal opportunities to develop their CT skills. This finding aligns with Bian et al. (2017), who discussed how gendered interests and expectations shape the types of cognitive skills that are emphasized in educational contexts. They found that girls were more likely to engage with tasks that involved relational thinking, while boys were more likely to be exposed to tasks that focused on abstract, logical reasoning.

Moreover, the study underscores the significant role that family support plays in shaping students' access to technology and their attitudes toward technology-related activities. Male students often have greater access to digital devices, which allows them to engage with technology outside the classroom. Female students, on the other hand, may face restrictions based on traditional gender roles that limit their exposure to technology. This disparity in access further exacerbates the gender gap in CT skills, reinforcing the need for equitable access to resources at home and in the classroom. This resonates with findings from other research, such as Cunningham & Frenette (2018), which highlighted that gendered differences in access to technology outside of school contribute to the growing disparity in digital literacy between boys and girls.

It is also important to note that when provided with an inclusive learning environment and the opportunity to engage in collaborative, project-based learning, female students demonstrated CT skills that were equal to their male counterparts. This finding highlights the power of inclusive teaching strategies that emphasize cooperation, collaboration, and problem-solving rather than competition. Gender-sensitive teaching approaches that avoid reinforcing traditional gender roles can help bridge the gap in CT skill development. This also supports the work of Margolis & Fisher (2002), who found that when girls are given equal access to technology and encouraged to collaborate in group settings, they are more likely to develop strong technical and problem-solving skills.

The practical implications for elementary school teachers are profound. First, there is a clear need for gender-inclusive technology literacy training. Teachers should be trained to recognize gendered differences in technology engagement and encouraged to create inclusive environments where both male and female students feel equally confident exploring and applying technology. Incorporating gender-sensitive approaches, such as encouraging girls to lead projects or participate in hands-on technological tasks, can foster greater equity in CT skill development.

Additionally, media plays a pivotal role in shaping perceptions of technology and gender. Teachers and educators should be mindful of the media and educational content presented in the classroom. Materials that depict diverse role models in the technology field—such as female engineers, scientists, and programmers—can counteract stereotypical portrayals and inspire both male and female students. Teachers can integrate CT-based thematic curricula that includes a variety of learning experiences. Activities that combine technology with real-world applications and storytelling, for example, can appeal to both boys' abstract reasoning and girls' relational thinking, allowing them to engage with CT in ways that resonate with their strengths.

This study provides important theoretical insights into how gender influences the development of Computational Thinking (CT) skills. It challenges traditional views that suggest inherent cognitive differences between genders in relation to CT. Instead, the findings suggest that differences in CT skills are shaped more by external factors—such as teacher expectations, socialization at home, and gendered interactions in the classroom—rather than by any inherent gender differences in cognitive abilities.

The findings also contribute to the development of gender schema theory, which posits that individuals internalize gender roles from an early age and that those roles influence the way they engage with different tasks and activities. By linking gendered experiences to students' approaches to CT, this study strengthens the theory's application to educational contexts and highlights the role of socialization in shaping students' engagement with technology.

In summary, this study not only reinforces the importance of inclusive teaching strategies but also provides empirical evidence that gender expectations significantly shape the development of CT skills in elementary school students. It calls for further research into how these factors influence other aspects of education and underscores the importance of creating equal opportunities for all students, regardless of gender, to excel in the rapidly evolving world of technology.

While the study provides valuable insights into the gendered differences in CT skills, there are several limitations that should be considered. First, the sample size of 40 students, though manageable for a qualitative study, may not be representative of a larger population. A broader sample would be necessary to generalize the findings more widely. Additionally, the study did not include a comparison between male and female teachers, which could have provided further insights into how gender influences teaching styles and student outcomes. Finally, the absence of long-term data means that the study only captures a snapshot of students' CT skill development, without exploring how these skills evolve over time.

4. CONCLUSION

This study reveals that gender differences in the mastery of Computational Thinking (CT) skills among elementary school students are not solely due to cognitive differences between male and female students, but are heavily influenced by social, cultural factors, and the learning approaches used both in the classroom and at home. Each CT component — decomposition, pattern recognition, abstraction, and algorithmic thinking — shows distinct trends based on gender. Male students generally exhibit higher confidence in experimenting and solving tasks related to logic and technology, while female students tend to be more cautious, systematic, and meticulous, especially when supported by a collaborative and non-competitive learning environment.

These differences largely stem from environmental influences, such as gender stereotypes in society, parenting styles at home, and the way teachers interact with students in the classroom. The learning experiences students have from an early age shape how they perceive their abilities and which fields are considered "suitable" or "unsuitable" for their gender. Nevertheless, the results also indicate that when provided with an inclusive, relevant, and gender-sensitive learning approach, female students can demonstrate CT skills on par with their male counterparts.

Given these findings, it is essential for educators and policymakers to recognize the existence of gender biases in learning and adopt more equitable teaching strategies. Specific strategies for educators include implementing teaching approaches that foster collaboration and creativity without competition, providing opportunities for all students, regardless of gender, to engage in hands-on technology activities, and being mindful of how gender stereotypes can influence students' self-perception and confidence. Additionally, integrating more gender-inclusive materials and offering equal opportunities for male and female students to take on leadership roles in collaborative projects could help bridge the gap in CT skill development.

It is also important to consider curriculum changes that prioritize gender-neutral teaching methods and integrate discussions about technology and problem-solving that are accessible to all students. This would not only help students develop the necessary technical skills but also encourage them to think critically and creatively in a supportive and inclusive environment.

For further research, longitudinal studies could provide a deeper understanding of how gender differences in CT mastery evolve over time, and cross-regional comparisons could highlight the impact of different educational and cultural contexts on the development of these skills. By continuing to investigate these factors, educators can better design strategies that ensure all students have equal opportunities to develop the critical thinking and problem-solving skills necessary for success in the 21st century.

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