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Indonesian Students' Computational Thinking Performance Based on Level and Gender

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ABSTRACT

Computational thinking (CT) has become an essential competency for students in the 21st century. This study examines the CT proficiency of Indonesian students using data from the Bebras Challenge 2023, an international competition designed to evaluate students' CT skills. The research employs a quantitative ex post facto approach, including a sample of 3,648 students from elementary, junior high, and senior high schools in Indonesia who participated in the Bebras Challenge 2023 and achieved a minimum score of 50. The primary data source for this study is secondary, derived from the Bebras Challenge 2023 test results obtained legally from the official website bebras.or.id, adhering strictly to ethical guidelines regarding participant anonymity. Data analysis techniques include using SPSS 23 software and applying descriptive and inferential statistical methods, specifically the Kruskal-Wallis and Mann-Whitney tests, to examine average score discrepancies across different groups. The findings indicate that CT skills among Indonesian students are significantly underdeveloped, with 87% of participants scoring below the minimum threshold of 50. The average scores of those who exceeded the threshold were around 56.25, indicating room for improvement. Significant disparities in CT abilities were observed among student groups categorized as Siaga, Penggalang, and Penegak, with varying proficiency levels. Additionally, gender-based differences were noted, with male students demonstrating superior CT abilities compared to female students. The study emphasizes the need for collaborative efforts among educators, policymakers, and communities to enhance CT education in Indonesia, advocating for integrated CT curricula, targeted educator training programs, and inclusive learning environments that foster CT skills across all student demographics.

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1. INTRODUCTION

Computational Thinking (CT) skills are increasingly crucial for preparing students for the contemporary workplace, which is heavily influenced by technological advancements (Lye & Koh, 2014). Various industries, including technology, finance, healthcare, and manufacturing, now demand proficiency in CT (Pérez-Escoda et al., 2016). According to the World Economic Forum, these skills are essential for addressing complex problems, developing algorithms, and utilizing computing technologies in professional environments (Sart & Yildiz, 2022). International organizations such as OECD and UNESCO emphasize integrating CT into educational frameworks to prepare future generations for digital challenges (Bati, 2022; OECD, 2019). As a result, many countries and educational institutions are incorporating CT education at all academic levels, from elementary to higher education, to develop students' strong analytical, creative thinking, and problem-solving skills (Lye & Koh, 2014). This preparation enhances their ability to tackle real-world challenges in both professional and personal contexts.

The curriculum in Indonesia faces several challenges in fostering CT skills. One significant challenge is the limited integration of CT, often confined to computer or technology subjects rather than being incorporated throughout the curriculum (Maharani et al., 2021). Additionally, insufficient teacher training hampers effective CT instruction (Said et al., 2024). Many schools, particularly those in rural or underdeveloped areas, also face barriers such as inadequate access to necessary technology for CT education, including reliable internet connectivity and sufficient computing devices (Yuliana et al., 2021). The existing evaluation and assessment systems may not fully capture or incentivize CT skill development, potentially hindering the progress of CT-

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oriented curricula (Triswidrananta et al., 2020). Reviews of ICT curricula and OECD studies in the "PISA 2022 Digital Literacy Framework" indicate that shortcomings in integrating CT could weaken students' preparedness for current digital challenges. Addressing these issues is critical to enhancing the effectiveness of CT skill development across all Indonesian schools.

Global trends in CT education highlight a significant increase in integration within educational curricula worldwide (Fitriyah et al., 2024). Advanced nations like the United States, Canada, the United Kingdom, and various European countries have made substantial progress in embedding CT across all educational levels, from primary schools to universities. These countries have established national standards and ensured universal access to CT education (Grover & Pea, 2013). Many nations support national initiatives and CT competitions such as the Bebras Challenge (Pluhár et al., 2022), which foster student engagement in CT and raise public awareness of its importance. Since 2016, Indonesia's involvement in the Bebras Challenge (Natali & Nugraheni, 2023) reflects a comprehensive national effort to promote consistent CT education across all schools, engaging students from diverse educational levels and regions.

Previous research has analyzed Bebras Challenge data among Indonesian students, focusing on task difficulty across age groups and the correlation between scores and completion times (Natali & Nugraheni, 2023). The official Bebras Challenge Indonesia website publishes student test results transparently, showing successful participation with scores meeting or exceeding the minimum threshold of 50. While assessing data from students with lower scores is important, examining factors influencing performance in this competition provides valuable insights applicable to other students. Influential factors include educational level, gender, and prior exposure to programming or computing (Kanaki & Kalogiannakis, 2022; Krakowski et al., 2023). This study uses data from the 2023 Bebras Challenge as its primary source to analyze Indonesian students' CT performance, offering a relevant assessment of current CT proficiency levels.

This research aims to address the following questions:

1. How do Indonesian students perform in CT skills based on Bebras Challenge 2023 data?
2. Are there significant disparities in CT performance among students across different educational levels (e.g., elementary, junior high, senior high)?
3. Do significant differences in CT performance exist between genders across various educational levels?

Research holds significant implications for educators and curriculum developers. The findings can help educators identify areas needing reinforcement in CT education and implement effective teaching methodologies to enhance students' CT skills. For curriculum developers, the study provides insights into creating more comprehensive and relevant CT education frameworks within schools. Aiming to substantially contribute to enhancing CT education in Indonesia, the research serves as a cornerstone for ongoing efforts to develop effective curricula and teaching methodologies and elevate the quality of CT education across all educational levels in Indonesia.

2. MATERIAL AND METHOD

Research Design and Participants

A quantitative Ex Post Facto research design was utilized for this study. Ex Post Facto research is defined by the absence of manipulation or control over independent variables, as these conditions naturally occur before the study (Giuffre, 1997). Pre-existing data from the 2023 Bebras Challenge was used, with no direct control over the variables of interest, such as student levels and gender. The data were naturally occurring, and the research was conducted post-event. This type of research avoids intervention with research subjects, such as manipulating specific variables to observe their effects, enhancing the accuracy of the study's findings. The systematic methodology employed is illustrated in **Figure 1.**

Table 1. Number of Students Participating in the Bebras Challenge 2023

Category	n
Students with Scores Less Than 50	40516
Students with Scores of at Least 50	5884
Total	46400

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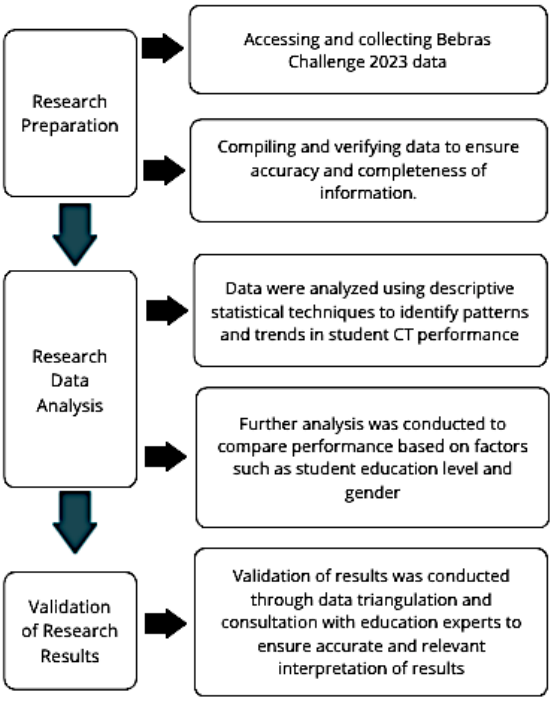

Figure 1. Research Procedure

The population for this study consists of all students who participated in the Bebras Challenge 2023 in Indonesia and achieved a minimum score of 50. This criterion was chosen to select subjects with higher or above-average CT skills to identify patterns or specific characteristics exhibited by these students. **Table 1** provides details regarding the participation in the Bebras Challenge 2023, indicating that 46,400 students participated according to the bebras.id website. After excluding students with scores below 50, 5,884 students were identified as the final study population.

Simple random sampling was employed to ensure representative and valid research findings. This involves randomly selecting sample members from the population without stratification (Amin et al., 2023). The sample size was determined through statistical calculations based on a 95% confidence level and a 1% margin of error. This approach was implemented to enhance the precision, accuracy, and generalizability of the research findings to a broader population, optimizing the quality of the study's results. Using the sample size calculation formula illustrated in Equation 1, the required sample size was determined to be 3,648 students. A complete list of eligible students was sorted and assigned numbers, and random numbers were generated using Excel software to select the sample from the population. Demographic information of the student participants is presented in **Table 2.**

$$n = \frac{N.Z^2.p.(1-p)}{(N-1).E^2+Z^2.p.(1-p)} \quad \text{.....(1)}$$

Explanation:

n = Required sample size
N = Population size (5884)
Z = Z-value for 95% confidence level (typically 1.96)
p = Proportion of success (assumed as 0.5 for the worst-case scenario)
E = Margin of error (0.01)

The data distribution across different groups includes 233 students from the Penegak category, 790 from Penggalang, 1817 from Siaga, and 907 from Si Kecil. Regarding gender, there were 2082 male students (57%) and 1566 female students (43%). This quantitative study employs an Ex Post Facto research design, utilizing data from the Bebras Challenge as the primary instrument. The dataset includes individual scores, test levels or categories, and gender demographics, as presented in Table 2.

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Table 2. Student Demographic Data

Category	Number of Students
Total Sample Size	3648
Categories based on Test Levels	
Si Kecil (Grades 1-3 Elementary)	907
Siaga(Grades 4-6 Elementary)	1817
Penggalang (Grades 7-9 Junior High)	790
Penegak (Grades 10-12 Senior High)	233
Gender Categories	
Male	2082
Female	1566

Data Collection

Data for this study was gathered from the official Bebras Challenge platform, where student test results were publicly disclosed and accessible on the bebras.or.id website under the Bebras Challenge 2023 results section. The dataset includes student names, school affiliations, organizing bureau, overall scores, test levels, and gender. The national Bebras Indonesia committee officially announced this secondary data in spreadsheet format, which is publicly available. For this research, the dataset was filtered based on specific inclusion criteria, focusing on students who achieved qualifying scores in the Bebras Challenge. The flowchart depicting the data collection process is presented in **Figure 2.**

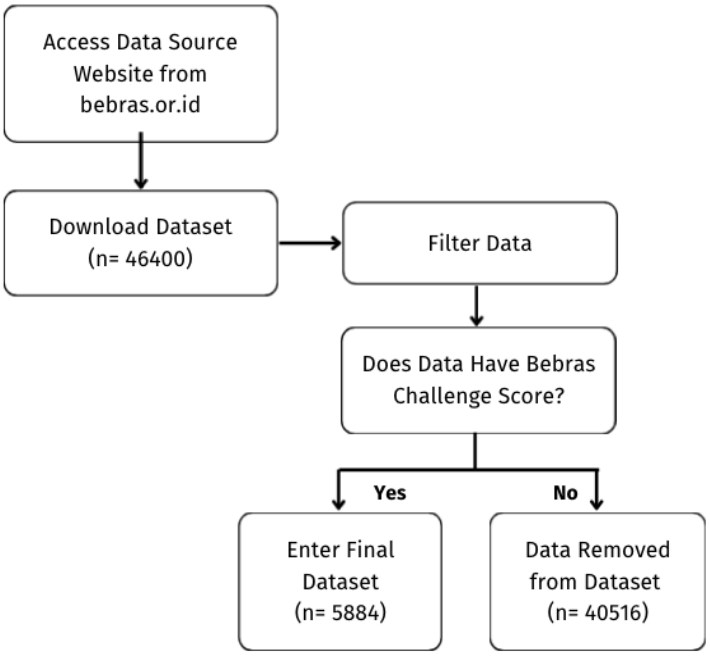

Figure 2. Flowchart of Data Collection

Data Analysis

Descriptive and inferential analyses were conducted using SPSS 23. Descriptive analysis measured mean, median, and frequency distribution to characterize students' CT abilities. Inferential statistical tests examined hypotheses regarding potential statistically significant differences among student groups. Initial data analysis requirements, including homogeneity and normality testing, were addressed. Levene's test assessed whether the research data originated from a homogeneous population, while the Kolmogorov-Smirnov test examined whether the research sample followed a normal distribution. The Kruskal-Wallis test determined if significant differences existed among the Si Kecil, Siaga, Penggalang, and Penegak groups. Additionally, the Mann-Whitney test assessed whether significant differences existed between male and female student groups.

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Validation and Ethical Considerations

Research adhered strictly to ethical principles by prioritizing the confidentiality of students' data. Individual identities and school affiliations were not disclosed, minimizing potential ethical concerns arising from the research findings. The data organization's credibility, trustworthiness, and reputation were verified to ensure the validity of the secondary data obtained from the bebras.or.id website. This verification process ensured that the data was accurate and reliable for the study's purposes. A one-time data collection methodology maintained consistency. The data collection and processing process was meticulously documented using Microsoft Excel to ensure transparency and reproducibility.

Limitations

Several limitations of this study must be acknowledged. These include restricted access to highly detailed data and potential biases in the sampling process. Additionally, the results of the Bebras Challenge may only partially capture students' CT abilities in other contexts.

3. FINDINGS

The study investigates Indonesian students' CT capabilities using data from the 2023 Bebras Challenge, focusing on participants who scored above 50. The evaluation covers the overall CT proficiency of students and examines disparities in CT skills across different educational levels and genders. Statistical analyses provide a comprehensive understanding of these dimensions.

Overview of Sample Characteristics

Based on **Table 1**, the study comprises a total sample size of 3,648 participants. Students are classified into four groups based on their participation in test categories: Si Kecil (Grades 1-3 of elementary school) with 907 students, Siaga(Grades 4-6 of elementary school) with 1,817 students, Penggalang (Grades 7-9 of junior high school) with 790 students, and Penegak (Grades 10-12 of senior high school) with 233 students. Additionally, students are categorized by gender: 2,082 male and 1,566 female. Student scores were analyzed to generate descriptive statistics, as shown in **Table 3**.

Table 3. Statistical Data of Students

Descriptive Statistic	
Mean	67,41
Median	64,58
Mode	56,25
Standard Deviation	13,43
Minimum	50
Maximum	100
Count	3648

Table 3 presents comprehensive statistical data on students, detailing the distribution of scores and demographic characteristics. Analysis of **Table 3** reveals that the mean score among students is 67.41 out of a total sample of 3,648 participants. The highest score achieved is 100. The most frequently attained score by students in the Bebras Challenge is 56.25

Descriptive Analysis of CT Performance

A comprehensive understanding of CT abilities across student groups—Si Kecil, Siaga, Penggalang, and Penegak—is provided through descriptive statistical analysis in **Table 4.**

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Table 4. Statistical Data of Bebras Scores of Students in 2023 Based on Level

Descriptive Statistic	Si Kecil	Siaga	Penggalang	Penegak
Mean	71.32	67.73	63.64	62.61
Median	68.75	64.58	60.67	58.67
Mode	84.38	64.58	52.83	50
Standard Deviation	14.57	13.14	11.82	10.94
Minimum	50	50	50	50
Maximum	100	100	100	91.05
Count	907	1718	790	233

The maximum score achieved by students in the Si Kecil, Siaga, and Penggalang groups is 100, while in the Penegak group, it is 91.05. The Si Kecil group exhibits an average score of 71.32, with the most frequent score being 84.38. There is notable variability in scores within this group, reflected by a standard deviation 14.57. The Siaga group shows an average score of 67.73, with a common score of 64.58 and a standard deviation of 13.14, indicating less variability than the Si Kecil.

The Penggalang group records an average score of 63.64, with a mode of 52.83 and a standard deviation of 11.82, suggesting relatively consistent scores within this group. Similarly, the Penegak group has an average score of 62.61, with 50 being the most frequent score obtained. This group demonstrates even less variability with a standard deviation 10.94, indicating greater score uniformity than previous groups.

Descriptive Statistics by Gender

Descriptive statistics of CT abilities across gender groups reveal potential performance disparities between male and female students. Results indicate a marginal difference in performance between male and female students who scored a minimum of 50 in the 2023 Bebras Challenge. Male students predominantly scored 62.50, while female students scored 56.25. On average, male students attained a slightly higher score (67.85) than female students (66.83). Median scores also indicate a slight advantage for male students (64.58) over female students (63.33). Male students exhibit slightly higher variability in score distribution, with a standard deviation of 13.56, whereas female students show a standard deviation of 13.24. Both groups achieved the same maximum score of 100. The number of male participants (2,082) exceeds that of female participants (1,566). Despite these slight differences, the overall performance of male and female students in the Bebras Challenge 2023 does not exhibit significant disparity, as shown in **Table 5.**

Table 5. Statistical Data of Bebras Scores of Students in 2023 Based on Gender

Descriptive Statistic	Male	Female
Mean	67.85	66.83
Median	64.58	63.33
Mode	62.50	56.25
Standard Deviation	13.56	13.24
Minimum	50	50
Maximum	100	100
Count	2082	1566

Inferential Statistics

Homogeneity and Normality Test

Preliminary tests were conducted to assess the homogeneity of variances and the normality of Bebras Challenge scores before conducting mean difference tests for each group of students. Levene's test examined the homogeneity of variances across groups, while the Kolmogorov-Smirnov test assessed the normality of score distributions. The results of these tests are presented in **Table 6** and **Table 7.**

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Table 6. Homogeneity Test Results (Levene's Test)

Statistic	df1	df2	Sig.
19.339	5	3642	0.000

Table 7. Normality Test Results

Test	Statistic	df	Sig.
Kolmogorov-Smirnov	0.101	3648	0.000
Shapiro-Wilk	0.945	3648	0.000

Levene's test results indicate that the variance of student scores in the Bebras Challenge 2023 data is not homogeneous (Sig. < 0.05). Similarly, the Kolmogorov-Smirnov and Shapiro-Wilk test results show that the distribution of student scores deviates from normality (Sig. < 0.05). As the data does not satisfy the assumptions for parametric tests, non-parametric tests were employed. Specifically, the Kruskal-Wallis test compared groups across educational levels, and the Mann-Whitney test compared scores between gender groups.

Comparative Analysis

Findings of inferential statistical analyses examine disparities in students' CT abilities across different educational levels and genders. The Kruskal-Wallis test assessed variations across educational levels, while the Mann-Whitney test determined differences between genders.

Table 8a shows the mean ranks of students' scores across the Si Kecil, Siaga, Penggalang and Penegak groups. **Table 8b** presents the test statistics for the Kruskal-Wallis test.

Table 8a. Kruskal-Wallis Test Results (Mean Rank)

Level	N	Mean Rank
Si Kecil	907	2121.30
Siaga	1718	1863.01
Penggalang	790	1511.40
Penegak	233	1446.77
Total	3648	

Table 8b. Kruskal-Wallis Test Results (Test Statistics)

Statistic	Value
Chi-Square	174.220
df	3
Asymp. Sig.	0.000

Kruskal-Wallis test results indicate significant differences in scores among the Si Kecil, Siaga, penggalang and Penegak groups (Asymp. Sig. < 0.05). This result rejects the null hypothesis (H_0) that there is no difference in scores among these groups, confirming the alternative hypothesis (H_1) of score differences among the groups.

Table 9a shows male and female students' mean ranks and sum of ranks. **Table 9b** presents the test statistics for the Mann-Whitney test.

Table 9a. Mann-Whitney Test Results (Mean Rank and Sum of Ranks)

Gender	N	Mean Rank	Sum of Ranks
Male	2082	1858.38	3869140.50
Female	1566	1779.46	2786635.50
Total	3648		

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Table 9b. Mann-Whitney Test Results (Test Statistics)

Statistic	Value
Mann-Whitney U	1559674.500
Wilcoxon W	2786635.500
Z	-2.241
Asymp. Sig. (2-tailed)	0.025

Mann-Whitney test results reveal a significant difference in CT performance between male and female students (Asymp. Sig. < 0.05). This rejects the null hypothesis (H_0) that there is no difference in scores between male and female groups, confirming the alternative hypothesis (H_1) of score differences between genders.

4. Discussion

Performance of Computational Thinking Skills of Indonesian Students

Computational Thinking skills have become a significant focus in educational research in Indonesia, particularly in the context of the digital age. Evaluating CT performance among students who score between 50 and 100 in the Bebras Challenge provides valuable insights for improving educational models and addressing enrichment needs. This study explores the level of CT proficiency among Indonesian students and analyzes the differences in their abilities across various educational levels and genders.

Initial findings reveal that Indonesian students achieved an average score of 67.41 among those who scored at least 50 points in the Bebras Challenge 2023, indicating relatively strong performance. This finding is important for educators, stakeholders, and policymakers as it suggests a positive potential in this domain that could inform further educational strategies. With appropriate support, there is significant potential to enhance CT skills across the student population in Indonesia. Given the study's limitations, further research is recommended to conduct qualitative analyses through interviews or surveys with high-achieving students to elucidate effective learning strategies, motivational factors, family support, and other influential elements. Such insights could inform strategies to improve CT skills among students who have not yet reached their full potential.

Only 13% of participating students scored above 50, emphasizing the need for comprehensive efforts to improve CT skills among Indonesian students, considering the relatively low overall scores. These findings have significant implications for CT education in Indonesia, particularly concerning developing and implementing effective teaching strategies. Project-based learning methods and the use of technological tools could enhance CT skills. Designing enrichment programs and providing additional support should be prioritized to assist students who have not yet realized their full potential. Educational policies must ensure adequate attention to CT education, including integrating CT into the school curriculum, allocating budgets for educational resources, and providing professional development programs for teachers.

These findings align with previous research highlighting the widespread need for improvement in CT skills among Indonesian students (Gunawan et al., 2023; Izzah et al., 2023). Nuvitalia et al (2022) suggests that suboptimal teaching materials, methods, and models may contribute to these deficiencies. The study also identifies significant performance gaps, with most students scoring around 56.25, indicating a disparity between those with excellent CT skills (score of 100) and those who meet the minimum threshold of 50. Addressing this gap requires increased attention from educators and policymakers to ensure equitable access to CT skill development opportunities across all educational levels in Indonesia. Workshops and specialized teacher training, developing systematically integrated CT curricula, and creating e-learning platforms that provide quality CT learning materials in remote areas are necessary.

Educators are encouraged to implement effective teaching strategies that have proven successful in enhancing student CT abilities, such as robotics education applied to K-12 education in Italy (Chiazzese et al., 2019), programming instruction applied to K-12 education in China (Kong, 2016), interactive classroom activities used in early childhood education in the United States (Lee et al., 2023), and STEAM integration applied to middle

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school students in Lithuania (Juškevičienė et al., 2021). Factors influencing CT performance include teaching quality, curriculum design, and access to technology. Therefore, a coherent approach to integrating computational concepts throughout the curriculum is crucial. Addressing socioeconomic disparities is vital as they can limit access to educational resources that support CT learning. Recommendations for addressing these disparities include comprehensive teacher training, integration of CT-focused curricula, and ensuring equitable access to technology and educational resources across regions, including remote and economically disadvantaged areas. Implementing these measures is expected to significantly enhance students' CT skills, preparing them for success in the digital world.

Differences in CT Performance Across Educational Levels

Analysis reveals significant differences in average scores on the Bebras Challenge 2023 across various educational levels, consistent with findings by Natali and Nugraheni (2023), highlighting varying levels of CT performance among different age groups in Indonesia. This underscores the need for ongoing efforts to enhance students' CT skills over time (Atmatzidou & Demetriadis, 2016). These results contrast with studies conducted by Korucu et al. (2017) and Rijke et al. (2018). Such differences may be attributed to variations in curriculum, teaching approaches, or socioeconomic conditions in the countries where these studies were conducted.

Younger students often improve CT skills more than older age groups, highlighting the importance of readiness and appropriate teaching approaches for each educational level (Chiazzese et al., 2019). This study observed the highest average scores among elementary school students, followed by junior, intermediate, and senior students, indicating a decline in CT skills as students progress through higher educational levels. This decline requires special attention. One possible reason is that older students might experience reduced interest or motivation in learning CT skills if they do not see direct relevance to their academic or career goals. Strategies to enhance student motivation and engagement are needed, including demonstrating how CT skills apply to real-world contexts and career opportunities.

Despite the Bebras Challenge adjusting questions to fit the specific difficulty level of each grade, research by Natali and Nugraheni (2023) suggests that questions for junior and senior high school students may not always align with their cognitive abilities. Maintaining appropriate question difficulty—neither simple nor too complex—is crucial for effectively assessing CT skills across all educational levels. One contributing factor to lower average CT scores at higher educational levels may be differences in curriculum structure. Higher education levels often emphasize specialized subjects that may not prioritize CT skill development uniformly. Additionally, the depth and complexity of educational content at these levels might shift focus away from enhancing CT skills.

There is a critical need for explicit and systematic integration of CT learning throughout all educational levels. This requires curriculum revisions emphasizing computational skills essential for students' future academic and professional readiness. The education system should shift to ensure fair opportunities for all students to develop strong CT skills, supported by comprehensive resources and a curriculum that aligns with holistic skill development goals.

Differences in CT Performance Across Genders

The study findings reveal significant gender disparities in average scores on the Bebras Challenge 2023, with statistical analysis indicating that male students achieved higher average scores than female students. This difference suggests potential variations in problem-solving approaches or computational strategies between genders. Boys and girls may have different thinking styles; for instance, boys often display a greater tendency toward systematic and logical approaches to problem-solving, while girls might be more inclined to use relational or collaborative approaches (Duffy et al., 1997). These variations could impact how they tackle tests like the Bebras Challenge.

Societal perceptions and expectations regarding CT abilities can influence students' motivation and

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interest in this domain. Stereotypes suggesting that boys excel in technology can undermine girls' confidence and affect their career choices. Varying levels of support and encouragement based on gender in their environments may further impact students' engagement in computational learning.

Addressing gender gaps in CT skills is crucial for education, as these disparities can affect career paths and perpetuate gender imbalances in technology and STEM fields overall. Such imbalances can ultimately limit the skilled workforce's ability to innovate and advance. Psychological differences between genders also play a role, with girls often showing strengths in verbal tests while boys excel in spatial and mathematical assessments (Hyde, 2016). Recognizing that these stereotypes do not universally apply and can vary among individuals is important. A meta-analysis by Hyde (2016) further suggests that there are typically no inherent differences in problem-solving and computational thinking abilities between male and female students.

Several recommendations should be considered to promote gender equality in CT education. Developing inclusive educational programs that encourage early engagement of female students in CT concepts is crucial. Training educators to recognize and address gender biases in teaching practices can create a supportive learning environment for all students. Educating parents and communities about gender equality in STEM fields and encouraging equitable support for students in technology-related endeavors is essential. Supporting educational policies that actively promote gender equality and remove barriers to female students' participation in computational fields can facilitate a more inclusive educational landscape. Implementing these measures is expected to foster an environment where all students, regardless of gender, can thrive and effectively develop their computational thinking and technological skills.

5. CONCLUSION

The findings and discussions presented in this study reveal several significant conclusions regarding CT skills among Indonesian students. A substantial majority, 87%, of students scored below the minimum threshold of 50 in the Bebras Challenge 2023, indicating a pervasive low level of CT proficiency. Even among those surpassing the threshold, many achieved scores around 56.25, highlighting a stark disparity between students with higher CT abilities and those at the minimum competency level. This underscores the urgent need for comprehensive efforts to enhance the quality of CT education across Indonesia. Effective strategies successfully implemented in various countries such as the United States, Italy, Lithuania, and China—including robotics education, programming learning, interactive games, and integrating CT with STEAM subjects—can serve as alternatives to overcome this challenge. Factors influencing CT performance, such as teaching quality, curriculum design, and access to technology, further underscore the need for strategic interventions. Notable discrepancies in CT proficiency across different educational levels were identified, with primary-level students (grades 1-3) exhibiting higher average scores than their senior-level counterparts (high school). This discrepancy necessitates tailored adjustments in curricula and educational approaches that cater to students' developmental stages, ensuring a more effective CT education system. Gender-based differences in CT skills were evident, with male students consistently achieving higher average scores than female students in the Bebras Challenge 2023. This disparity emphasizes the importance of implementing inclusive CT education practices that foster gender equity and promote equal participation in the computing field. Collaborative efforts involving educators, policymakers, and the community are indispensable in fostering the development of CT skills among Indonesian students. Recommendations include the formulation of cohesive curricula seamlessly integrating CT, extensive training programs for teachers in CT instruction, and establishing inclusive learning environments that provide equal support to all students. Implementing these recommendations can effectively enhance CT education in Indonesia, preparing students to excel in an increasingly digital world while ensuring equitable access and opportunities for all learners.

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