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The Socio-Scientific Issues Approach as A Catalyst for Critical Thinking Skills in Elementary School

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ABSTRACT

This research aims to evaluate the effectiveness of the Socio-Scientific Issues (SSI) approach in improving students' critical thinking skills within the context of 21st-century learning. The type of research employed in this study is quantitative research using a quasi-experimental approach with a non-equivalent control group design. The sample in this research consisted of 57 students. Data collection techniques included tests and observations. Data analysis involved normality testing, homogeneity testing, linearity testing, and hypothesis testing. The results of the normality test showed a significance value of 0.189 based on the Kolmogorov-Smirnov test. Since 0.189 > 0.05, it indicates that the data from both groups are normally distributed. The homogeneity test in the Test of Homogeneity of Variances table showed that both the experimental and control class data had a significance value of 0.567 > 0.05, indicating that the data are homogeneous. The linearity test results in the ANOVA table showed a significance value of 0.903 > 0.05, indicating that there is no deviation from a linear relationship between the independent and dependent variables. According the T-Test results, the significance value (sig. 2-tailed) was 0.000 < 0.05, which statistically indicates that the null hypothesis (H_0) is rejected. Therefore, it can be concluded that there is a significant effect of using the Socio-Scientific Issues (SSI) approach on improving students' critical thinking skills. This means that a learning approach based on social issues examined through a scientific lens has proven to be effective in fostering the development of students' critical thinking abilities.

1. INTRODUCTION

The rapid advancement of science and technology in the 21st century has had a significant impact on various aspects of life, including education. The 21st century is characterized by rapid technological advancements and a more globalized economy, and critical thinking has emerged as a highly relevant and indispensable skill for students (Chen et al., 2024; Geng et al., 2024; Santos-Meneses & Drugova, 2023; Solikah et al., 2024). Students employ this skill to solve problems, gather evidence, and evaluate information (Song et al., 2024). Through critical thinking, students can distinguish accurate from inaccurate information. Within this framework, education is no longer expected to focus solely on content mastery but must also emphasize the development of higher-order thinking skills (HOTS) that able to equip students to face the complex and dynamic global challenges. To address these demands, it is essential to cultivate critical thinking skills. These skills serve as a fundamental foundation for students in navigating diverse information and in making sound and responsible decisions. Critical thinking is a mental process that involves the ability to analyze information in depth, evaluate the validity of arguments, identify hidden assumptions, and draw logical and relevant conclusions. Critical thinking as the ability to assess a situation objectively, consider multiple perspectives, and provide reasoned and evidence-based responses.

Nowadays in the digital era, where students are exposed to an overwhelming flow of information that may not always be accurate or valid, critical thinking becomes an essential skill to protect them from being easily influenced by misleading content. Critical thinking is widely recognized as essential for academic success and professional development (Le & Chong, 2024; Lucas, 2019; Van et al., 2022). It is often described as a higher-order cognitive process focusing on an individual's ability to comprehend a problem and devise reasonable solutions (Li et al., 2024). This process is characterized by systematic analysis of information, consideration of multiple perspectives, and application of logical reasoning to make sound judgments and decisions (Tang et al., 2024; Yusuf et al., 2024). Therefore, to develop a high-quality human capital capable of competing in technological innovation, it is imperative to cultivate the critical thinking skills of the younger generation, enabling them to efficiently seek and evaluate information (Lestari & Sunarso, 2024).

Moreover, critical thinking is an instrumental in enhancing the quality of classroom learning. With critical thinking, students are not just passive recipients of information but active participants in constructing knowledge, questioning received information, and finding solutions to the problems they encounter. Therefore, transforming critical thinking into a fundamental component of every learning process is crucial. This can be achieved through the implementation of teaching approaches and strategies that encourage students to explore, discuss, employ an open-minded approach, and reflect independently. Education in the 21st century must position critical thinking as the foundation for shaping competent, adaptive learners who can contribute positively to society and the nation.

Aligned with 21st-century learning paradigms, teachers are no longer merely transmitters of information but are required to become facilitators capable of designing learning experiences that focus on the development of 21st-century skills. Modern education must include the development of Critical Thinking and Problem Solving, Creativity and Innovation, Communication, Collaboration, Character, and Global Citizenship collectively as known as the 6C skills (British Council, 2022; Shabrina & Utari, 2022). These six competencies form the essential foundation for equipping students to adapt to increasingly complex, dynamic, and unpredictable global challenges.

Education ought to progress further at achieving cognitive outcomes, nevertheless emphasis needs to be placed on building higher-order thinking skills that enable students to evaluate information objectively, solve problems, and make informed decisions in real-life situations. One learning approach that has proven relevant and effective in achieving these goals is the Socio-Scientific Issues (SSI) approach. This approach integrates social issues related to science into the learning process, especially those that are controversial, complex, and require ethical judgment (Fita et al 2021). Utilizing this approach, students are invited to explore issues from multiple perspectives, analyze their impacts, and formulate logical and responsible solutions. SSI-based learning not only broadens students' understanding of scientific and social literacy but also strengthens reflective and argumentative thinking, as well as enhances moral sensitivity in decision-making.

This approach cultivates a bridge between academic content and real life, making learning more contextual and meaningful. In practice, students are trained to construct arguments based on scientific evidence, consider others' viewpoints, and effectively communicate their ideas. Therefore, integrating SSI into the curriculum is vital for shaping a generation of learners who are critical, adaptive, and socially and intellectually responsible in today's society.

The Socio-Scientific Issues (SSI) approach has been shown to effectively enhance student engagement, argumentative ability, and higher-order thinking skills. It has the potential to support the development of intellectual capacity, communication skills, social behavior, empathy, and student

participation. Thus, learning is no longer teacher-centered but also motivates students to actively engage and sharpen their critical thinking skills through real-life social events.

In learning process of the fifth-grade subject *Pancasila in My Life*, students are expected to think critically about emerging problems. However, in reality, teachers often rely on monotonous teaching methods such as lectures and assignments and tend to adopt a teacher-centered approach. This is evidenced by various national assessments and literature studies that highlight the lack of learning activities that encourage students to analyze, evaluate, and reflect on information in depth. One of the main causes is the continued use of conventional, teacher-centered approaches with minimal reflective dialogue. Teachers play a significant role from the planning of innovative learning to its implementation and evaluation (Mbuik & Nitte, 2025). To enhance students' critical thinking skills, teachers should use an effective to organize classroom learning processes appropriately. According to Cahyaningsih & Nahdi (2020), developing suitable instructional media aligned with appropriate learning models is crucial for effective classroom organization. Instructional media play a significant role in the learning process as they can simplify complex or abstract concepts that may be difficult for students to grasp. The entire educational process, from planning innovative instruction, conducting teaching and learning activities in the classroom, to evaluating learning outcomes, hinges on the teacher. In the planning stage, teachers are expected to design learning strategies that are not only aligned with the curriculum but also relevant to the needs and characteristics of students. Innovations at this stage may include selecting creative learning methods, using engaging digital media, or developing contextual and meaningful learning materials. The teacher's role as a learning designer is crucial in creating effective and enjoyable learning experiences. During the execution phase, teachers are responsible for applying the plan in the classroom. In this study, pedagogical skills and communication abilities are essential. Teachers must guide, motivate, and manage the classroom effectively to create a conducive learning environment. Equally important is the teacher's role in evaluating the learning process and outcomes. Evaluation should go beyond academic achievement and serve as a foundation for continuous improvement. Teachers, as motivators in the learning process, play a crucial role during the planning phase, which begins with evaluating students' needs, interests, and levels of understanding. This evaluation enables them to design instruction that is responsive to learners' needs. Teachers create motivating learning environments by providing diverse resources, learning materials, and a variety of strategies and approaches to accommodate different learning styles. Furthermore, in planning instruction, teachers are required to use technology wisely by integrating it into the learning process to support and enhance students' motivation to learn (Rifai, Nahak et al., 2024). Therefore, the teacher is not merely a content deliverer but also a change agent who plays a strategic role in improving education quality through ongoing innovation particularly in developing students' critical thinking skills through approaches such as Socio-Scientific Issues (SSI).

This research aims to evaluate the effectiveness of the Socio-Scientific Issues (SSI) approach in enhancing students' critical thinking skills in 21st-century learning. The SSI approach is selected for its ability to integrate relevant social issues with scientific knowledge, thereby encouraging students to analyze, evaluate, and make decisions logically and responsibly. In an increasingly complex and dynamic world, critical thinking is an essential asset that every individual must possess, especially when facing real-world problems that require reflective thinking and rational solutions. It is expected that this study will provide a significant contribution to the development of innovative and contextual learning strategies. The results will not only enrich educational scholarship but also serve as a practical reference for educators in designing instruction that equips students with 21st-century skills. Therefore, the SSI approach is anticipated to be one of the strategic solutions in addressing the demands of modern

education, which increasingly requires active student engagement in meaningful, problem-solving-oriented learning experiences.

2. METHODOLOGY

This research employed a quantitative research design utilizing a quasi-experimental approach, specifically the posttest only design non equivalent control group as described by Creswell (2024). This design was chosen because it allows for comparison of treatment effects between two naturally existing groups that were not randomly assigned, which aligns with the real conditions of the school environment. The study aimed to evaluate the effectiveness of the Socio-Scientific Issues (SSI) approach in enhancing students' critical thinking skills in the context of 21st-century learning. The sample consisted of all fifth-grade students from SD Negeri Sikumana 2, Kupang City, totaling 57 participants. The participants were divided into two groups: the experimental class (VA), which included 28 students and received instruction using the SSI approach, and the control class (VB), which included 29 students and was taught using conventional methods. Data collection techniques included a critical thinking skills test and classroom observation to examine both students' cognitive outcomes and their engagement during the learning process. To ensure the validity and reliability of the findings, the data were analyzed through several statistical procedures, including tests of normality (to assess the distribution of data), homogeneity tests (to test the equality of variances), linearity tests (to examine the relationships among variables), and hypothesis testing (to determine significant differences between the groups). These analyses provided a foundation for drawing objective and evidence-based conclusions regarding the impact of the SSI approach on critical thinking development among elementary school students.

Table 1. Research Design

E	x	O_1
K	-	O_2

3. RESULTS AND DISCUSSION

Results

This research, the improvement of students' critical thinking skills in the experimental class after being treated using the Socio-Scientific Issues (SSI) approach showed a significant increase, as evidenced by the distribution of student scores in the experimental and control classes presented down below :

Table 2. Score Distribution of Experimental and Control Classes

Experimental			Control		
N	Valid	28	N	Valid	29
	Missing	0		Missing	0
Mean		84.75	Mean		58.90
Median		85.00	Median		60.00
Mode		78	Mode		55
Std. Deviation		6.985	Std. Deviation		7.570
Variance		48.787	Variance		57.310
Range		26	Range		29
Minimum		74	Minimum		46
Maximum		100	Maximum		75
Sum		2373	Sum		1708

Based on the calculation results presented in the table above, a significant difference is observed between the average scores of students in the experimental and control classes following the learning process. The experimental class, which received treatment through the Socio-Scientific Issues (SSI) approach, achieved an average score of 84.75 from a total of 28 valid samples. These findings indicate that the SSI approach is effective in enhancing students' critical thinking skills. Through this approach, students are encouraged to analyze socio-scientific issues, consider multiple perspectives, and construct arguments based on empirical data and scientific evidence.

Meanwhile, the control class, which employed only conventional teaching methods, recorded an average score of 58.90 from 29 valid samples. Conventional approaches tend to be one-directional and offer limited opportunities for students to explore concepts and engage in deep thinking. These findings thus reinforce the notion that 21st-century education requires innovative approaches that not only deliver content but also foster critical, collaborative, and creative thinking skills (Parker 2022). Therefore, the SSI approach can be recommended as a relevant and adaptive instructional strategy to meet the demands of modern education. The data above represent the class mean scores, namely:

Table 3. Average Scores of the Experimental and Control Classes

	Class	N	Mean	Std. Deviation	Std.Error Mean
Enhancement of critical thinking skills	Experimentalal	28	84.74	6.985	1.320
	Control	29	58.90	7.570	1.406

According the results presented in the Group Statistics table above, the findings show that the average score of students' critical thinking skill improvement in the experimental class was 84.74. Meanwhile, the control class only achieved an average score of 58.90. Thus, there is a mean score difference of 25.85 points between the two groups. This difference indicates that students who participated in learning using the Socio-Scientific Issues (SSI) approach demonstrated a significantly greater improvement in critical thinking skills compared to those who underwent conventional instruction.

These findings reinforce the assumption that the Socio-Scientific Issues (SSI) approach is capable of creating a more stimulating and intellectually engaging learning environment. Through this approach, students are not merely passive recipients of information, but are actively involved in analyzing science-based social issues, considering multiple perspectives, and making decisions grounded in logical reasoning and scientific evidence. This aligns with the characteristics of 21st-century learning, which emphasizes the importance of higher-order thinking skills. Therefore, the SSI approach can be regarded as an effective instructional strategy to enhance the overall quality of students' critical thinking processes.

Table 4. Normality Test Results

		Unstandarized Residual
N		57
Normal Parameters[a]	Mean	.0000000
	Std. Deviation	7.22339905
Most Extreme Differences	Absolute	.144
	Positive	.144
	Negative	-.093
Kolmogorov-Smirnov Z		1.086
Asymp. Sig. (2-tailed)		.189

The normality test table presented above indicates that the data on students' critical thinking skills improvement, both in the experimental and control groups, yielded a significance value of 0.189 based on the Kolmogorov-Smirnov test. This value (0.189 > 0.05) exceeds the commonly used threshold for normality testing. Therefore, it can be concluded that the data from both groups are normally distributed. A normal distribution is a critical assumption for conducting parametric statistical analyses, such as the t-test, which is used to examine significant differences between two groups. This finding confirms that the collected data are suitable for further analysis using appropriate statistical techniques. The normality of data distribution also reflects that the sampling process and treatment administration were conducted proportionally and did not result in extreme data deviations. This adds to the validity and credibility of the research findings. Consequently, further analysis on the effectiveness of the Socio-Scientific Issues (SSI) approach in enhancing students' critical thinking skills can be carried out with a high degree of confidence, as the data distribution meets the necessary statistical assumptions

Table 5. Homogeneity Test

Levene Statistic	df1	df2	Sig.
.331	1	55	.567

The results of the homogeneity test, as presented in the Test of Homogeneity of Variances table, indicate that the data from both the experimental and control groups have a significance value of 0.567 based on Levene's test. This value is greater than the standard significance threshold of 0.05, suggesting that there is no significant difference in variances between the two groups. Namely, the data on students' critical thinking skills improvement in the experimental and control groups are homogeneous or exhibit uniform variance distribution. This homogeneity of variance is one of the fundamental assumptions required for the application of parametric statistical tests, such as the t-test, to ensure the validity of the comparative analysis between the two groups.

This condition of homogeneity also indicates that the characteristics of data distribution in both groups are relatively balanced, with no significant disparities. This strengthens the internal validity of the study, as any differences in outcomes found later can be more reliably attributed to the treatment applied (in this case, the Socio-Scientific Issues approach) rather than to external factors that might influence data distribution. Therefore, the results of the homogeneity test provide a strong statistical foundation for proceeding with further analysis on the effectiveness of the applied learning approach in enhancing students' critical thinking skills.

Table 6. Linearity Test

			Sum of Squares	df	Mean Squares	F	Sig.
Control* Experimental	Between Groups	(Combined)	451.667	11	41.061	.574	.823
		Linearity	134.554	1	134.554	1.881	.189
		Deviation from Linearity	317.113	10	31.711	.443	.903
	Within Groups		1144.333	16	71.521		
	Total		1596.000	27			

The results of the linearity test presented in the ANOVA table show a significance value of 0.903> 0.05. Based on the decision-making criteria for linearity testing, a significance value above 0.05 indicates no deviation from a linear relationship between the independent and dependent variables. In other words,

the relationship between the treatment variable namely, the Socio-Scientific Issues (SSI) approach and the variable of students' critical thinking skill improvement is linear. Therefore, the more effectively the SSI approach is implemented in the learning process, the higher the level of critical thinking skills that can be achieved by students.

This linear relationship is essential in demonstrating the consistency between the treatment applied and the outcomes achieved. In the context of 21st-century education, critical thinking skills are among the core competencies students must possess, as these abilities support them in analyzing information, evaluating arguments, and making logical and responsible decisions. The SSI approach, which integrates real-life and context-based socio-scientific issues, encourages students to engage in deeper and more reflective thinking. Therefore, the presence of a linear relationship reinforces the assumption that the SSI approach consistently contributes positively to the enhancement of students' critical thinking quality. This finding provides a strong foundation to assert that the implementation of socio-scientific issue-based learning strategies is worthy of further development and broader application within the framework of modern education aimed at cultivating higher-order thinking skills (HOTS).

Table 7. Independent Samples T-Test Results

		t-test for Equality of Means				
		t	df	Sig. (2-tailed)	Mean Difference	Std. Error Diffence
Enhancement of critical thinking skills	Equal variances asummed	13.388	55	.000	25.853	1.931
	Equal Variances not asummed	13.407	54.890	.000	25.853	1.928

According the analysis results presented in table 7, the obtained significance value (sig. 2-tailed) is 0.000, which is less than 0.05. Statistically, this indicates that the null hypothesis (H_0) is rejected. Therefore, it can be concluded that there is a significant effect of using the Socio-Scientific Issues (SSI) approach on the improvement of students' critical thinking skills. In other words, the learning approach that incorporates socially relevant issues examined through a scientific perspective has been proven effective in fostering the development of students' critical thinking abilities.

The Kolmogorov-Smirnov test showed, both the experimental and control groups shown an unstandardized residual value of 0.189, which is greater than 0.05. This indicates that the data from both groups are normally distributed, allowing for analysis using parametric statistical methods. Furthermore, a homogeneity test was conducted to examine the equality of variances between groups. The results of Levene's test revealed a significance value of 0.567, which exceeds the threshold of 0.05, indicating that the data have homogeneous variances.

Moreover, the linearity test presented in the ANOVA table shows a significance value of 0.903, which is well above the 0.05 threshold. This indicates that the relationship between the independent variable (the SSI approach) and the dependent variable (critical thinking skills) is linear. Within this framework, the more effectively the SSI approach is implemented, the greater the improvement in students' critical thinking skills that can be achieved.

The culmination of the overall analysis is demonstrated through the t-test for hypothesis testing. In this test, a significance value (2-tailed) of 0.000 < 0.05 was obtained. This result further strengthens the evidence that the use of the Socio-Scientific Issues (SSI) approach has a significant effect on improving students' critical thinking skills. Thus, this approach has proven to be effective when applied to classroom learning, particularly among fifth-grade students at SD Negeri Sikumana 2 Kota Kupang in the lesson "Pancasila in My Life."

Holistically, these findings confirm that the SSI approach is capable of creating a contextual learning environment that encourages students to think reflectively, critically, and responsibly in addressing real-life issues. In the era of 21st-century education, this approach is highly relevant for broader adoption as it not only enhances students' cognitive competence, but also fosters social awareness and value-based decision-making skills.

Discussion

The findings of this study demonstrate that the Socio-Scientific Issues (SSI) approach significantly enhances students' critical thinking skills, as evidenced by the substantial mean score difference between the experimental group (84.75) and the control group (58.90). These results align with contemporary educational research emphasizing the necessity of developing higher-order thinking skills in 21st-century learning contexts (Chen et al., 2024; Geng et al., 2024; Santos-Meneses & Drugova, 2023).

The effectiveness of the SSI approach in fostering critical thinking can be attributed to its pedagogical framework that transforms students from passive information recipients into active knowledge constructors. This transformation is consistent with theoretical foundations that position critical thinking as a higher-order cognitive process involving systematic analysis, perspective consideration, and logical reasoning application (Li et al., 2024; Tang et al., 2024; Yusuf et al., 2024). The SSI approach operationalizes these cognitive processes by presenting students with authentic socio-scientific dilemmas that require evidence-based argumentation and ethical reasoning.

The substantial improvement observed in the experimental group supports previous research highlighting critical thinking as essential for academic success and professional development (Le & Chong, 2024; Lucas, 2019; Van et al., 2022). The SSI approach's integration of controversial, complex social issues requiring ethical judgment (Fita et al., 2021) creates learning environments that mirror real-world problem-solving scenarios, thereby enhancing students' capacity to "assess situations objectively, consider multiple perspectives, and provide reasoned and evidence-based responses" as conceptualized in contemporary critical thinking frameworks.

From a theoretical perspective, the SSI approach addresses the fundamental challenge identified in 21st-century education: moving beyond content mastery toward developing higher-order thinking skills (HOTS) that equip students for complex global challenges. The approach's effectiveness lies in its ability to bridge academic content with real-life applications, making learning contextual and meaningful while simultaneously developing the 6C skills (Critical Thinking and Problem Solving, Creativity and Innovation, Communication, Collaboration, Character, and Global Citizenship) identified as essential 21st-century competencies (British Council, 2022; Shabrina & Utari, 2022).

The statistical validation of this study's findings strengthens the empirical foundation for SSI implementation. The normal distribution of data (Kolmogorov-Smirnov test: $p = 0.189 > 0.05$), homogeneity of variances (Levene's test: $p = 0.567 > 0.05$), and linear relationship between variables ($p = 0.903 > 0.05$) provide robust methodological support for the significant treatment effect ($p = 0.000 < 0.05$). This linear relationship particularly reinforces the theoretical assumption that systematic implementation of socio-scientific issue-based learning consistently enhances critical thinking development.

The pedagogical implications of these findings extend beyond mere instructional technique adoption. The SSI approach addresses the identified deficiency in conventional, teacher-centered methodologies that limit reflective dialogue and higher-order thinking development. As Lestari & Sunarso (2024) emphasize, developing suitable instructional approaches aligned with appropriate learning models is crucial for effective educational outcomes. The SSI approach fulfills this requirement by providing a

structured framework for integrating real-world issues with scientific inquiry, thereby fostering the analytical, evaluative, and reflective capabilities essential for navigating information-rich digital environments.

Furthermore, the study's findings contribute to understanding how educational approaches can effectively address the challenge of preparing students to "distinguish accurate from inaccurate information" in an era of overwhelming information flow (Song et al., 2024). The SSI approach's emphasis on evidence-based reasoning and multiple perspective consideration directly addresses this contemporary educational imperative, supporting students' development as critical information consumers and responsible decision-makers.

The practical significance of these results extends to curriculum design and teacher professional development. The approach's success in enhancing critical thinking skills suggests that educational systems must prioritize innovative pedagogical strategies that move beyond traditional content delivery toward more sophisticated learning experiences. This aligns with research emphasizing teachers' strategic roles as change agents in improving education quality through ongoing innovation, particularly in developing students' critical thinking capabilities through approaches such as SSI.

In conclusion, this study's findings provide empirical support for the theoretical proposition that socio-scientific issue-based learning represents a viable solution for addressing 21st-century educational demands. The SSI approach's demonstrated effectiveness in fostering critical thinking skills positions it as a pedagogically sound strategy for preparing students to engage meaningfully with complex, real-world challenges while developing the intellectual capabilities necessary for active citizenship and professional success in an increasingly interconnected global society.

4. CONCLUSION

Based on the findings of this research, it can be concluded that the Socio-Scientific Issues (SSI) approach exerts a statistically significant influence on the enhancement of students' critical thinking skills. This conclusion is supported by the substantial difference in the mean learning outcome scores between the experimental and control groups. The experimental group, which was taught using the SSI approach, achieved a mean score of 84.75, whereas the control group, which did not receive instruction through the SSI approach, obtained a lower mean score of 58.90. The resulting difference of 25.85 points indicates that the SSI approach has a demonstrably positive and tangible impact on the development of students' critical thinking abilities.

Furthermore, hypothesis testing using the paired sample t-test revealed a two-tailed significance value of 0.000 (< 0.05), indicating that the null hypothesis (H_0) is rejected and the alternative hypothesis (H_a) is accepted. Statistically, this result confirms that the SSI approach significantly affects students' critical thinking skills. In other words, the SSI approach proves to be an effective pedagogical method in fostering higher-order thinking skills, which are essential competencies in 21st-century education.

The SSI approach, by integrating contemporary socio-scientific issues into the context of science or other content areas, provides students with authentic opportunities to engage actively in the learning process. This method trains students to critically analyze information, formulate arguments based on evidence, consider diverse viewpoints, and make ethical and logical decisions. These skills are central to critical thinking, which is increasingly vital in today’s complex and rapidly evolving society.

Moreover, the findings suggest that the SSI approach not only improves students' conceptual understanding of subject matter but also cultivates their reflective thinking, social awareness, and ability to solve problems both independently and collaboratively. Students’ active involvement in exploring real-

world, contextual issues contributes to a learning experience that is more meaningful, relevant, and applicable to everyday life.

In conclusion, the implementation of the Socio-Scientific Issues approach can be regarded as a highly promising instructional strategy in shaping learners who are not only academically proficient but also socially responsive and critically minded. The results of this study contribute constructively to pedagogical innovation, particularly in subjects related to science and social issues. Therefore, it is recommended that educators at various educational levels consider the SSI approach as a viable alternative in designing instructional practices that are intellectually challenging, contextually grounded, and aligned with the demands of the contemporary era.

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