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THE EFFECT OF THE PANCASILA LEARNING APPROACH BASED ON SOCIO-SCIENTIFIC ISSUES ON IMPROVING ENVIRONMENTAL CONCERN ATTITUDES OF STUDENTS AT SMP NEGERI 2 TAKENGON

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Abstract: *The purpose of this study was to determine whether there is a significant influence of the Socio-Scientific Issues-Based Pancasila Learning Approach on Increasing Environmental Awareness of Students at SMP Negeri 2 Takengon. The approach used in this study is a quantitative approach. A quantitative approach is a study whose research data is in the form of numbers and is analyzed using statistics. The choice of this approach is based on the consideration that the researcher wants to see whether there is a significant influence on students' environmental awareness attitudes before and after the implementation of Socio-Scientific Issues (SSI)-based Pancasila learning at SMP Negeri 2 Takengon. The results of the study stated that at a significant level of α = 0.05, tcount = 4.57 and ttable = 2.011 were obtained, and this means that because –ttable < tcount > ttable, namely -2.011 < 4.57 > 2.011, it can be concluded that Ho is rejected and Ha is accepted: namely "There is a strong and significant influence from the application of the Pancasila learning approach based on Socio-Scientific Issues in increasing students' caring attitudes towards the environment at SMP Negeri 2 Takengon.*

Keywords: *Pancasila Learning, Approach Based on Socio-Scientific Issues, Improving Environmental, Awareness in Students*

Abstrak: Penelitian ini bertujuan untuk mengetahui apakah terdapat pengaruh yang signifikan dari pendekatan pembelajaran Pancasila berbasis *Socio-Scientific Issues* (SSI) terhadap peningkatan kepedulian lingkungan peserta didik di SMP Negeri 2 Takengon. Penelitian ini menggunakan pendekatan kuantitatif, yaitu pendekatan penelitian yang datanya berupa angka dan dianalisis menggunakan metode statistik. Pemilihan pendekatan ini didasarkan pada tujuan penelitian untuk mengetahui ada atau tidaknya pengaruh yang signifikan terhadap sikap kepedulian lingkungan peserta didik sebelum dan sesudah diterapkannya pembelajaran Pancasila berbasis Socio-Scientific Issues (SSI) di SMP Negeri 2 Takengon. Hasil penelitian menunjukkan bahwa pada taraf signifikansi α = 0,05, diperoleh nilai (t hitung=4,57) dan (t tabel=2,011). Karena nilai (t hitung) lebih besar daripada (t tabel), yaitu 4,57 > 2,011, maka H_0 ditolak dan H_a diterima. Dengan demikian, dapat disimpulkan bahwa terdapat pengaruh yang kuat dan signifikan dari penerapan pendekatan pembelajaran Pancasila berbasis *Socio-Scientific Issues* terhadap peningkatan sikap kepedulian lingkungan peserta didik di SMP Negeri 2 Takengon.

Kata Kunci: Pembelajaran Pancasila, Pendekatan Berbasis Isu Sosial-Sains, Meningkatkan Kesadaran Lingkungan pada Peserta Didik

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INTRODUCTION

Sustainable development has become a global priority in response to increasingly complex environmental challenges, including pollution, waste accumulation, ecosystem degradation, and the unsustainable use of natural resources. Addressing these challenges requires not only environmental policies and technological interventions but also educational strategies that cultivate environmental awareness, responsible decision-making, and sustainable behavior among younger generations. In this context, Education for Sustainable Development (ESD) provides an important framework for integrating environmental, social, and economic considerations into educational practices. ESD aims to equip learners with the knowledge, skills, values, and attitudes necessary to make informed and responsible decisions that contribute to a more sustainable future (UNESCO, 2017, 2018). Rather than focusing exclusively on the transmission of environmental knowledge, ESD emphasizes the development of critical thinking, ethical responsibility, and active participation in addressing sustainability challenges (Klarin, 2018; Sund & Gericke, 2020). Consequently, education has a strategic role in translating sustainability principles into everyday practices and fostering a generation capable of responding critically and constructively to environmental problems (Hariyono et al., 2018; Novidsa et al., 2020; Rahman et al., 2019).

Despite the growing recognition of sustainability in educational discourse, environmental degradation remains closely associated with patterns of human behavior and inadequate public participation in environmental conservation. Environmental problems, such as industrial pollution, household waste accumulation, vehicle emissions, and forest fires, demonstrate the interconnectedness of ecological conditions, social practices, and individual responsibility (Dhewanthi, 2015; Islamiyah et al., 2022). Household waste management is particularly relevant to everyday environmental behavior because inappropriate waste disposal can contribute to water pollution, deteriorating sanitation, and drainage obstruction that increases flood risks (Hasibuan, 2016; Marliani, 2014). These problems suggest that environmental protection cannot depend solely on infrastructure, regulations, or technological solutions. It also requires the development of environmental concern as a disposition that encourages individuals to recognize environmental problems, evaluate their consequences, and take responsibility for their actions. Therefore, schools have an important role in fostering environmental concern through learning experiences that connect knowledge, values, and responsible behavior with students' everyday lives.

Education for Sustainable Development in Indonesia can be integrated across educational levels and subject areas because sustainability is an interdisciplinary concern that extends beyond the natural sciences (UNESCO, 2018; Sund & Gericke, 2020). One potentially significant but insufficiently explored context is Pancasila Education, a subject that provides opportunities to connect civic values with environmental responsibility. Pancasila, as the philosophical foundation of the Indonesian state, provides a normative framework for cultivating humanity, mutual cooperation, social justice, and responsibility toward the common good. These principles can inform students' understanding of environmental protection as more than an individual preference or a matter of ecological knowledge. Environmental stewardship can also be understood as a civic responsibility involving respect for others, collective well-being, and the preservation of environmental resources for present and future generations. From this perspective, environmental concern becomes relevant to the formation of responsible citizenship because environmental problems frequently involve collective action, competing interests, and

questions of fairness in the distribution of environmental benefits and risks. Nevertheless, the educational potential of Pancasila values depends on how they are translated into meaningful learning experiences rather than merely presented as abstract moral principles.

A key pedagogical challenge, therefore, is to design Pancasila Education that enables students to connect civic values with concrete environmental problems and to develop the capacity to respond to those problems critically and responsibly. Conventional approaches that emphasize conceptual explanations and the memorization of normative principles may provide a foundation for understanding Pancasila, but they do not necessarily provide sufficient opportunities for students to investigate environmental problems, consider competing perspectives, or formulate evidence-informed solutions. Environmental concern is unlikely to develop optimally when learners are positioned primarily as recipients of information rather than as active participants in examining the consequences of human decisions. A more contextualized and participatory approach is needed to bridge the gap between students' understanding of civic values and their willingness to demonstrate environmental responsibility in everyday situations. This challenge highlights the importance of pedagogical approaches that situate Pancasila values within authentic social and environmental contexts.

One approach that may address this challenge is Socio-Scientific Issues (SSI)-based learning. SSI refers to the use of complex, socially relevant issues connected to scientific knowledge and evidence, which often involve uncertainty, competing viewpoints, ethical considerations, and no single straightforward solution (Sadler & Murakami, 2014). Through SSI-based learning, students are encouraged to examine evidence, evaluate arguments, consider the consequences of alternative decisions, and reflect on the ethical and social implications of potential solutions (Paraskeva-Hadjichambi et al., 2015). These characteristics make SSI particularly relevant to environmental education because problems such as waste management, water pollution, and environmental degradation cannot be adequately understood through scientific explanations alone. They also involve human behavior, community interests, social responsibility, and the ethical implications of individual and collective choices. By engaging students in discussions and investigations of such issues, SSI-based learning can create opportunities to develop critical reasoning and a more reflective understanding of environmental responsibility.

The pedagogical relevance of SSI extends beyond science education when its central principles are adapted to the learning objectives of other subjects. In Pancasila Education, environmental issues can serve as authentic contexts for examining how civic values guide individual and collective decision-making. For example, discussions about household waste, plastic pollution, or the cleanliness of the school environment can encourage students to investigate the causes of environmental problems, identify the stakeholders involved, evaluate alternative responses, and consider how mutual cooperation and social responsibility can inform collective action. In this process, Pancasila values become analytical and practical resources for evaluating real-world dilemmas rather than merely concepts to be memorized. Such integration may help students understand that environmental protection involves both an awareness of ecological consequences and a civic commitment to the common good. Thus, SSI-based Pancasila learning offers a pedagogical opportunity to connect environmental knowledge, ethical reflection, civic values, and responsible decision-making within a coherent learning experience.

Previous studies provide an initial empirical basis for considering the educational potential of SSI. Dusturi et al. (2024), for example, reported that an SSI approach in science learning significantly improved students' critical thinking skills. Similarly, Shoba et al. (2023) indicated that

SSI-based science learning contributed to students' awareness of global issues, including environmental concerns. These findings suggest that SSI can facilitate active engagement with complex problems and encourage students to examine issues beyond the acquisition of factual knowledge. However, improvements in critical thinking or awareness of global issues should not automatically be interpreted as evidence of improved environmental concern, because these outcomes represent related but conceptually distinct dimensions of learning. Environmental concern specifically involves students' recognition of environmental problems and their willingness to regard environmental protection as an important responsibility. Accordingly, the effectiveness of SSI should be examined in relation to the particular educational outcomes and subject contexts in which the approach is implemented.

Despite these promising findings, an important research question remains regarding the application of SSI-based learning in Pancasila Education, particularly its potential to improve students' environmental concern. Research on SSI has frequently been associated with science learning, critical thinking, scientific reasoning, and the discussion of socio-environmental controversies. The integration of SSI into civic and values-oriented subjects presents a distinct pedagogical opportunity because it positions environmental problems not only as scientific matters but also as questions of citizenship, ethical responsibility, collective action, and the application of national values. However, the extent to which this integration can improve students' environmental concern requires empirical examination. Based on the literature discussed above, the present study addresses this issue by investigating SSI-based Pancasila learning at SMP Negeri 2 Takengon. The study is positioned at the intersection of sustainability education, civic education, and contextualized pedagogy, with particular attention to environmental concern as an educational outcome. Its contribution lies in examining whether an approach commonly associated with science learning can be meaningfully adapted to Pancasila Education to support the development of environmentally responsible students.

SMP Negeri 2 Takengon was selected as the research site because its educational context provides an opportunity to investigate the relationship between Pancasila learning and environmental responsibility within students' everyday surroundings. Takengon and its surrounding region are associated with distinctive natural environments and local ecological concerns, providing potentially meaningful contexts for discussing environmental conservation and community responsibility. Nevertheless, the relevance of these contextual characteristics to students' environmental experiences must be established through the actual conditions observed at the school and in its surrounding community. Within this context, SSI-based Pancasila learning can connect classroom discussions with locally relevant environmental issues, allowing students to examine environmental problems through evidence, dialogue, ethical reflection, and civic values. Such contextualization is important because environmental concern may be more meaningfully developed when students can relate educational concepts to problems they recognize in their own lives.

Accordingly, this study aims to examine the effect of the Socio-Scientific Issues-based Pancasila learning approach on improving students' environmental concern at SMP Negeri 2 Takengon. Specifically, it investigates whether integrating socially relevant environmental issues into Pancasila Education can strengthen students' concern for environmental problems and their understanding of environmental protection as a civic responsibility. By examining this relationship, the study seeks to contribute to the development of sustainability-oriented civic education and provide empirical insights into the pedagogical integration of SSI within Pancasila Education. The findings are expected to inform teachers and curriculum developers seeking to

connect civic values with contextual environmental learning and to strengthen the role of Pancasila Education in fostering environmentally responsible citizenship.

METHODS

This study employed a quantitative approach to examine the effect of the Socio-Scientific Issues (SSI)-based Pancasila learning approach on students' environmental awareness at SMP Negeri 2 Takengon. A quantitative approach was selected because it enables the measurement of research variables and the statistical analysis of differences or effects associated with an instructional intervention. According to Creswell and Creswell (2018), quantitative research involves examining relationships between variables through numerical data and statistical procedures. The study focused on students' environmental awareness before and after the implementation of SSI-based Pancasila learning. Data were collected using a research instrument designed to measure students' environmental awareness. The learning intervention integrated socio-scientific issues into Pancasila instruction by connecting civic values with environmental problems and encouraging students to consider the social, ethical, and civic implications of environmental issues. The collected data were analyzed using a *t*-test to determine whether the observed difference in students' environmental awareness was statistically significant. The hypothesis was tested at a significance level of 0.05. The null hypothesis (H_0) stated that SSI-based Pancasila learning did not produce a statistically significant effect on students' environmental awareness, whereas the alternative hypothesis (H_a) stated that the effect was statistically significant. The decision was based on comparing the calculated *t*-value with the critical *t*-value and examining whether the result met the predetermined significance criterion. Statistical hypothesis testing provides a systematic basis for evaluating evidence against a null hypothesis (Field, 2018).

RESULT AND DISCUSSION

A. Result

This study examined the effect of the Socio-Scientific Issues (SSI)-based Pancasila learning approach on improving students' environmental concern at SMP Negeri 2 Takengon. The analysis focused on determining whether the implementation of SSI-based learning was associated with a statistically significant improvement in students' environmental concern. The research hypothesis was tested at a significance level of $\alpha = 0.05$.

The statistical analysis produced a calculated t-value of 4.57, while the critical t-value was 2.011. The calculated t-value exceeded the critical value, indicating that the observed result met the criterion for statistical significance under the reported testing procedure. Accordingly, the null hypothesis (H_0) was rejected, and the alternative hypothesis (H_a) was supported. These findings indicate a statistically significant difference associated with the implementation of the SSI-based Pancasila learning approach.

Table 1. Summary of Hypothesis Testing

Statistical parameter	Result
Significance level (α)	0.05
Calculated t-value	4.57
Critical t-value	2.011
Statistical decision	Reject H_0
Research conclusion	Statistically significant result

The results provide statistical evidence supporting the effectiveness of SSI-based Pancasila learning in relation to students' environmental concern. However, the interpretation of this finding should take into account the research design and the specific statistical procedure employed. In particular, the reported t-values establish statistical significance under the stated decision rule, but they do not independently indicate the magnitude of the effect or establish the extent of improvement in students' environmental concern.

From an educational perspective, the finding suggests that integrating socio-scientific environmental issues into Pancasila Education may offer a meaningful way to connect civic values with environmental responsibility. By engaging students with socially relevant environmental problems, this approach creates opportunities to examine the consequences of human actions, consider different perspectives, and relate environmental protection to collective responsibility. Nevertheless, the extent to which these learning processes contributed to the observed statistical result requires further interpretation in relation to the theoretical framework and previous research.

B. Discussion

1. The Effectiveness of SSI-Based Pancasila Learning in Developing Environmental Concern

The principal finding of this study is the statistically significant result associated with the implementation of the Socio-Scientific Issues (SSI)-based Pancasila learning approach. The calculated t-value of 4.57 exceeded the critical value of 2.011 at the 0.05 significance level. This finding supports the research hypothesis that SSI-based Pancasila learning is associated with students' environmental concern. The result provides an empirical basis for examining how a learning approach that integrates socially relevant environmental problems with civic values may contribute to sustainability-oriented education.

The educational significance of this finding lies in the potential of SSI to transform environmental learning from the transmission of information into an inquiry-oriented process. Environmental problems, including household waste, water pollution, and the degradation of natural resources, involve more than factual knowledge. They also require learners to consider human behavior, competing interests, ethical responsibilities, and the consequences of individual and collective decisions. SSI-based learning can provide opportunities for students to examine these interconnected dimensions through evidence-based discussion and problem analysis (Sadler & Murakami, 2014).

Within this learning process, students are encouraged to move beyond recognizing environmental problems toward considering why these problems occur, who is affected by them, and what responsibilities individuals and communities have in addressing them. Such engagement may provide a foundation for developing environmental concern because learners encounter environmental protection as a meaningful social responsibility rather than merely an abstract concept. The statistically significant finding in this study is therefore consistent with the

pedagogical rationale underlying SSI: socially relevant problems can create learning opportunities that connect conceptual understanding with ethical reflection and responsible decision-making. Nevertheless, statistical significance should not be interpreted as definitive evidence that SSI alone caused the observed outcome. The strength of the causal claim depends on the research design, the availability of a comparison group, the measurement of environmental concern before and after the intervention, and the control of potential confounding variables. Accordingly, the present finding should be understood in relation to the study's methodological characteristics rather than as universal evidence that SSI-based learning will produce the same outcome in every educational context.

2. Integrating Pancasila Values with Environmental Responsibility

An important contribution of this study is its examination of SSI within Pancasila Education rather than exclusively within science learning. This integration creates an opportunity to interpret environmental concern through the perspective of civic values, social responsibility, and collective well-being. Environmental protection can be understood not only as an ecological obligation but also as a civic commitment because environmental problems frequently affect shared resources and the quality of life of other members of society.

The principles embodied in Pancasila provide a normative foundation for this interpretation. The second principle, which emphasizes just and civilized humanity, can inform discussions about the consequences of environmental degradation for human health and dignity. The third principle, national unity, can be connected to collective efforts to protect shared environments. The fourth principle, deliberation and representation, can provide a basis for discussing how communities negotiate different interests and make decisions about environmental problems. Meanwhile, the fifth principle, social justice for all Indonesian people, can help students examine the unequal distribution of environmental risks and the responsibility to preserve environmental resources for present and future generations.

When these principles are integrated with SSI-based learning, students can investigate environmental problems while evaluating the ethical and civic implications of possible solutions. For example, a classroom discussion about waste disposal can involve identifying the sources of waste, examining its effects on the surrounding environment, considering the responsibilities of individuals and local institutions, and evaluating the role of mutual cooperation in developing practical solutions. In this process, Pancasila functions not merely as a set of normative principles but as a framework for interpreting social problems and guiding responsible civic action.

This argument is important because environmental concern is not necessarily developed through environmental information alone. Students may understand that pollution is harmful without perceiving environmental protection as a personal or collective responsibility. SSI-based Pancasila learning may help bridge this gap by placing environmental problems within a broader framework of moral judgment, social responsibility, and citizenship. The findings of this study consequently provide a basis for further investigating the role of civic education in strengthening the relationship between environmental understanding and responsible attitudes.

However, the specific mechanisms through which Pancasila values influence environmental concern cannot be established solely from the reported t-value. To demonstrate that the integration of civic values is a distinctive contributor to the outcome, further research would need to examine students' learning experiences, the instructional activities implemented, and the extent to which changes in environmental concern are associated with particular dimensions of Pancasila-based reflection.

3. SSI-Based Learning and Education for Sustainable Development

The findings also have implications for Education for Sustainable Development (ESD), which emphasizes the development of knowledge, values, skills, and attitudes needed to address sustainability challenges (UNESCO, 2017, 2018). From an ESD perspective, environmental concern is an important educational outcome because sustainability requires individuals to recognize the consequences of their actions and consider the long-term implications of decisions for environmental and social well-being.

The relevance of SSI-based Pancasila learning to ESD lies in its potential to connect environmental problems with social and ethical dimensions. Environmental degradation is rarely the result of isolated ecological processes; it is also influenced by consumption patterns, institutional arrangements, community practices, and individual decisions. Therefore, learning about sustainability requires students to understand the connections between human behavior, environmental conditions, and collective responsibility.

SSI provides a pedagogical structure through which these connections can be explored. Students can investigate the causes and consequences of environmental problems, evaluate alternative responses, and consider the values underlying different decisions. When incorporated into Pancasila Education, these activities can further encourage students to consider the relationship between personal responsibility and the common good. This combination may help situate environmental protection within a broader understanding of sustainable citizenship.

The finding of statistical significance in the present study is consistent with the proposition that contextualized and socially relevant learning can contribute to sustainability-oriented educational outcomes. Nevertheless, environmental concern should not be equated with demonstrated sustainable behavior. A student may express concern about pollution without consistently engaging in waste separation, reducing plastic consumption, or participating in environmental conservation. Consequently, the findings should be interpreted as evidence concerning the measured outcome rather than proof that the intervention necessarily produces sustained behavioral change.

This distinction is particularly important for ESD research. If the objective is to develop environmentally responsible citizens, educational evaluation should consider not only students' attitudes but also their ability to apply environmental knowledge, participate in collective action, and maintain responsible practices over time. Future studies could therefore extend the present investigation by examining whether changes in environmental concern are associated with observable environmental practices and sustained civic engagement.

4. Positioning the Findings in Relation to Previous Research

The present findings can be discussed in relation to previous studies suggesting that SSI-based learning can support students' engagement with complex social and environmental problems. Dusturi et al. (2024) reported improvements in students' critical thinking through SSI-based science learning, while Shoba et al. (2023) highlighted the contribution of SSI to students' awareness of global issues, including environmental concerns. These studies provide a relevant starting point for understanding the pedagogical potential of SSI in educational settings.

The present study extends this line of inquiry by examining SSI within Pancasila Education and focusing on environmental concern as the outcome of interest. This distinction is significant because critical thinking, global awareness, environmental knowledge, and environmental concern are related but conceptually different constructs. Whereas critical thinking concerns the evaluation of information and arguments, environmental concern focuses on the importance individuals attach to environmental problems and their willingness to recognize environmental protection as

a responsibility. Evidence of improvement in one construct cannot automatically be treated as evidence of improvement in another.

By examining environmental concern in a civic education context, this study introduces an additional perspective on the potential application of SSI. It suggests that the pedagogical value of SSI may extend beyond scientific reasoning to the consideration of environmental problems as matters of social responsibility and citizenship. The contribution is therefore not simply the application of SSI to another subject area, but the examination of how a socially contextualized learning approach may support an educational objective closely connected to civic values.

Nevertheless, the novelty of this contribution should be framed carefully. The available findings do not establish that this is the first study to integrate SSI with Pancasila Education or that the approach is superior to alternative pedagogies. Such claims require a systematic review of relevant literature and, where superiority is claimed, appropriate comparative evidence. The more defensible contribution is the provision of empirical evidence from SMP Negeri 2 Takengon concerning the relationship between SSI-based Pancasila learning and students' environmental concern.

This positioning also identifies an opportunity for further research. Comparative studies could investigate whether SSI-based Pancasila learning produces different outcomes from conventional Pancasila instruction or other contextualized learning approaches. Researchers could also examine which instructional components such as evidence evaluation, ethical deliberation, collaborative problem-solving, or reflection on civic values are most strongly associated with changes in environmental concern.

5. Pedagogical Implications for Pancasila Education

The findings have practical implications for teachers seeking to develop environmental concern through Pancasila Education. Rather than treating environmental protection solely as an additional topic, teachers can integrate locally relevant environmental issues into the learning process and connect them to the values and responsibilities of citizenship.

A practical implementation can be organized into several interconnected activities. First, teachers introduce an environmental issue that students can recognize in their daily lives, such as waste accumulation or the cleanliness of the school environment. Second, students investigate the causes, consequences, and stakeholders associated with the issue by examining available evidence and considering different perspectives. Third, they deliberate on alternative solutions and evaluate these solutions in relation to Pancasila values, social responsibility, and the common good. Finally, students formulate feasible proposals or participate in collective environmental activities and reflect on the implications of their decisions.

This sequence is intended to connect environmental inquiry with civic reflection and practical responsibility. It also provides opportunities for students to recognize that environmental problems cannot always be resolved through individual action alone, because effective solutions may require cooperation among students, schools, families, and communities.

At the curriculum level, the integration of SSI into Pancasila Education may support a more contextualized understanding of citizenship. Students can examine how values such as humanity, unity, deliberation, and social justice inform decisions about shared environmental resources. Teachers can also assess learning through a combination of written reflections, discussions, problem-solving tasks, and observations of environmental practices, provided that these measures are aligned with the intended learning outcomes. However, the implementation of SSI requires careful instructional planning. Teachers need to select issues appropriate to students'

developmental levels, provide reliable information, facilitate balanced discussion, and prevent classroom debates from becoming unsupported exchanges of opinion. Environmental issues should be explored through relevant evidence and reasoned argument, while Pancasila values should provide a framework for reflection rather than a predetermined substitute for critical inquiry. These considerations are important if SSI-based Pancasila learning is to support both environmental concern and responsible democratic participation.

6. Limitations and Directions for Future Research

Although the statistical result supports the research hypothesis under the reported testing procedure, several methodological considerations should guide its interpretation. First, the available statistical information is limited to the calculated and critical t-values. Without descriptive statistics, sample size, degrees of freedom, and the exact test specification, it is not possible to determine the magnitude of the observed difference, calculate an effect size, or independently verify the statistical analysis.

Second, the strength of the conclusion depends on the research design. If the study employed a one-group pretest–posttest design, the observed difference may be influenced by factors such as maturation, repeated testing, or other learning experiences occurring during the intervention. If a suitable control group was included, the analysis should clarify whether the reported t-value represents a within-group comparison or a between-group comparison. This distinction is essential for evaluating the extent to which the outcome can be attributed to the SSI-based learning approach.

Third, the study's focus on a single school limits the extent to which its findings can be generalized to other educational settings. The characteristics of the students, school environment, teacher practices, and local environmental issues may influence the implementation and outcomes of SSI-based learning. Replication across schools with different social and environmental contexts would provide a stronger basis for evaluating the broader applicability of the approach.

Future research should therefore report complete statistical information, including sample characteristics, pretest and posttest means, standard deviations, the appropriate test statistic, degrees of freedom, exact p-values, and effect sizes. Where feasible, studies should use comparison groups and follow-up measurements to distinguish immediate changes in environmental concern from more sustained outcomes. Qualitative interviews, classroom observations, and student reflections could also help explain how students interpret environmental problems, apply Pancasila values, and translate concern into environmental practices. Taken together, these considerations do not negate the reported finding but clarify its evidential scope. The present study provides a useful empirical starting point for examining SSI-based Pancasila learning as an approach to environmental concern. Stronger causal claims and broader theoretical conclusions will require additional evidence concerning the size, durability, and mechanisms of the observed effect.

CONCLUSION

This study concludes that the Socio-Scientific Issues (SSI)-based Pancasila learning approach demonstrated a statistically significant result in relation to improving students' environmental concern at SMP Negeri 2 Takengon. The hypothesis-testing results showed a calculated t-value of 4.57, exceeding the critical t-value of 2.011 at a significance level of 0.05. Accordingly, the null hypothesis was rejected and the alternative hypothesis was supported. These findings provide empirical support for the potential of integrating socially relevant environmental issues into Pancasila Education to strengthen students' concern for environmental protection. The educational significance of this approach lies in its potential to connect Pancasila values with contextual environmental problems, critical reflection, ethical reasoning, and collective

responsibility. By engaging students in examining environmental issues and considering possible solutions, SSI-based learning can provide meaningful opportunities to understand environmental protection as both an ecological concern and a civic responsibility. This approach also offers a practical way to connect Pancasila Education with the broader goals of Education for Sustainable Development. The findings suggest that teachers can enrich Pancasila Education by incorporating relevant environmental issues into classroom discussions, collaborative problem-solving, and reflective learning activities. However, the extent to which the intervention produces sustained behavioral changes remains to be established. Further research involving larger and more diverse samples, appropriate comparison groups, effect-size estimates, and follow-up assessments is needed to strengthen causal conclusions and examine whether improvements in environmental concern translate into consistent pro-environmental behavior. Overall, this study contributes to the discussion of sustainability-oriented civic education by highlighting the potential of SSI-based Pancasila learning to connect civic values with environmental responsibility. Its findings provide a foundation for further empirical investigation into how contextualized and issue-based pedagogical approaches can support the development of environmentally responsible citizenship among students.

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