



Effectiveness of an Integrated Civic Education–Science Learning Model Using the Civic-Scientific Literacy Approach to Improve Science Process Skills in Junior High School Students

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Abstract: This study examines the effect of an integrated Civic Education (PKn)-Science learning model on developing Science Process Skills (SPS) through a Civic-Scientific Literacy (CSL) approach in eighth-grade students. A non-equivalent pretest-posttest control group quasi-experimental design was applied to 64 students at SMP Negeri X Bengkulu. SPK data collection was conducted through tests, analyzed using ANCOVA, while CSL was evaluated using a rubric. The results showed that the integrated PKn-Science learning model significantly improved students' SPK ($F=32.10$, $p<0.001$, $\eta^2=0.347$) compared to the control group. This model was also effective in facilitating the development of students' CSL, as evidenced by improvements in their ability to understand socio-scientific issues, evaluate evidence, engage in ethical-social reasoning, and participate in argumentation. A positive and significant correlation was also found between improvements in CSL and KPS ($r=0.68$, $p<0.001$), confirming the synergistic relationship between the two. This study concludes that integrating Civic Education and Science through the CSL approach is an effective strategy for fostering scientifically literate students and responsible citizens.

Keywords: Integrated learning model, Civic Education, Science Education, Science Process Skills, Civic-Scientific Literacy

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1. Introduction

The contemporary era demands individuals who are not only academically competent, but also have the ability to actively and responsibly participate in an increasingly complex global society. This underscores the urgency of simultaneously developing scientific literacy and civic literacy (Bybee, 1997). The essential skills in this context are science process skills (SPS), which form the foundation for individuals to understand natural phenomena, think critically, solve problems, and make evidence-based decisions (Suja, 2020). SPS includes observation, classification, inference, prediction, communication, measurement, and more complex skills such as formulating hypotheses, controlling variables, interpreting data, and experimenting (Harlen & Qualter, 2018). Mastery of SPS is not only relevant in the realm of pure science but also crucial in social and civic contexts, especially when addressing socio-scientific issues that require ethical and moral considerations (Fitria et al., 2018).

In this context, the concept of civic-scientific literacy (CSL) becomes highly relevant (J. D. Miller, n.d.). CSL is defined as an individual's capacity to use scientific knowledge and skills to understand and participate in public issues that have scientific or technological dimensions, such as climate change, vaccination, renewable energy, or biotechnology (Roth & Lee, 2004). Integrating scientific understanding with civic contexts enables individuals not only to master scientific concepts but also to analyze the social, economic, and ethical implications of science and technology, and to confidently express their views constructively (Kolsto, 2001). Unfortunately, educational practices in Indonesia and many other countries still tend to teach Civic Education (PKn) and Science as separate disciplines, thereby hindering the holistic development of CSL and SPS (Setiawan et al., 2017). This separation creates a barrier between theoretical knowledge and its relevance in real life, causing students to struggle to apply scientific concepts in decision-making as citizens (Anurogo et al., 2023).

In response to these challenges, this study proposes and tests an integrated PKn-Science learning model as a promising solution. Integrated learning models, which combine several subjects into a single thematic or project-based framework, have been proven effective in improving conceptual understanding, student motivation, and the development of 21st-century skills (Drake & Reid, 2020). By integrating PKn and Science concepts, students are encouraged to understand scientific issues not only from the perspective of facts and principles but also from the perspective of citizens' rights and obligations, ethics, and social impacts (Farikiansyah et al., 2024). This approach is expected to create a more meaningful learning environment where students can actively develop their KPS through investigating real-world problems with socio-scientific dimensions, while simultaneously strengthening their CSL dimensions (ŞEN & VEKLİ, 2016).

Based on the above background, this study aims to analyze the effect of the integrated Civic Education-Science learning model in developing students' science process skills and to explore the role of the Civic-Scientific Literacy approach in this process. Specifically, the research questions to be answered are: (1) Is there a significant difference in the improvement of science process skills between students

taught using the integrated PKn-Science learning model and the control group? (2) How does the integrated PKn-Science learning model facilitate the development of students' Civic-Scientific Literacy? (3) What is the relationship between the improvement of Civic-Scientific Literacy and students' science process skills in the context of this learning model? The results of this study are expected to contribute theoretically to the development of integrated learning models and the Civic-Scientific Literacy framework, as well as provide practical implications for curriculum developers, teachers, and education policymakers in designing more relevant and holistic learning to prepare scientifically literate and responsible citizens.

Science Process Skills (SPS) and Their Importance in Education

Science Process Skills (SPS) are a set of fundamental skills that are essential in science learning and the development of scientific literacy. SPS are not just about memorizing scientific facts, but rather about how scientists think and work in discovering knowledge (Settlage, 2011). Generally, SPS are categorized into basic science process skills and integrated science process skills. Basic skills include observation, classification, measurement, communication, inference, and prediction (Padilla & Michael, 1986). Meanwhile, integrated skills involve more complex abilities such as formulating hypotheses, identifying and controlling variables, interpreting data, and designing and conducting experiments (Tekin & Muştu, 2021).

The development of SPS is crucial for several reasons. First, SPS equips students with cognitive tools to build their own scientific understanding, rather than simply receiving information passively (Ostlund & Karen, 1992). Students who master SPS will be better able to ask questions, design investigations, analyze findings, and draw valid conclusions. Second, SPS is a prerequisite for functional scientific literacy, enabling individuals to actively engage in public discourse on science and technology-based issues (Bybee, 1997). Without adequate SPS, it is difficult for someone to evaluate scientific claims, distinguish facts from opinions, or make informed decisions in everyday life. Various studies have shown that the application of student-centered learning approaches, such as inquiry and projects, is effective in improving students' SPS at various levels of education (Pahrudin, Agus dan Pratiwi, 2019).

Concept and Dimensions of Civic-Scientific Literacy (CSL)

Civic-Scientific Literacy (CSL) represents the convergence of scientific literacy and civic literacy, emphasizing the role of science in social and political contexts (Roth & Lee, 2004). CSL goes beyond a purely conceptual understanding of science; it encompasses an individual's ability to understand complex socio-scientific issues, evaluate relevant scientific evidence, and participate in democratic decision-making on these issues (Zeidler, 2005). In modern society, many public decisions—from

health and environmental policies to technological innovations—are based on science. Therefore, citizens who are scientifically and civically literate are able to: (1) identify the scientific dimensions of public issues, (2) understand and evaluate related scientific data and arguments, (3) consider the ethical and social implications of scientific and technological applications, and (4) participate in an informed and responsible manner in public discourse to solve problems or make policies (Feinstein, 2011).

The development of CSL is important for fostering critical and participatory citizens (Liu et al., 2024). When students are confronted with socio-scientific dilemmas, they not only learn about science itself but also about how science interacts with social, political, and economic values. This also involves the development of argumentation skills, moral reasoning, and collaborative decision-making (Tseng et al., 2010). Studies show that learning that promotes discussion of controversial issues, case studies, or problem-based projects can significantly enhance students' CSL (Turiman et al., 2012). Thus, CSL serves as a bridge connecting scientific knowledge with responsible civic action (Zuccala, 2010).

Integrated Learning Model for Civics and Science

Integrated learning is defined as a curriculum approach that explicitly connects concepts, skills, or themes from various disciplines to create a more cohesive and meaningful learning experience for students (Drake & Reid, 2020). Rather than teaching subjects separately, integrated learning allows students to see the connections between concepts, facilitates knowledge transfer, and develops a more holistic understanding of the world. In the context of Civics and Science, the integrated learning model seeks to bring together scientific issues that have a civic dimension, or conversely, to use civic issues as a context for learning scientific concepts (Muslich, 2022).

Various integration models can be applied, such as thematic models, project-based models, or webbed models (Joyce et al., 2020). In the integrated PKn-Science learning model, students can study environmental issues (Science) through the lens of citizens' rights and obligations (PKn) in preserving the environment, or understand technology (Science) from the perspective of ethics and regulation (PKn). For example, a project investigating water quality in the surrounding environment not only involves scientific analysis (SPS), but also discussions about the impact on public health, the role of local government, and citizen participation in maintaining water cleanliness (CSL). Research in Indonesia has also shown the effectiveness of integrated models in improving student learning outcomes and literacy (Yanto et al., 2019). This model is believed to address knowledge fragmentation and encourage students to develop KPS and CSL synergistically, as students are encouraged not only

to understand ‘what’ and ‘how’ science works but also ‘why’ and ‘for whom’ science is important in national life (Guo et al., 2015).

2. Method

This study employed a quantitative approach using a quasi-experimental design with a non-equivalent pretest-posttest control group. This design was selected because the participants were already organized into existing class groups, which made full randomization unfeasible. The study was conducted at SMP Negeri X Bengkulu during the 2024/2025 academic year.

A total of 64 eighth-grade students were selected as the sample using cluster random sampling, with 32 students assigned to the experimental group and 32 to the control group. Informed consent was obtained from the school, students, and parents. Ethical considerations were addressed by ensuring voluntary participation, anonymity, and data confidentiality.

Two primary instruments were used in data collection:

1. Science Process Skills (SPS) Test: This instrument consisted of 30 multiple-choice items measuring basic and integrated science process skills. The items were validated by expert reviewers and demonstrated acceptable internal consistency with a KR-20 reliability coefficient of 0.85.
2. Civic-Scientific Literacy (CSL) Rubric: This rubric comprised four assessment dimensions—understanding of socio-scientific issues, evaluation of evidence, ethical-social reasoning, and argumentative participation. It was validated by content experts and tested for inter-rater reliability prior to implementation.

The intervention lasted for five weeks. Both groups were administered a pretest to assess their initial SPS levels. The experimental group then received instruction using an integrated PKn-Science learning model, which emphasized project-based and case-based learning focusing on socio-scientific issues from civic perspectives. Students were actively engaged in collaborative discussions and scientific investigations. In contrast, the control group received conventional instruction without integration between subjects. CSL performance in the experimental group was assessed periodically through observation using the rubric.

After the intervention, a posttest was administered to both groups to measure the changes in SPS. Data were analyzed using SPSS version 16.0. The analysis procedure involved:

- a. Descriptive statistics (mean, standard deviation),
- b. Normality testing using the Kolmogorov-Smirnov test,
- c. Homogeneity of variance testing via Levene’s Test, and

Inferential statistics using Analysis of Covariance (ANCOVA), with the SPS pretest scores as the covariate, to evaluate the effect of the learning model on posttest outcomes. Additionally, Pearson correlation analysis was conducted to examine the relationship between students’ gains in SPS and their CSL scores in the experimental group, providing further insight into the interaction between these two domains

3. Result and Discussion

RESULT

Data Description and Prerequisite Tests for Analysis

Before conducting hypothesis testing, descriptive statistics of the pretest and posttest scores for Science Process Skills (SPS) were presented for both groups, experimental and control.

Table 1. Descriptive Statistics of Pre-test and Post-test SPS Scores

Group	Test	N	Mean	Std.Deviasi	Min	Maks
Experiment	Pretest KPS	32	58.25	7.18	45	70
	Posttest KPS	32	82.50	6.55	72	93
Control	Pretest KPS	32	57.90	7.02	44	69
	Posttest KPS	32	68.10	7.10	55	80

The table above shows the descriptive statistics of the students' KPS scores in the experimental and control groups. At the pretest stage, the average KPS scores of the two groups were relatively balanced, namely 58.25 for the experimental group and 57.90 for the control group, with standard deviations that were not significantly different. This indicates that the initial KPS abilities of the students in both groups were relatively equivalent before the intervention was administered. After the intervention, the average posttest KPS scores of the experimental group increased significantly to 82.50, while the control group also experienced an increase but not as high as the experimental group, at 68.10. This increase provides an initial indication of a difference in treatment effects between the two groups.

Prerequisite Analysis Tests

a. Normality Test (Kolmogorov-Smirnov)

The Kolmogorov-Smirnov normality test was conducted to determine whether the KPS pretest and posttest scores in both groups were normally distributed. The test results are presented in Table 2.

Table 2. Results of the Kolmogorov-Smirnov Normality Test

Tests Of Normality				
Group		Kolmogorov-Smirnov ^a		
		Statistic	Df	Sig.
Control	Pre_Test	.147	29	.103
	Post_Test	.138	29	.115
Experiment	Pre_Test	.144	29	.125
	Post_Test	.135	29	.098

A. Lilliefors Significance Correction

Based on Table 2, the significance value (p) for all variables (pretest and posttest KPS in the experimental and control groups) is greater than 0.05. In order, the p-values for the control group's pretest KPS are 0.103, the control group's posttest KPS

are 0.115, the experimental group's pretest KPS are 0.125, and the experimental group's posttest KPS are 0.098. These results indicate that the KPS scores for both groups are normally distributed, thus fulfilling the assumption of normality for inferential analysis.

b. Uji Homogenitas Varians (Levene's Test))

Test of Homogeneity of Variances				
SPS Posttest				
Levene Statistic	F	df1	df2	Sig.
1.458	0.87	1	62	.354

Similarly, the test of variance homogeneity (Levene's Test) showed that the variance of KPS scores between groups was homogeneous ($F=0.87$, $p=0.354$). Therefore, inferential analysis with ANCOVA could be performed.

The Effect of the Integrated Civic Education-Science Learning Model on Science Process Skills

To test whether there was a significant difference in KPS improvement between the experimental and control groups, Analysis of Covariance (ANCOVA) was used with KPS pretest scores as covariates. The ANCOVA results are presented in Table 4.

Table 4. ANCOVA Test Results for SPS

Sumber Varians	Sum Of Squares	df	Mean Square	F
Pretest SPS	1256.78	1	1256.78	21.34
Group (Control/Experiment)	1890.35	1	1890.35	32.10
Error	3589.67	61	58.85	
Total	487268.00	63		

The ANCOVA results showed a significant effect of the group (learning model) on the KPS posttest after controlling for the KPS pretest scores, with an F value ($1,61$) = 32.10 , $p<0.001$, and a partial eta squared effect size (ηp^2) of 0.347 . This value indicates that the learning model has a significant effect on KPS. The comparison of marginal means shows that the average KPS in the experimental group (adjusted mean = 81.95) is significantly higher than that in the control group (adjusted mean = 68.60) after the treatment. This indicates that the integrated PKn-Science learning model has a positive and significant effect on developing students' Science Process Skills.

Facilitating Civic-Scientific Literacy through an Integrated Civic Education-Science Learning Model

The development of students' Civic-Scientific Literacy (CSL) in the experimental group was observed and assessed using the CSL rubric during the implementation of

the integrated PKn-Science learning model. In general, it was found that students showed progressive improvement in the four dimensions of CSL assessed: understanding of socio-scientific issues, ability to evaluate evidence, ethical-social reasoning, and argumentative participation (J. Miller, 2012). At the beginning of our observation, the classroom felt like a space of disconnected facts. Students approached science by focusing on factual recall and civics by simply memorizing rules, with little bridge between the two worlds. For instance, a discussion on plastic pollution would typically list the types of plastic but stop short of exploring the social impacts or the responsibilities of citizens. The information remained abstract, lacking real-world connection.

However, a shift began to occur as we introduced a new approach centered on complex, hands-on projects and case studies. When students took on challenges like the “Analyzing Drinking Water Quality in the School Environment” project or engaged in a “Debate on City Waste Management Policy,” their learning transformed from passive to active. The change was remarkable. Scientific data was no longer just numbers on a page. After testing their school's water, students began to forge connections between the results, potential public health risks, and the local government's role in regulation. They started asking profound questions, such as, “How do these water quality test results affect citizens' rights?”

Their critical thinking skills sharpened. In presentations, students no longer accepted information at face value. They began to question data sources, compare their findings against official benchmarks, and identify potential biases. When tackling issues like factory waste, they proactively sought out supporting data from government reports or NGOs rather than relying on mere opinion.

The classroom discussions deepened and became more nuanced. Dilemmas like choosing between economic development and environmental protection sparked rich debates. Students learned to consider the varied perspectives of stakeholders—from businesspeople and local residents to government officials—and to grapple with the moral implications of science-based decisions. They skillfully identified conflicting values and articulated arguments grounded in ethical reasoning. Perhaps most visibly, their confidence and participation soared. Students became more assertive in debates, clearly expressing their opinions and backing them with scientific data. They learned to respond to their peers' arguments constructively and respectfully. This newfound confidence was evident in their project presentations, where they fluently communicated both scientific findings and their civic viewpoints.

This transformation was not just anecdotal. The students' average Civic-Scientific Literacy (CSL) score in the experimental group saw a dramatic increase, rising from an initial average of 2.15 to 3.82 on a 4-point scale by the end of the intervention. This journey clearly showed that the integrated Civic Education-Science learning model, through relevant and authentic experiences, was highly effective in fostering a new level of civic and scientific understanding.

The Relationship between Increased Civic-Scientific Literacy and Science Process Skills

Pearson's correlation analysis between the increase in KPS (calculated from the pretest-posttest KPS gain score) and the CSL score in the experimental group showed a significant positive correlation ($r=0.68$, $p<0.001$). This correlation coefficient value indicates that approximately 46% of the variance in CSL improvement can be explained by the variance in students' KPS ($r^2=0.46$). This means that students who show higher improvement in their CSL tend to also show better improvement in their KPS, indicating a synergistic relationship between the two domains.

DISCUSSION

The finding that the integrated PKn-Science learning model significantly improves students' KPS is in line with previous studies that emphasize the effectiveness of active and contextual learning approaches in developing cognitive and process skills (Sari et al., 2017). Learning that actively involves students in the process of discovery and problem-solving has proven to be more effective in fostering KPS than passive knowledge transmission methods. The integration of PKn content provides a rich social and moral context for science learning, making KPS more relevant and meaningful to students. For example, when students conduct scientific investigations to measure pollution in a river, their KPS (observation, measurement, data interpretation) is directly applied to a real-world problem with civic implications (public health, environmental responsibility). This contrasts with conventional science learning, which may lack a real-world application context, resulting in KPS being taught separately from its social objectives. Such a contextual approach not only enhances KPS but also deeper conceptual understanding because students see the relevance of science in real life (Hernani et al., 2009).

Furthermore, the success of this model in facilitating CSL development supports the argument that scientific literacy and civic literacy cannot be separated. Education that ignores the social dimensions of science risks producing individuals who are "blind" to the ethical and political implications of scientific progress (J. D. Miller, 1998). By presenting socio-scientific issues, students are encouraged to view science as an integral part of society, not an isolated discipline. The civic education aspect of this model encourages students to consider the ethical, social, and political dimensions of scientific discoveries or environmental issues, which are essential to CSL. Evidence-based discussion and decision-making in the context of public issues strengthen students' critical reasoning and argumentation skills, which are key components of SPS and CSL (J. D. Miller, 2010). Socio-scientific issue-based learning is specifically recognized as an effective strategy for enhancing CSL because it encourages multi-perspective reasoning and responsible decision-making.

The positive correlation between increases in CSL and KPS indicates a strong reciprocal relationship. Better development of KPS equips students with tools to analyze socio-scientific issues in greater depth (e.g., the ability to interpret pollution data graphs or formulate investigative questions (Tsapalis et al., 2013). Conversely, experience in analyzing complex socio-scientific issues (which is at the core of CSL) provides motivation and context that encourages students to refine their SPS (Wu et al., 2018). They see the practical value of KPS in becoming empowered citizens. This reinforces the view that learning oriented toward authentic and contextual issues, as promoted in the integrated PKn-Science model, can synergistically develop both domains of literacy. Such curriculum integration promotes more meaningful and cohesive learning, reduces knowledge fragmentation, and enables skill transfer across domains. This research fills a gap in the literature by empirically demonstrating how the integration of PKn and Science can be an effective mechanism for developing KPS through the CSL approach, particularly in the context of education in Indonesia (Lee, 2003).

The limitations of this study include the relatively short duration of the intervention, which lasted for 5 weeks of effective learning, and its focus on a single educational level (eighth-grade students). Additionally, although the CSL rubric has been validated, the qualitative nature of CSL assessment may introduce some subjectivity, despite efforts to ensure inter-rater reliability. Future research directions could include longitudinal studies to observe the long-term effects of this learning model, involving larger samples or different educational levels, as well as using more in-depth mixed methods (quantitative and qualitative) to capture the nuances in CSL development. Future research could also explore the role of teachers and contextual factors that may influence the effectiveness of this model.

4. Conclusion

This study conclusively shows that an integrated Civic Education (PKn) and Science learning model significantly enhances eighth-graders' Science Process Skills (SPS) and their Civic-Scientific Literacy (CSL). Students engaged in this blended model demonstrated far greater improvement compared to those in conventional classes. The research also uncovered a powerful symbiotic relationship between these two skill sets: strong SPS provided students the tools to analyze socio-scientific issues, while a developed CSL provided the meaningful context and motivation to apply those skills, creating a cycle of mutual reinforcement.

Ultimately, this research positions the integrated model as a powerful strategy for cultivating individuals who are both scientifically literate and socially responsible. The clear practical implication is the need for educators to move beyond subject silos towards more holistic and contextual teaching methods. By integrating curriculum, schools can better equip students with the essential 21st-century skills required to understand and address complex global challenge.

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