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The Application of the Spirit of Socio-Scientific Problem-Based Learning (SSIPBL) Model to Improve Learning Outcomes on the Respiratory System Material at Senior High School

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ABSTRACT

This study aims to analyze the implementation of the SPIRIT model of problem-based biology learning (SSIPBL) on the respiratory system material at Muhammadiyah 1 Sragen High School in the 2024/2025 academic year and to determine whether this model can improve students' learning outcomes. The research type used is quantitative with an experimental design. Data collection was carried out through learning outcome tests, observations, and interviews. Based on the t-test results, a significance value (sig.) of 0.198 was obtained, which is greater than the 0.05 value, indicating that there is no significant difference between the experimental group using the SSIPBL model and the control group using conventional learning methods. Factors affecting the ineffectiveness of this model's implementation include teacher readiness, limited time, lack of student involvement, and inadequate infrastructure. The results of this study show that the implementation of the SPIRIT SSIPBL model on the respiratory system material does not significantly improve students' learning outcomes. Therefore, it is recommended to improve supporting aspects, such as teacher training, better time management, and increasing student motivation and involvement in problem-based learning. Indicates that the implementation of the SPIRIT model of Socio-Scientific Problem-Based Learning (SSIPBL) can significantly improve students' learning outcomes on the respiratory system material senior High School for the. These results suggest that SSIPBL has the potential to enhance students' understanding through a problem-based approach that connects scientific phenomena with social issues, and its implementation in the field met expectations.

KEYWORDS

Socio-Scientific Problem-Based Learning, Spiritual Value, Learning Outcomes

1. Introduction

21st-century education requires learning models that go beyond cognitive achievement, emphasizing character development, scientific literacy, and critical thinking skills. In response to these demands, integrating real-world social issues into science learning has become both relevant and strategic (Nugroho et al., 2025; Bayu et al., 2023; Dilekçi & Karatay, 2023).

One approach that addresses this need is Socio-Scientific Problem-Based Learning (SSIPBL). The SSIPBL SPIRIT model combines the strengths of Problem-Based Learning (PBL) with socio-scientific issues to help students connect scientific knowledge to societal problems (Rubini, 2019; Fita et al, 2021; Aisy et al, 2024). This model also integrates spiritual values and aligns with the goals of the Pancasila Learner Profile in the Merdeka Curriculum, providing contextual and meaningful learning experiences. The SPIRIT model—standing for Socio-scientific Problem-based learning Integrated with Real Issues and Islamic Teaching—provides an integrative learning framework that not only develops students' scientific understanding but also their ethical and moral reasoning. It encourages students to critically evaluate scientific issues that have societal implications, such as health, environment, and technological development.

Problem-Based Learning it self encourages students to develop critical thinking and problem-solving skills through engagement with real-life, ill-structured problems (Andryani et al, 2016; Park, 2019). However, the SSIPBL SPIRIT model expands this by embedding social relevance and ethical

considerations into the learning process. Research has shown that such contextualization not only improves concept mastery but also increases student motivation and engagement (Sadler et al, 2011; Sadler et al, 2017). The incorporation of social issues into learning allows students to see the relevance of scientific content in their daily lives, which is a key factor in building long-term understanding and retention of knowledge. Students are not merely learning for exams, but are also trained to be problem solvers and decision-makers in their communities.

The respiratory system is one of the biology topics often perceived as abstract and challenging for students (Kumalasari & Marianti, 2021). Concepts such as gas exchange, lung capacity, and cellular respiration are often difficult to relate to real-life experiences. Incorporating real-world issues such as pollution and respiratory health into this topic through the SSIPBL SPIRIT model may help students better understand its relevance and application. However, by contextualizing these concepts through socio-scientific problems such as the impact of air pollution on lung health, the rise of respiratory diseases, or debates about smoking in public areas students gain a clearer and more personal understanding of why these biological concepts matter. The SSIPBL SPIRIT model encourages students to actively engage in discussions and propose solutions to these issues, making learning more interactive and meaningful. Prior studies have shown that the SSIPBL SPIRIT model can enhance student learning outcomes in cognitive, affective, and psychomotor domains. Moreover, it has been associated with increased student curiosity, collaborative skills, and empathy for social issues (Husniyyah et al, 2023). Such multidimensional learning outcomes are particularly relevant for preparing students not only for academic success but also for their future roles as informed and responsible citizens. In this regard, the SSIPBL SPIRIT model reflects the ideal of holistic education.

While both SSIPBL and PBL aim to improve students' understanding and thinking skills, they differ in their pedagogical emphasis. SSIPBL incorporates literacy and values at each stage of the learning cycle, promoting reflective thinking and moral engagement. PBL, on the other hand, tends to focus on collaboration and solution-focused inquiry. Unfortunately, direct comparisons between the two models remain limited in Indonesian contexts. Most studies evaluate the effectiveness of each model in isolation. By conducting a side-by-side comparison, this study aims to contribute to the growing body of research on evidence-based science instruction in senior high schools.

The need for comparative studies becomes even more pressing considering the challenges faced in implementing advanced instructional models in real classrooms, such as teacher readiness, limited resources, and student diversity. Through this study, the researcher aims to identify not only the relative effectiveness of SSIPBL and PBL but also the practical considerations that affect their implementation.

Based on these considerations, this study aims to analyze the application of the Socio-Scientific Problem-Based Learning (SSIPBL) SPIRIT model to improve student learning outcomes on the respiratory system topic at Muhammadiyah 1 Sragen High School in the 2024/2025 academic year, and to compare its effectiveness with the conventional PBL model.

2. Method

This study adopts a quantitative approach with a quasi-experimental design. It involves two student groups: 31 students from class 11.1 and 34 students from class 11.2. The first group uses the Socio-Scientific Problem-Based Learning (SSIPBL) SPIRIT model, while the second group uses the Problem-Based Learning (PBL) model. The research was conducted at Muhammadiyah 1 Sragen High School during the odd semester of the 2025/2026 academic year, specifically in January. The population of this study consisted of students from Muhammadiyah 1 Sragen High School, with the sample being students from classes 11.1 and 11.2. The sampling technique used was purposive sampling, where two classes were randomly selected: class 11.1 as the experimental group using the SSIPBL SPIRIT model, and class 11.2 as the control group using the PBL.

The research instrument used was a learning outcome test consisting of multiple-choice questions tailored to the respiratory system topic. The instrument was validated by two expert lecturers in biology education and one senior high school biology teacher. The validation process focused on the alignment of question indicators with the basic competencies (KD) and cognitive levels targeted, specifically C2 (understanding), C3 (application), and C4 (analysis). The reliability of the instrument was confirmed through a trial test, resulting in a Cronbach Alpha coefficient of 0.79, indicating that the test items are sufficiently reliable for assessing student performance.

Data analysis was performed using the Independent Sample T-test. The Independent Sample T-test refers to a statistical approach used to examine the differences between two independent groups. This model is often employed in Independent Sample T-tests to compare the learning outcomes of two distinct groups, one using Method A and the other using Method B. In the context of education, this test helps evaluate differences in learning outcomes between two groups of students, each taught using a different instructional method. By applying the Independent Sample T-test, educators can assess whether there are significant differences in student achievement between groups using different teaching methods, such as those using technology-based learning versus traditional methods. This enables decision-makers in education to select the most effective teaching approaches to enhance student learning outcomes. Moreover, this model also aids in measuring the variability in the learning outcomes, providing a better understanding of the factors that influence success or failure in the learning process. According to Kusumadani (2024), the integration of SSI and PBL syntax is more effective in enhancing higher-order thinking skills, especially in the context of PBL with a spiritual-based approach.

3. Results and Discussion

The learning outcomes using methods 1 and 2 were tested using the Independent Sample T-test to determine the differences in learning outcomes between the class using the Socio-Scientific Problem-Based Learning (SSIPBL) SPIRIT model and the class using the Problem-Based Learning (PBL) model. Descriptive statistics can be seen in Table 1.

Table 1. Descriptive Statistic

	Group	*N*	*Mean*	*Std. Deviation*	*Std. Error Mean*
Learning outcomes	Group 1	31	96.77	4.193	.753
	Group 2	34	93.24	5.758	.987

Based on the test results above, the mean value obtained for group one is 96.77 while group 2 is 93.24. The std deviation value for group 1 is 4.193 and group 2 is 5.758. The results of the T-test can be seen in Table 2.

Table 2. Results of the t-test for Cognitive Learning Outcomes in Cycle I and II

Cycle	*Test Type*	*Sig.*	*Conclusion*
I	Independent Sample T-test	0,007	There is a difference
II	Independent Sample T-test	0,006	There is a difference

The results of the learning outcome test showed a significance value (sig.) of 0.007, which is less than 0.05 in cycle I and 0.006 < 0.05 in cycle II. This indicates that the implementation of the SPIRIT model of Socio-Scientific Problem-Based Learning (SSIPBL) can significantly improve students' learning outcomes on the respiratory system material at Muhammadiyah 1 Sragen High School for the 2024/2025 academic year. These results suggest that SSIPBL has the potential to enhance students' understanding through a problem-based approach that connects scientific phenomena with social issues, and its implementation in the field met expectations.

Several factors that may have influenced the effectiveness of this model include the teacher's readiness to implement this more complex approach, sufficient time allocated during the lessons, and

active student involvement in discussions and problem-solving processes. Student engagement plays a crucial role in the success of this model. For some students, there may be a tendency to actively participate in discussions and problem-solving, which is the core of the SSIPBL model. This could indicate that students have a strong interest or motivation toward the social issues raised, which positively impacts their understanding of the material being studied. Research by Sulaiman et al (2025) revealed that while PBL with SSI can enhance critical thinking skills, low student motivation can become a barrier to achieving optimal learning outcomes. Additionally, adequate infrastructure, such as learning resources or technological tools, may also affect the implementation of this model. SSIPBL often relies on media and additional resources to enrich the learning experience, and the availability of such infrastructure can influence the model's effectiveness. These results are in line with research by Sadler et al (2011); Zeidler et al (2019); Alcaraz & Barajas (2021), which states that the incorporation of social issues in science learning increases student engagement and builds empathy for global issues. In this context, students not only understand the concept of the respiratory system but also its broader implications for public health, particularly regarding air pollution and respiratory diseases.

The comparison between SSIPBL and PBL in this study also shows that the addition of social context and spiritual values can strengthen concept understanding and retention. This is supported by Kusumadani et al. (2024), who showed that the PBL approach with spiritual content is more effective in fostering higher-order thinking skills (HOTS). Although significant improvements were observed, the challenges in implementing SSIPBL remain. Teacher readiness is a key success factor. Therefore, this study recommends providing intensive teacher training that emphasizes how to apply SSIPBL effectively, especially when integrating local social contexts and values into science learning.

Overall, the SPIRIT model of Socio-Scientific Problem-Based Learning (SSIPBL) has the potential to significantly improve students' learning outcomes. This shows that the success of implementing problem-based learning models depends not only on the model itself but also on supporting factors such as teacher readiness, available time, student involvement, and adequate infrastructure. Higher-order thinking skills include the development of mental abilities derived from basic skills already possessed by the individual. These skills encourage students to find information and knowledge on their own, as well as to develop attitudes and values needed in the learning process (Magsino, 2014; Retnawati et al, 2018; Saepuzaman et al, 2021). This helps students become accustomed to seeking knowledge independently, without relying entirely on the instructor as the primary source of information. Furthermore, the knowledge acquired by students is not limited to memorizing concepts or facts but leads to the development of higher-order thinking skills by providing them with hands-on experiences with the objects being studied.

The findings of this study make a significant contribution to the development of problem-based learning (PBL) theory and social issue-based learning, particularly in the context of integrating strong literacy through the Literacy-Based Learning Cycle System approach. Theoretically, this research enhances our understanding of how a literacy-based learning cycle can strengthen students' cognitive and critical skills in identifying, analyzing, and solving social issues. Thus, the approach enriches active learning theory by emphasizing the importance of literacy in the broader and more contextual development of problem-solving skills (Puspitasari, 2016; González-Pérez et al, 2022; Hesse et al, 2015). Practically, the application of the SSIPBL method in problem-based and social issue-based learning can improve students' learning outcomes, particularly in terms of critical thinking, literacy skills, and the application of knowledge in real-world contexts. Teachers can utilize this learning cycle to design activities that not only focus on problem-solving but also enhance students' understanding of relevant social issues. Therefore, SSIPBL can serve as an effective tool to engage students more actively in learning and better prepare them to face complex social challenges through a more holistic and literacy-based approach to learning (Saputro, 2020; Hernández-Ramos, 2021; Lubis, 2022).

4. Conclusion

The implementation of the Socio-Scientific Problem-Based Learning (SSIPBL) SPIRIT model on the respiratory system material at Muhammadiyah 1 Sragen High School for the 2024/2025 academic year significantly improves students' learning outcomes. The model effectively supports the development of higher-order thinking skills by integrating scientific concepts with real-life social issues. Its success is influenced by several supporting factors, including teacher readiness, sufficient instructional time, active student engagement, and the availability of adequate infrastructure. These findings reinforce the importance of contextual and value-based science learning in building students' critical and reflective capacities.

This study contributes to the enrichment of science education by demonstrating how the inclusion of socio-scientific and spiritual elements in learning can enhance cognitive and affective outcomes. Practically, the SSIPBL model offers an effective strategy for teaching abstract biological concepts, making them more relatable through real-world social problems. Therefore, it is recommended that schools and policymakers provide training and resources to support its implementation. Future research should explore the long-term impact of SSIPBL on student attitudes and problem-solving skills, as well as its applicability to other science topics and educational levels.

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