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The Effectiveness of the Scratch-Assisted Jigsaw Learning Model to Improve Students' Creative Thinking Skills and Science Literacy on the Topic of Measurement

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Abstract: This research developed and validated a Scratch-assisted Jigsaw learning instrument for teaching physics measurement concepts. It also investigated the model's impact on students' creative thinking skills and scientific literacy. A True Experimental Research design with a quantitative approach, using a pre-test post-test control group, was employed. The instrument underwent rigorous validation, including feasibility assessments and field tests. Effect size analysis determined the model's impact. The developed instruments met eligibility standards and significantly enhanced students' creative thinking and scientific literacy. Hypothesis testing showed a significance value below 0.05. Effect sizes for creative thinking (0.33) and scientific literacy (0.32) were both medium, indicating a noticeable positive impact. The Scratch-assisted Jigsaw model is a reliable and effective approach, offering a valuable and innovative alternative for improving physics education quality by enhancing creative thinking and scientific literacy.

Keywords: Creative thinking; Jigsaw; Scientific literacy; Scratch

Introduction

The 21st century demands innovative and adaptive approaches in physics education to cultivate higher-order thinking skills, including critical, creative, collaborative, and communicative abilities, essential for a deeper understanding of physics concepts (Trilling & Fadel, 2020). However, traditional teaching methods often fail to develop these crucial skills. Consequently, implementing technology-based interactive learning models becomes vital for enhancing student engagement and participation in physics.

The current Merdeka Curriculum emphasizes integrating technology into science education to improve student comprehension. Technology-based learning provides broader access to information and fosters creative thinking (Rufaidah et al., 2021). Scratch, a visual programming software, offers an interactive platform for exploring scientific concepts (Saputra & Perdana, 2024). Therefore, incorporating the Scratch-assisted Jigsaw learning model presents a promising alternative for more effective physics instruction.

Previous studies highlight persistent challenges in students' creative thinking skills and scientific literacy in physics. Research by Hamdi et al. (2023) and Mislah et al. (2024) revealed alarmingly low levels of creative thinking among students. Similarly, PISA's 2019 report indicated Indonesian students' low global ranking in scientific literacy (OECD, 2019), further supported by Suparya et al. (2022) showing only 35% of students with good scientific literacy in physics. These deficiencies are largely attributed to conventional, one-way lecture methods that limit students' ability to develop new ideas (Kadarwati & Widodo, 2020) and the limited integration of technology, hindering comprehension of abstract concepts (Lestari, 2021). Furthermore, students' lack of engagement in hands-on experiments (Barus et al., 2024) and minimal use of digital media (Budiyono, 2020) contribute to poor conceptual understanding and problem-solving skills.

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Various innovative approaches have been explored to address these issues. Project-based learning (Azizah & Wulandari, 2024) and inquiry-based methods (Asriani et al., 2021) have shown promise in fostering creative thinking. The Jigsaw learning model has also improved creative thinking and scientific literacy (Hariyati, 2023). For scientific literacy, STEM-based learning (Hazana, 2024) and problem-based learning (Bota et al., 2022; Faizin et al., 2024) have proven effective. Additionally, integrating Scratch as an instructional tool can enhance conceptual understanding and increase student participation (Bui et al., 2025).

However, these existing approaches often have limitations, such as insufficient integration of cooperative learning with technology (Suparya et al., 2022) or focusing on a single skill rather than fostering both creative thinking and scientific literacy simultaneously (Ramadhanti & Astriani, 2024). The traditional Jigsaw model itself has drawbacks, including the dominance of more active students and challenges for those with lower reading skills (Suparni, 2017). Integrating interactive learning media like Scratch can mitigate these issues, fostering greater active participation, collaboration, and balanced contributions (Isnaini et al., 2021).

The Scratch-assisted Jigsaw learning model offers a promising solution to these challenges. This combined approach encourages collaboration, idea exchange, and independent learning through Jigsaw (Susilo et al., 2016), while Scratch provides an engaging platform for visualizing physics concepts, making learning more appealing and accessible (Sunarti & Rusilowati, 2021; Vidaroini & Perdana, 2024). This integration facilitates sharing knowledge, deepens conceptual understanding, and improves student motivation and academic performance by creating an enjoyable and efficient learning environment. It also plays a crucial role in developing stronger problem-solving skills and relating theoretical concepts to real-world applications. The Jigsaw model encourages students to explore and discuss concepts independently, while Scratch enables them to design interactive simulations that stimulate imagination and innovation (Ningrum et al., 2023), fostering an open and adaptable mindset (Aminah et al., 2019). Furthermore, this approach enhances scientific literacy by encouraging structured information presentation and providing hands-on visual engagement with scientific concepts (Ramanda et al., 2019; Yudhistira et al., 2022; Paling & Suparyono, 2024; Prihastuti & Sukaesih, 2024).

This research specifically focuses on the physics topic of "Measurement," which is fundamental for understanding experiments and data analysis (Sandari, 2021). The Jigsaw model will enable students to grasp different aspects of measurement through group discussions, while Scratch will help visualize abstract concepts, making them more tangible.

Based on this background, this study introduces a more explorative alternative by combining the Jigsaw learning model with Scratch as a digital learning tool. This approach is expected to enhance students' creative thinking skills and scientific literacy. Therefore, this research, titled "The Effectiveness of the Jigsaw Learning Model Assisted by Scratch in Enhancing Students' Creative Thinking Ability and Science Literacy on the Topic of Measurement," aims to develop a valid and reliable instrument, analyze the profile of students' creative thinking skills and science literacy in physics learning before and after applying the Scratch-assisted Jigsaw learning model on the measurement topic, and evaluate the effectiveness of this learning model in improving these skills.

Method

This study employed a quantitative research approach, specifically a True Experimental Research design with a pre-test post-test control group design. The study sample comprised 108 tenth-grade students from SMA Negeri 1 Imogiri, divided into three groups through cluster sampling: an experimental class, control class 1, and control class 2. The experimental class received instruction using the Jigsaw learning model assisted by Scratch. Control class 1 was taught using the Jigsaw learning model with PowerPoint, while control class 2 used the Jigsaw model without additional learning media.

Data analysis involved three types: instrument analysis, descriptive analysis, and inferential analysis. Instrument analysis focused on reliability and validity tests. Questionnaires were distributed to expert validators, practitioner validators, and students. Data collected were analyzed using the QUEST program. Descriptive analysis involved examining students' pre-test and post-test scores from all three classes. The evaluation of questions designed to measure creative thinking ability and scientific literacy is based on the INFIT Mean of Square (INFIT MNSQ) score. An item is considered valid if its INFIT Mean of Square value falls within the range of 0.77 to 1.30. If the INFIT MNSQ value lies outside this range, the item requires revision or further analysis. Therefore, this analysis is crucial to ensure that the instruments utilized are of high quality and meet measurement standards.

Inferential analysis included prerequisite tests and hypothesis tests. Prerequisite tests, performed using SPSS software, included normality and homogeneity tests. Data were considered normally distributed or homogeneous if the significance value exceeded 0.05.

The results of the data analysis show that the significance value is less than 0.05, so a non-parametric analysis was performed. The Kruskal-Walli's test was applied for the main hypothesis, and the Mann-Whitney test was used for minor hypotheses. Finally, an effect size analysis was conducted to evaluate the impact of the Scratch-assisted Jigsaw learning model on students' creative thinking skills and scientific literacy. The effect size was calculated using the Epsilon Squared equation. The following are the criteria for the effect size test used in this study.

Table 1. Effect size test interpretation criteria

E_R	Criteria
$0.80 \leq E_R < 1.00$	Very strong
$0.60 \leq E_R < 0.80$	Strong
$0.40 \leq E_R < 0.60$	Relatively strong
$0.20 \leq E_R < 0.40$	Medium
$0.10 \leq E_R < 0.20$	Weak
$0.00 \leq E_R < 0.10$	Very weak

Result and Discussion

The feasibility of the Scratch-assisted Jigsaw learning model instrument was thoroughly evaluated by three expert validators (one lecturer and two physics teachers) and assessed through student responses from a limited trial involving 60 XI and XII graders who had previously covered the measurement topic. The instrument achieved a high level of feasibility across all aspects, indicating its suitability for educational use (Utami et al., 2024). Student feedback also confirmed the instrument's good readability.

Similarly, the Students' Worksheet (LKPD) instrument underwent feasibility assessment by three expert validators and student readability evaluations during the limited trial. The LKPD consistently achieved a high feasibility rating and was deemed good in readability, confirming its appropriateness for physics instruction. The Scratch media itself was also assessed by three expert validators and through student feedback in the limited trial. Results showed the Scratch media to be of high feasibility and good readability, further validating its suitability as a physics learning tool.

Finally, the test instrument designed to measure students' creative thinking skills and scientific literacy in measurement was rigorously evaluated as shown in Table 2 and 3. It underwent assessment by three expert validators (one lecturer and two physics teachers) and subsequent empirical testing. Content validity, determined through expert evaluations and analyzed using Aiken's V, yielded a high category for both creative thinking and scientific literacy sections, affirming the instrument's readiness for further use. Consequently, the test instrument proceeded to a limited trial with XI and XII grade students.

Table 2. Aikens V validity of creative thinking ability question instrument

Number of question	Score	Category
1	0.89	High
2	0.89	High
3	0.89	High
4	0.89	High
5	0.89	High
6	1	High
7	0.78	Medium
8	1	High
9	1	High
10	0.89	High
11	0.89	High
12	1	High
13	1	High
14	1	High
15	0.89	High
Mean	0.93	High

Table 3. Aikens V validity of science literacy ability question instrument

Number of question	Score	Category
1	0.89	High
2	0.89	High
3	1	High
4	1	High
5	1	High
6	0.89	High
7	1	High
8	1	High
9	1	High
10	1	High
11	1	High
12	1	High
13	1	High
14	1	High
15	0.78	Medium
Mean	0.96	High

The test instruments that had been assessed using Aiken's V were further analyzed through empirical testing. The empirical test results for creative thinking questions indicated that four items were invalid, while for science literacy questions, five items were found to be invalid. These invalid questions were excluded from the field test stage. A question is considered valid if its INFIT MNSQ value falls within the range of 0.77–1.30 (Heru & Suparno, 2019). Following the validity analysis, the test instrument underwent reliability testing. The results showed that the creative thinking test instrument had a reliability score of 0.46, categorized as medium, while the science literacy test instrument obtained a 0.67 reliability score, categorized as high. These findings confirm that the test instrument is suitable for the next phase, namely the field test stage for Grade X students. Below are the analysis results of the creative thinking and science literacy instruments, obtained using the Quest application.

Table 4. Creative thinking ability questions

Number of question	INFIT MNSQ	Category
1	0.67	Not Valid
2	0.95	Valid
3	0.86	Valid
4	0.79	Valid
5	0.66	Not Valid
6	1.14	Valid
7	1.22	Valid
8	1.02	Valid
9	0.97	Valid
10	0.74	Not Valid
11	0.86	Valid
12	1.46	Not Valid
13	1.01	Valid
14	0.88	Valid
15	1.06	Valid

The implementation of the Jigsaw learning activity was carried out in three different classes, each receiving a distinct treatment. The experimental class applied the Jigsaw learning model assisted by Scratch, while control class 1 utilized the Jigsaw learning model with PowerPoint media. Meanwhile, control class 2 implemented the Jigsaw learning model without incorporating any additional learning media. The learning process was conducted over two sessions, focusing on the Measurement topic for Grade X students. Throughout the study, researchers observed and compared the improvement in post-test scores across all three classes. The following graph presents the average creative thinking ability of students based on the three assessed indicators.

Table 5. Science literacy ability questions

Number of question	INFIT MNSQ	Category
1	0.77	Valid
2	0.77	Valid
3	1.11	Valid
4	0.68	Not Valid
5	1.18	Valid
6	0.64	Not Valid
7	1.08	Valid
8	1.03	Valid
9	1.25	Valid
10	0.73	Not Valid
11	1.18	Valid
12	0.73	Not Valid
13	1.05	Valid
14	0.87	Valid
15	1.32	Not Valid

The Scratch-assisted Jigsaw learning model significantly improved students' creative thinking skills. Before the intervention, students' creative thinking was in the "needs guidance" category. However, the experimental class's average score rose to 81.94 (excellent category) after implementing the Scratch-assisted Jigsaw model. Specifically, the experimental group excelled in classifying ideas, outperforming both control classes (Irman et al., 2025).

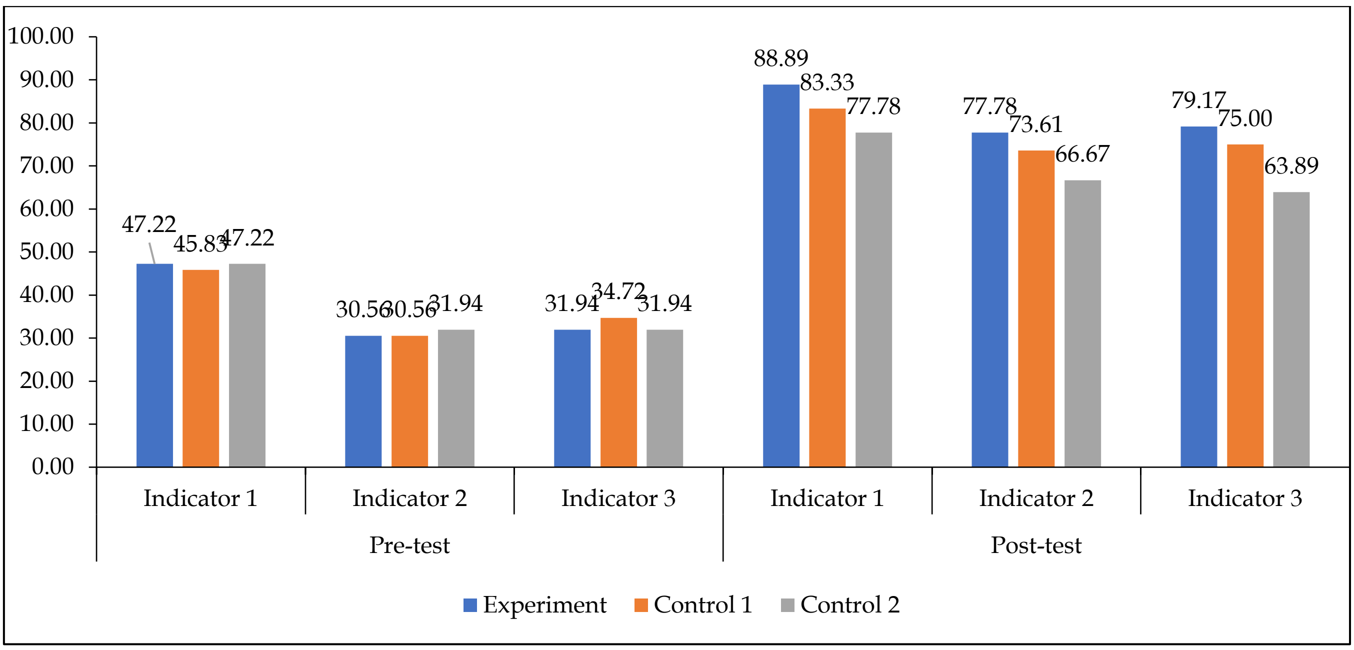

Figure 1. Graph of the average score of pre-test and post-test of students' creative thinking ability

In contrast, Control Class 1, utilizing the Jigsaw model with PowerPoint, showed a "good" improvement with an average score of 77.31, yet this was still lower than the experimental class. This supports previous research suggesting Scratch is more effective for enhancing creative thinking (Janika et al., 2025). Control Class 2, without any additional media, achieved an average score of 69.44 (sufficient category). The lack of learning media in Control Class 2 presented greater challenges, reinforcing that media use positively impacts student scores and comprehension (Syahfitri, 2025), as students generally expect comprehensive learning resources. The following graph illustrates the average students' science literacy skills based on the three indicators used.

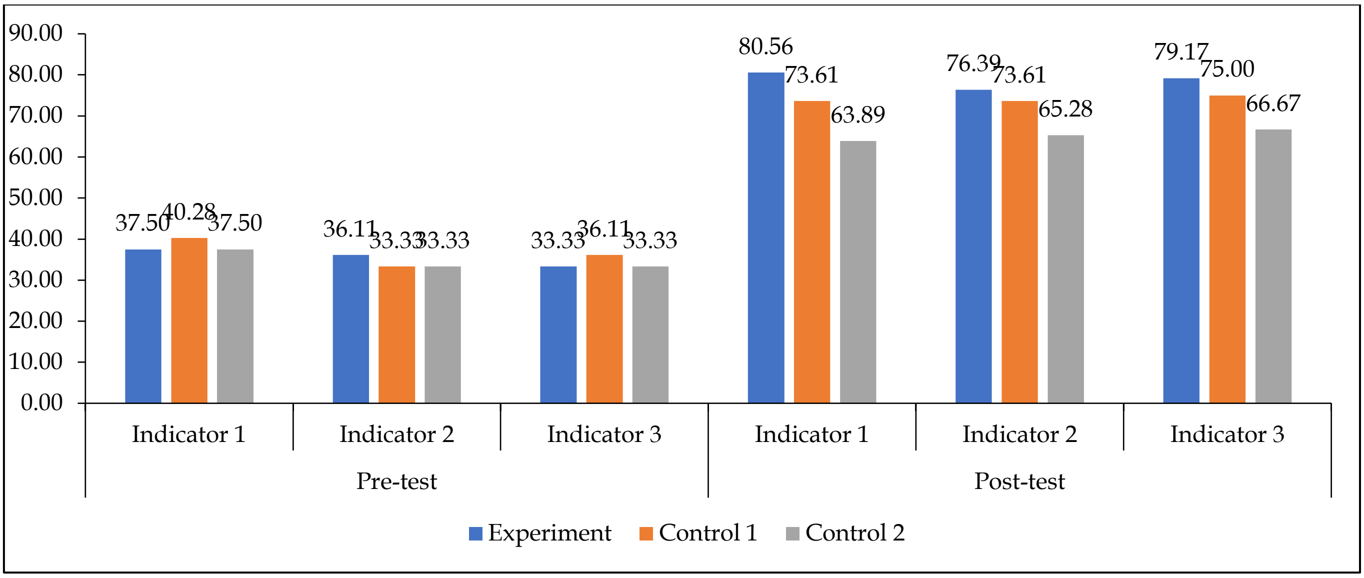

Figure 2. Graph of the Average Value of Pre-Test and Post-Test of Students' Science Literacy Ability

Students across all three classes initially showed limited science literacy skills, categorized as "requiring guidance." However, the experimental class, which utilized the Scratch-assisted Jigsaw learning model, demonstrated the most substantial improvement. Their average science literacy score soared to 78.70, placing them in the "good" category. Notably, the highest achievement in this class was in applying evidence, a crucial aspect of developing scientific literacy (Azahra et al., 2025). This suggests that the experimental group became more proficient at using valid scientific evidence to solve problems.

In comparison, control class 1, which used the Jigsaw model with PowerPoint, achieved a "good" average science literacy score of 74.07. Conversely, control class 2, employing the Jigsaw model without any media assistance, scored the lowest at 65.28%, falling into the "moderate" category. This highlights the significant role that appropriate learning media played in boosting students' science literacy, even within the same Jigsaw framework.

The effectiveness of the learning model in enhancing creative thinking skills and science literacy was statistically validated. Both the Kruskal-Wallis test (for the major hypothesis) and the Mann-Whitney test (for the minor hypothesis on creative thinking) yielded significance values below 0.05. This conclusively confirms that the Jigsaw physics learning model effectively improves students' creative thinking abilities.

Similarly, the Kruskal-Wallis test and Mann-Whitney test for science literacy analysis also produced significance values less than 0.05. These consistent results further support the conclusion that the Jigsaw physics learning model is effective in enhancing students' science literacy skills.

The overall impact of the Scratch-assisted Jigsaw learning model was quantified using effect size analysis (epsilon squared). The effect size for creative thinking skills was 0.33, and for science literacy skills, it was 0.32, both categorized as moderate. These findings indicate that the Scratch-assisted Jigsaw learning model has a meaningful, albeit moderate, effect on improving both creative thinking and science literacy in the context of learning measurement.

Conclusion

The developed test instrument, designed to measure students' creative thinking and scientific literacy, was validated by three experts and empirical testing, confirming its high reliability and suitability for evaluating physics learning. The implementation of the

Scratch-assisted Jigsaw learning model significantly improved students' abilities. Pre-test scores in the experimental class averaged 36.57 for creative thinking and 35.65 for scientific literacy, both indicating a "needs guidance" level. Post-test scores dramatically increased to 81.94 for creative thinking (excellent category) and 78.70 for scientific literacy (good category). Effectiveness analysis revealed medium effect sizes: 0.33 for creative thinking and 0.32 for scientific literacy. The notably greater improvement in the experimental class, compared to the control group, suggests that the Scratch-assisted Jigsaw model is an effective alternative for enhancing creative thinking and scientific literacy in physics education.

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Author Contributions
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Conflicts of Interest
The authors declare that there is no conflict of interest in the preparation of this article.

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