Enhancing Spatial Literacy through ClassPoint-Integrated Geometry Learning: A Quasi-Experimental Study Type

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ABSTRACT

This study evaluates the efficiency of ClassPoint learning media in improving students' spatial literacy in geometry education. Spatial literacy, which includes imagery, reasoning, and communication skills, is crucial for understanding and solving complex geometric problems. The research employed a quasi-experimental methodology, dividing 52 eleventh-grade students into two groups: one utilizing ClassPoint for the experiment and the other employing conventional methods as the control group. We collected data through pretests and post-tests with instruments devised particularly to assess three characteristics of spatial literacy. The data analysis included t-tests and N-Gain to evaluate the intervention's effectiveness. The results demonstrated that students in the experimental group showed a significant improvement in spatial literacy compared to the control group. The mean score of the experimental group increased from 66.38 to 85.23 following the intervention, with N-Gain scores for vision at 0.84 (high category), reasoning at 0.81 (high category), and communication at 0.70 (medium category). The interactive features of ClassPoint, such as quizzes, polls, and live annotations, improved the learning experience and aided students' understanding of concepts. This study contributes to educational literature by illustrating the effectiveness of the ClassPoint learning medium in improving spatial literacy in geometry education. This study's practical consequences recommend employing learning tools such as ClassPoint in mathematics lessons to foster a more innovative, engaging, and pertinent educational atmosphere. We expect the results of this study to guide educators and policymakers in developing learning strategies that enhance students' spatial skills development.

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I. Introduction

Spatial literacy is essential in geometry learning, especially in comprehending and manipulating geometric objects. It helps students with spatial visualization and representation, which are essential for understanding more complex geometry and mathematics concepts (Jiménez-Vilcherrez et al., 2023; Koparan et al., 2023; Menouer et al., 2024), as well as improving problem-solving skills (Bistron & Schwering, 2024; Wulandari et al., 2019). At the basic and secondary education levels, spatial literacy is a critical foundation for learning complicated topics in mathematics, including geometric transformations and spatial relationships between objects (Frick, 2019; Hollebrands, 2003; Lane et al., 2019).

Low spatial literacy in high school students is one of the key barriers to studying geometry, impacting the limited understanding of geometric concepts (Adams et al., 2023; Harris, 2023). Conventional, less participatory learning methodologies exacerbate this problem by rarely allowing students to visualize topics dynamically. Students have trouble understanding geometry concepts that need them to be able to see and move around in three dimensions when they are taught in a way that focuses on memorization and following steps rather than deep understanding of space (Crompton & Ferguson, 2024; Demitriadou et al., 2020; Glasnović Gracin & Kuzle, 2024).

In addition, limited instructional time and lack of resources, such as software and visualization tools that support the teaching of spatial concepts, are significant barriers to the development of students' spatial literacy (Mjenda et al., 2023; Ziatdinov & Valles, 2022). Teaching geometric transformations, such as rotation, reflection, and translation, is often done statically without the support of dynamic visual aids. As a result, students have difficulty understanding the transformation process thoroughly (Fujita et al., 2020; Paulino et al., 2023; Rodríguez et al., 2021). This limitation highlights the

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need for innovation in geometry learning media to enhance visualization and interactivity, thereby supporting students' spatial literacy development more effectively.. This solution is important to create more relevant and meaningful geometry learning for students. To overcome these problems, a new media that is more effective in improving students' spatial literacy is needed (Birgin & Acar, 2020; Del Cerro Velázquez & Méndez, 2021; Suherman et al., 2020).

ClassPoint is a viable learning medium. ClassPoint is a learning tool that enhances interactivity and comprehension in geometry education (Frisnoiry et al., 2024; Hidayat et al., 2023; Sujatmiko & Dyah.P., 2023). ClassPoint enables educators to develop interactive presentations involving students in the learning experience. ClassPoint offers features like interactive quizzes, polls, and live annotations on slides, allowing teachers to discern student misconceptions and deliver real-time feedback (Godsk & Møller, 2024; Simelane-Mnisi & Mji, 2019). ClassPoint enhances geometry education by incorporating interactive elements, such as quizzes and polls, which elevate student engagement and participation. Moreover, immediate feedback from educators, informed by student responses, facilitates the prompt identification and rectification of errors (Salas-Rueda, 2020). Consequently, a more effective strategy for enhancing students' spatial literacy, such as integrating media in education, is required. We anticipate that this strategy will enhance students' spatial literacy, better preparing them to overcome obstacles in geometry learning.

This study seeks to assess the influence of ClassPoint on students' spatial literacy, particularly regarding visualization, reasoning, and communication. This study hypothesizes that integrating ClassPoint in geometry learning will significantly improve students' spatial literacy compared to conventional learning media. This study's results are expected to contribute substantially to the educational literature by exploring the benefits of using ClassPoint interactive learning media in improving students' spatial literacy.

Overall, this study provides an opportunity to expand the understanding of how using ClassPoint learning media can improve students' spatial literacy. Using digital media to teach geometry has improved learning by creating an immersive and interactive environment that makes it easier to understand and remember difficult spatial concepts (Gunčaga & Záhorec, 2024; Poddar et al., 2024). Therefore, the study results are expected to provide practical implications for teachers and policymakers in adopting interactive learning media to create more effective and relevant learning in the digital era.

II. Method

This research used a quasi-experimental design comprising the experimental and control groups (Rahman & Rabiul Islam, 2022; Zajić & Maksimović, 2022). This study had 52 students, including 26 participants from the control group and 26 from the experimental group. The experimental group incorporated geometry learning materials with ClassPoint, whereas the control group employed traditional learning methods. We used the purposive random sampling approach to randomly select the sample from the population of 11th-grade students at SMA 1 Stabat, North Sumatra.

We gathered data using study instruments consisting of spatial literacy booklet tests, which we administered as a pretest and a post-test to the entire sample. We evaluated the efficacy of ClassPoint by comparing pretest and post-test scores across groups using a t-test. We administered the N-Gain exam to assess students ' spatial literacy enhancement. We performed data analysis using the statistical tool SPSS to evaluate the research hypothesis and present the findings in a scholarly manner. The study's results will elucidate the efficacy of ClassPoint in geometry education and its significance in enhancing students' spatial literacy.

The research hypotheses were as follows:

- There is a statistically significant difference between the mean scores of the experimental group on spatial literacy before and after the application of ClassPoint as a learning material on geometry.
- There is a significant effect of using ClassPoint in geometry learning on improving students' spatial literacy.

Table 1 indicates that the students' spatial literacy measures encompass three primary dimensions: visualization, reasoning, and communication (Pradana & Sholikhah, 2021). Visualization denotes students' capacity to conceive, manipulate, and mentally depict spatial objects or scenarios. This skill is crucial for comprehending geometric ideas, including an object's shape, size, position, and orientation in space. Additionally, reasoning includes students' ability to understand how things fit together in space and to draw logical conclusions from geometric patterns or changes. This indicator necessitates analytical and logical skills in processing spatial information to render precise conclusions. Communication encompasses students' capacity to articulate spatial ideas or concepts proficiently, whether orally, in written form, or through visual representations like diagrams. This communicative skill is essential for exhibiting student comprehension and conveying spatial concepts to others. These three indicators synergistically enhance one another, forming a crucial foundation for advancing students' spatial literacy, particularly in the context of geometry learning.

Table 1. Spatial Literacy Indicators

Indicator	Description
Visualization	The ability to imagine, manipulate, and represent objects or spatial situations in the mind. For example, visualizing geometric shapes or the relative position of objects in space.
Reasoning	The ability to understand spatial relationships between objects, including the ability to draw logical conclusions about patterns or geometric transformations. This involves systematic analysis and logical thinking about spatial elements.
Communication	The ability to explain spatial ideas through verbal, written, or visual means. For example, students can accurately describe the process of rotating or translating an object.

The Table 2 questionnaire evaluates students' spatial literacy skills in three key areas: Visualization, Reasoning, and Communication. The visualization component evaluates students' mental capacity to conceive and depict spatial objects. This encompasses skills such as visualizing geometric transformations and distinguishing shapes from various perspectives. The reasoning part tests students' ability to understand how objects are related in space and to draw logical conclusions about geometric transformations like translations, reflections, and rotations. The communication element emphasizes students' proficiency in articulating spatial concepts effectively, whether verbally, in writing, or through diagrams. This section contains inquiries regarding delineating geometric transformation procedures or applying geometric principles to practical situations. Statistical tests, such as t-tests and N-Gain tests, will be used to examine the questionnaire data and see how well using ClassPoint in geometry classes improves students' spatial literacy. We will also conduct a qualitative analysis to scrutinize the students' responses and engagement with the spatial literacy exercises.

III. Results and Discussion

This section presents the main findings based on the data collected through a quasi-experimental approach, involving 52 students in group XI from two groups: the experimental group using ClassPoint learning media and the control group using conventional learning methods. Pre-test and post-test data from each group were analyzed to evaluate the effectiveness of ClassPoint learning media in improving students' spatial literacy in geometry learning. The analysis began with a normality test using the Kolmogorov-Smirnov method and a homogeneity test using Levene's test to ensure the data met the assumptions of parametric statistics. Next, a paired t-test was applied to evaluate the improvement in the experimental group before and after the intervention, while an independent sample t-test compared the results of the experimental group with the control group.

Table 2. Spatial Literacy Assessment Questions for

Aspect	Questionnaire Statement
Visualization	I can understand geometric shapes better through the interactive visualizations presented using ClassPoint. The use of animations and diagrams in ClassPoint helps me visualize geometric transformations (such as rotation, translation, and reflection) clearly.
Spatial Representation	I can better draw or model 2D and 3D geometric objects after learning using ClassPoint. The materials delivered using ClassPoint help me understand the relationship between visual and mathematical representations of geometric shapes. I can predict the shape of a geometric object after a transformation (e.g., viewed from the side or top) with the help of ClassPoint materials.
Spatial Problem Solving	I feel more confident solving spatial geometry problems, such as front, top, and side views, after learning using ClassPoint. I can use the concepts learned through ClassPoint to explain how 2D shapes transform into 3D shapes in real life.
Interactivity	The interactive features in ClassPoint (such as quizzes and live annotations) make it easier for me to understand the geometry concepts taught. I feel more actively engaged in geometry learning through the use of interactive features in ClassPoint. Using ClassPoint makes me more interested in learning geometry compared to other teaching methods.

In addition, spatial literacy improvement was analyzed using N-Gain scores on three main indicators: visualization, reasoning, and communication. Results are presented in tables and descriptive narratives, which include comparisons of mean scores, standard deviations, and statistical significance, to illustrate the impact of using ClassPoint learning media on geometry learning. The findings provide a comprehensive picture of the effectiveness of ClassPoint learning media in improving students' spatial literacy skills and support an in-depth interpretation of the benefits of implementing interactive learning media in the learning process.

A. Normality Test

Normality testing is a crucial phase in statistical analysis. It ascertains whether the data follows a normal distribution, a fundamental prerequisite for parametric statistical tests. This study employed the Kolmogorov-Smirnov test for normalcy, utilizing SPSS software version 25. The outcomes of the normalcy test are displayed in Table 3.

Table 3. Normality Test

Group	Sig.	Information
Group Pre-test	0.070	Normal
Post-test Experimental Group	0.101	Normal
Control Group Pre-test	0.068	Normal
Control Group Post-test	0.100	Normal

The normality test findings indicate the following significant values for each group: Experimental Group Pre-test: 0.070, Experimental Group Post-test: 0.101, Control Group Pre-test: 0.068, and Control Group Post-test: 0.100. Every significance value surpasses 0.05, suggesting a regular distribution of data among the four groups. As a result, the assumption of normalcy is met, and these data meet the requirements to move on to the parametric statistical analysis phase.

B. Hegemony Test

Upon confirming the data's normality, the subsequent step is to perform a homogeneity test. This test seeks to assess the equality of variance between the experimental group and the control group. The acceptance or rejection of a hypothesis is determined by comparing the significance value (sig) of Levene's statistics to the 0.05 threshold, where a sig value greater than 0.05 signifies homogeneity of variance.

Table 4. Hegemony Test

	Test of Homogeneity of Variance		
	Levene Statistic	Sig.	Information
Experiment-Control Group	.120	.730	Homogeneous

According to Table 4, the homogeneity test yielded a Levene statistic of 0.120 and a significance value (Sig.) of 0.730. The difference between the experimental and control groups' pre- and post-test scores is insignificant because the significance value (sig) is greater than 0.05. The data presented above satisfy the assumption of homogeneity.

C. Hypothesis Test

1) There is a statistically significant difference between the mean scores of the experimental group on spatial literacy before and after the application of ClassPoint as a learning material on geometry.

This study's first hypothesis is that there is a statistically significant difference between the average spatial literacy scores of students in the experimental group before and after ClassPoint-based learning media were used to teach geometry. We employed a paired t-test to compare the mean scores of the pre-test and post-test within the experimental group.

Table 5. T-test results of hypothesis 1

Paired Samples Statistics			
	Mean	***t***	***Sig.***
Pre-test	66.38	12.471	000
Post-test	85.23	7.544	

The t-test results presented in Table 5 indicate that the mean pre-test score of students was 66.38, accompanied by a standard deviation of 12.471. This indicates that students' spatial literacy skills prior to utilizing the ClassPoint learning medium exhibit considerable variability. Following the implementation of this educational material, the average post-test score rose to 85.23, with a standard deviation of 7.544. The rise in the mean and a reduced standard deviation signify that students' learning outcomes have not only enhanced overall but also exhibited greater consistency among individuals. The calculated t-statistic was -8.892, with 25 degrees of freedom, and a two-tailed significance value of 0.000, less than the significant threshold of 0.05 ($p < 0.05$). So, a statistically significant difference exists between students' average spatial literacy scores before and after the ClassPoint learning medium was used in the classroom. Consequently, ClassPoint's learning medium has shown efficacy in enhancing students' spatial literacy in geometry; it significantly contributes to the comprehension and skills of high school students.

2) There is a significant effect of using ClassPoint in geometry learning on improving students' spatial literacy.

This study assesses the substantial impact of ClassPoint learning media on students' spatial literacy in geometry education. We performed hypothesis testing using an independent sample t-test, comparing the mean scores of the experimental and control groups. The table below displays the data findings from the aforementioned analysis.

Table 6. T-test results of hypothesis 2

Independent Samples Test Result			
Group	Std. Deviation	Sig	Sig. (2-tailed)
Experiment	7.544	.004	.000
Control	4.808		

The Independent Samples Test results in Table 6 indicate that the experimental group, comprising 26 students (N), has a mean score of 85.23 and a standard deviation of 7.544, whereas the control group, also consisting of 26 students, has a mean score of 76.19 and a standard deviation of 4.808. The degrees of freedom (df) is 50, the significance value (Sig.) is 0.004, and the two-tailed significance value (Sig. 2-tailed) is 0.000. The significance value is less than the significance level of 0.05 ($p < 0.05$), indicating a statistically significant difference between the experimental and control groups' learning outcomes.

This conclusion suggests that ClassPoint-based learning material significantly enhances students' spatial literacy. The big difference in average scores between the experimental and control groups shows that this media helps students understand spatial concepts. Therefore, we can utilize ClassPoint learning resources more extensively in the geometry learning process to improve the quality of student comprehension.

Furthermore, we conducted additional assessments with students to evaluate the factors influencing their understanding of spatial literacy. Examining these test results will yield a more profound knowledge of the elements contributing to the efficacy of ClassPoint-based learning.

D. Spatial Literacy

Spatial literacy is an important ability that includes the ability of individual students to understand, interpret, and visualize the relationship between objects in space. Education necessitates the development of spatial literacy, particularly in geometry learning. This ability involves three leading indicators: visualization, spatial reasoning, and communication, all of which play a role in improving students' understanding of geometric concepts and their ability to solve related problems. To support the improvement of spatial literacy, using interactive learning media such as ClassPoint is a promising alternative. It allows students to actively engage in learning by presenting clear visualizations and dynamic interactions.

Table 7. N-Gain Test of Students' Spatial Literacy

Indicator	N-Gain Score	Categories
Visualization	0.84	High
Reasoning	0.81	High
Communication	0.70	Medium

Based on the data in Table 7, the results showed an increase in students' spatial literacy, as analyzed through N-Gain scores on the three leading indicators. The visualization indicator yielded an N-Gain score of 0.84, placing it in the high category. This shows that using ClassPoint successfully helped students visualize geometric objects better. This medium can present visual representations that support a practical understanding of spatial relationships. The spatial reasoning indicator also showed a significant increase with an N-Gain score of 0.81, also in the high category. These results indicate that ClassPoint supports the development of students' logical and critical thinking skills in analyzing and solving spatial problems. In addition, the communication indicator has an N-Gain score of 0.70, which is in the medium category. Although students showed increased ability to convey geometric ideas or concepts, these results indicate that additional approaches are still needed to optimize further students' communication skills related to spatial literacy.

Therefore, this study's results indicate that the application of ClassPoint learning media is effective and positively impacts students' spatial literacy in all three aspects: visualization, reasoning, and communication. The results provide an essential contribution to supporting the use of ClassPoint learning media for more innovative and effective geometry learning in the future.

Table 8. Experience of using ClassPoint Media in Geometry learning

Aspect	The Questions Number	Average Score
Visualization	1	4.6
	2	4.5
Spatial	3	4.4
Representation	4	4.2
	5	4.3
Spatial Problem	6	4.4
Solving	7	4.5
Interactivity	8	4.5
	9	4.6
	10	4.4

Table 8 displays the findings from the descriptive analysis of student satisfaction with using ClassPoint learning media in geometry instruction, as assessed via a questionnaire administered to 26 students in the experimental group. The collected data encompasses four primary dimensions: visualization, spatial representation, problem-solving, and interactivity. The average scores for each questionnaire item reflect a significant level of student engagement with the ClassPoint learning medium evaluated during the educational process. The elevated average scores across all dimensions suggest students experienced a favorable learning environment using ClassPoint.

ClassPoint Media's visual quality aids students in understanding spatial literacy in geometry education. The research indicates that the visualization elements in ClassPoint media are clear and informative, achieving an average score of 4.5 to 4.6. The spatial representation component has an average score ranging from 4.2 to 4.4 for its capacity to illustrate and comprehend the relationship between visual and mathematical representations. This indicates that ClassPoint learning material effectively enhances students' spatial literacy representation skills.

The spatial problem-solving component enhanced students' confidence in addressing geometry difficulties, achieving an average score of 4.4. At the same time, applying geometric concepts to real-world scenarios via a 2D to 3D transformation attained a score of 4.5. The interactivity component achieved the best overall score, averaging 4.6 in student engagement with interactive elements, including quizzes and live annotations. The students' interest in learning geometry using ClassPoint was very high, achieving a score of 4.4. Qualitative data

from post-intervention surveys revealed that students positively perceived ClassPoint's interactive features.

Most students reported enhanced motivation, ease of understanding complex spatial tasks, and improved collaboration during geometry learning. Specific features such as live quizzes, slide annotation, and immediate feedback were cited as particularly engaging. These perceptions align with the quantitative improvements observed in the experimental group, offering triangulation that supports the validity of the intervention's impact.

The findings demonstrate that integrating ClassPoint as an interactive learning tool significantly enhanced students' spatial literacy in geometry, as evidenced by substantial gains across pre- and post-test scores (Mustopa et al., 2024). Spatial literacy, including visualization, reasoning, and communication skills, is essential in understanding and interpreting geometric relationships between objects. In this study, students' spatial literacy was measured through tests and data analysis that began with normality and homogeneity tests to ensure statistical validity. The Kolmogorov-Smirnov test showed that the data were normally distributed with a significance value of more than 0.05. In contrast, the homogeneity test with Levene's test showed that the variance between groups was homogeneous.

The use of ClassPoint proved to have a significant impact on improving students' spatial literacy. The statistical analysis showed that in the experimental class, the average score increased from 66.38 in the pre-test to 85.23 in the post-test, with a significance value of 0.000 ($p < 0.05$). The comparison between the experimental and control classes also showed a significant difference, where the average post-test score of the experimental class (85.23) was higher than that of the control class (76.19). These results corroborate previous studies indicating that integrating interactivity into geometry instruction leads to deeper cognitive engagement and improved spatial thinking (Bong & Chatterjee, 2022a; Ellinger et al., 2023; Querido, 2023).

The normalized gain (N-Gain) analysis further reinforces the intervention's effectiveness. The visualization indicator achieved the highest gain (0.84; high category), followed closely by reasoning (0.81; high category). These findings are consistent with Sheharyar et al. (2020). who emphasized that visualization-based platforms enhance students' spatial reasoning by allowing real-time manipulation of geometric forms and relationships. Visualization tools within ClassPoint, such as drawing layers and slide annotations, help concretize abstract ideas and stimulate geometric imagination. (Bong & Chatterjee, 2022b; Mazlan et al., 2023).

This study also supports prior claims regarding the pedagogical affordances of ClassPoint in making abstract geometry concepts accessible through dynamic and responsive visual media (Limbong & Wadham, 2024; Syahrul, 2021). Teachers noted higher levels of student participation, questioning, and conceptual exploration. These qualitative improvements align with constructivist learning theory, particularly Vygotsky's Zone of Proximal Development (ZPD), where interactive scaffolding is critical in advancing learners' spatial reasoning. Moreover, ClassPoint's flexibility contributes to improved learning continuity and student autonomy. With materials accessible beyond class time, students can review and engage with content asynchronously, supporting self-regulated learning (Abumosa, 2024; Barbetta, 2023; Ritonga et al., 2023). This aligns with 21st-century pedagogical models that emphasize mobility, personalization, and learner agency.

The study provides robust evidence that interactive platforms like ClassPoint can substantially elevate spatial literacy in geometry, particularly in visualization and reasoning dimensions. While communication gains were modest, they highlight an area for pedagogical enhancement, perhaps through integrating structured discussion prompts or collaborative problem-solving features. These findings support the implementation of ClassPoint in geometry and suggest broader applicability of interactive media in subjects requiring high-order spatial and analytical competencies (Stehle & Peters-Burton, 2019).

IV. Conclusion

This study utilized a quasi-experimental design to assess the impact of ClassPoint learning media on spatial literacy, specifically visualization, reasoning, and communication among Grade XI students at SMA 1 Stabat. Results demonstrated statistically significant improvements in the experimental group using ClassPoint, with high N-Gain scores in visualization (0.84) and reasoning (0.81), and a moderate gain in communication (0.70). The interactive features of ClassPoint not only deepened students' conceptual understanding of geometry but also encouraged active participation and boosted confidence in expressing spatial ideas. The findings emphasize the potential of digital tools like ClassPoint to foster a more engaging, logical, and visually rich learning environment. However, the study's scope was limited by its narrow demographic focus and the restricted dimensions of spatial literacy it assessed. Factors such as individual learning styles, group dynamics, or long-term retention were not explored. Future research should broaden its sample to include diverse student populations across regions and schools. Additionally, incorporating other aspects of spatial literacy, such as map interpretation or spatial navigation, could yield a more holistic understanding of student capabilities. Exploring alternative educational media alongside ClassPoint would also help evaluate its comparative effectiveness and sustainability in various

educational settings. Overall, the study supports the strategic integration of interactive media in mathematics education to enhance comprehension and learner engagement.

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