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The Effect of the Guided Inquiry Learning Model on Spatial Thinking Skills and Problem Solving Abilities of Geography Education Students at Tadulako University

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Abstract: The Guided Inquiry Learning Model emphasizes students' active engagement in constructing knowledge through a systematic investigation process with instructor support. This study aimed to examine the effect of the Guided Inquiry learning model on the spatial thinking skills and problem solving abilities of Geography Education students in the Geographic Information Systems (GIS) course at the Geography Education Study Program, Tadulako University. The study employed a quasi-experimental design with a pretest posttest control group. Two groups were involved: an experimental group taught using the Guided Inquiry model and a control group taught using conventional instruction. Spatial thinking skills and problem-solving abilities were measured using essay tests that had been validated for reliability and validity. Data were analyzed through normality and homogeneity tests, followed by an Independent Samples t-test using SPSS 25. The results indicated that the experimental group achieved higher posttest mean scores in both spatial thinking skills and problem solving abilities compared to the control group. Statistical analysis showed a significant difference in posttest spatial thinking scores between the experimental and control groups ($p < 0.05$), as well as a significant difference in problem-solving ability scores ($p < 0.05$). Furthermore, normalized gain analysis indicated that the experimental group achieved moderate to high gains in both variables, while the control group demonstrated low to moderate gains. These results suggest that the Guided Inquiry learning model is more effective than conventional instruction in improving spatial thinking skills and problem-solving abilities in the Geographic Information Systems course.

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INTRODUCTION

The Guided Inquiry Learning Model is an instructional model that prioritizes the active role of learners in acquiring knowledge through the process of investigating phenomena or problems independently, supported by guidance from educators. In this model, students are presented with a series of questions or problems that encourage them to explore, seek information, and analyze their findings. The educator acts as a facilitator who not only provides learning resources but also guides students in formulating hypotheses, testing assumptions, and drawing conclusions based on the evidence obtained (Khotimah et al., 2020). Through this approach, students not only develop cognitive skills but also enhance their ability to solve problems systematically. This model is highly effective in deepening the understanding of taught concepts and facilitating students in connecting theory with real-world practice, making it relevant across various learning contexts (Miftakhurrohmah., 2023).

The Guided Inquiry Learning Model was first introduced by Richard as an effort to promote more active and in-depth learning through independent discovery accompanied by guidance from instructors. This model has been widely applied across various disciplines, particularly in education, to enhance students' spatial thinking and problem-solving abilities (Hadiyanti, 2022). Studies conducted by Annisa et al. (2016) and (Haryanti et al., 2016) indicate that the implementation of this model in learning can improve students' critical thinking skills in processing information and solving complex problems. Furthermore, a

study Rizki (2021) found that the application of Guided Inquiry in science education programs resulted in significant improvements in students' understanding of scientific concepts, as well as their collaborative and communication skills. Over time, this model has become increasingly popular in research- and experiment-based education because it creates a more interactive learning environment focused on the development of higher-order thinking skills.

Despite these findings, several gaps remain. Most studies focus on general science education or short-term interventions, leaving limited evidence on its effectiveness in specific subjects, learning environments, or long term development of higher-order thinking skills (Yamtinah, 2025). Additionally, few studies have examined the simultaneous impact of GILM on critical thinking, collaboration, and communication skills together. Therefore, this research applies the Guided Inquiry Learning Model to address these gaps, aiming to provide a more comprehensive understanding of its effectiveness in fostering active learning, problem-solving, and collaborative skills in the target educational context (Beskara, 2024).

The primary objective of implementing this model is to encourage students to actively engage in the learning process so that they can more deeply connect theory with practice. Research conducted by (Ajeng Ayuningtias & Rukmana, 2023) demonstrates that the application of this model in learning can enhance students' conceptual understanding and scientific skills. Similarly, (Ajeng Ayuningtias & Rukmana, 2023) found that the implementation of the Guided Inquiry model in science education programs was effective in improving students' understanding of scientific concepts and their critical thinking abilities. This model also helps students develop essential research and analytical skills needed to face challenges in professional and academic settings.

The Guided Inquiry Learning Model is considered suitable for implementation in geography education courses because it can enhance students' spatial thinking, analytical skills, and problem-solving abilities, which are essential competencies for understanding geographic concepts (Angraeni, 2017) Geography students are required to comprehend complex spatial and environmental phenomena, which demand the ability to analyze maps, interpret geospatial data, and understand human–environment interactions (Rahmanelli & Prarikeslan, 2019). Through the Guided Inquiry approach, students can become more actively involved in exploring and discovering geographic concepts under lecturer guidance, encouraging them to think critically and creatively in solving geographic problems (Anasiru et al., 2020). Research by (Nuraini, 2016) indicates that this model is effective in improving students' spatial thinking skills, which are crucial in geographic studies. With the implementation of this model, students not only understand theory but also connect it with field practice, thereby deepening their understanding of geographic dynamics.

According to Hamdayama (2014), as cited in (Prasetiyo & Rosy, 2020). the Guided Inquiry Learning Model consists of six stages designed to support students in independently discovering knowledge. The first stage is orientation, in which an engaging topic or problem is introduced to stimulate students' curiosity. Next, students are asked to formulate the problem to be investigated, which serves as the focus of learning(Fariz., 2019). After that, students develop hypotheses or tentative assumptions regarding possible solutions to the formulated problem. In the following stage, students collect relevant information from various sources, such as literature, experiments, or observations, to test their hypotheses. Once the data are collected, students test their hypotheses by analyzing the obtained information to determine whether the hypotheses can be accepted or rejected. The final stage is drawing conclusions, in which students formulate conclusions based on the results of hypothesis testing and summarize their findings (Maya., 2021).

The Guided Inquiry Learning Model offers several key advantages. It promotes active student engagement in exploring geographic phenomena, deepening their understanding of concepts (Pokhrel, 2024)), and enhances spatial thinking skills such as map reading, geospatial analysis, and recognizing relationships between natural and social phenomena (Siti Nur Annisa., 2021) By formulating problems, collecting data, and testing hypotheses, students connect theory with real-world contexts while developing problem-solving skills for complex issues like climate change and resource management. Additionally, collaborative group activities improve communication and teamwork (Putra, 2022). However, the model also has limitations. It requires more time to complete learning stages than traditional methods

(Pramudya & Safrul, 2022), demands high learner independence, and relies on sufficient resources for experiments and data collection (Rasyid et al., 2019). Moreover, group work can be challenging for some students, potentially affecting dynamics and outcomes (Almira., 2020).

In practice, the teaching of Geographic Information Systems (GIS) to Geography Education students at Tadulako University encounters several significant challenges. Students often face difficulties in integrating and analyzing geospatial data from multiple sources, possess limited skills in interpreting digital maps, and struggle to apply GIS concepts to real-world case studies, such as disaster mapping, natural resource management, and spatial planning. These challenges highlight the need for a learning model that not only emphasizes theoretical knowledge but also enables students to connect concepts with field-based practice, thereby fostering the development of both spatial thinking and practical problem-solving skills. Accordingly, this study emphasizes the cultivation of applied and contextually relevant knowledge related to real-world environmental issues, distinguishing it from previous research that primarily addressed the cognitive aspects of spatial thinking without focusing on practical problem-solving abilities. The Guided Inquiry Learning Model is particularly suitable in this context, as it promotes critical and creative thinking, facilitates active student engagement, and equips learners with the essential skills required to address both academic and professional challenges in geography.

METHOD

This study employed a quasi-experimental research design aimed at analyzing the effect of the Guided Inquiry learning model on students' spatial thinking and problem-solving abilities. The research stage of this study followed by Table 1. The research design used was a Pretest Posttest Control Group Design. This design was selected because it allows for the measurement of changes in students' spatial thinking and problem-solving abilities before and after the implementation of the Guided Inquiry learning model. The design involved two comparison groups (Figure 1): an experimental group that received instruction using the Guided Inquiry model and a control group that received conventional instruction or no special treatment.

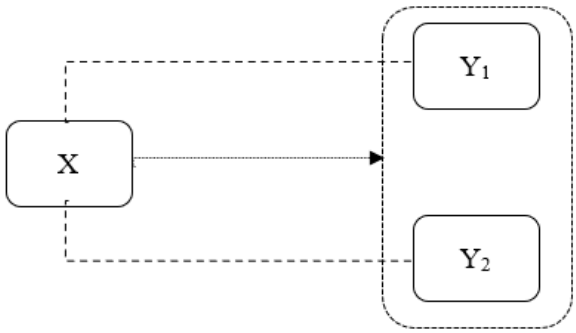

Figure 1. Variables with Two Dependent Variables.

a) Independent Variable (X).

Implementation of the Guided Inquiry Learning Model, characterized by stages of orientation, problem formulation, hypothesis development, data collection, hypothesis testing, and conclusion drawing, designed to promote active student engagement and deeper cognitive processing.

b) Dependent Variable 1 (Y_1) Spatial Thinking Skills.

Defined as the ability to understand, analyze, and interpret spatial relationships and geospatial information, including map reading, geospatial data analysis, and spatial orientation. This skill is crucial for comprehending geographic phenomena and making spatial decisions.

c) Dependent Variable 2 (Y_2) Problem-Solving Abilities.

Refers to the capacity to identify, analyze, and provide solutions to complex geographic problems, such as environmental management and spatial planning, by applying theoretical concepts.

Table 1. Research Stages of the Quasi-Experimental Study on the Guided Inquiry Learning Model

Research Stage	Activities / Description	Group
1. Preparation	• Selecting participants (56 students, 2 classes: B & C) • Validating research instruments (essay questions)	Experimental & Control
2. Pretest	• Measuring initial spatial thinking and problem-solving abilities through a pretest	Experimental & Control
3. Treatment	• Experimental: Implementation of the Guided Inquiry model (Orientation → Problem Formulation → Hypothesis Development → Data Collection → Hypothesis Testing → Drawing Conclusions) - Control: Conventional learning (lecture / no special treatment).	Experimental / Control
4. Posttest	• Measuring spatial thinking and problem-solving abilities after the treatment through a posttest	Experimental & Control
5. Data Analysis	• Prerequisite tests: normality (Shapiro–Wilk) & homogeneity (Levene) - Hypothesis testing: Independent Samples t-test ($\alpha = 0.05$)	Experimental & Control
6. Conclusion	• Interpreting analysis results • Showing practical implications of the research findings	Experimental & Control

This study involved two groups for analysis: an experimental group that implemented the Guided Inquiry learning model and a control group that used a conventional lecture-based learning approach. The experimental group received a specific treatment, while the control group did not receive any treatment. The purpose of comparing these two groups was to evaluate the impact of the given treatment. The research design employed was a pretest posttest design. The research subjects consisted of 56 students from the Geography Education Study Program at Universitas Tadulako, cohort 2023/2024, who were enrolled in the Geographic Information Systems course. The students were divided into two groups: the experimental group and the control group, each consisting of 28 students from Class B and 28 students from Class C, respectively.

Data collection in this study was conducted systematically to ensure the accuracy and relevance of the obtained data. Data were collected through pretests and posttests administered to both the experimental and control groups to measure students' spatial thinking and problem-solving abilities before and after the treatment. The pretest was conducted prior to the intervention to determine students' initial ability levels, while the posttest was administered after the intervention to assess the effect of the Guided Inquiry learning model. The research instrument consisted of essay-type questions that had been validated prior to use. The collected data were then analyzed using appropriate statistical methods to identify significant differences between the experimental and control groups, allowing conclusions to be drawn regarding the effect of the applied learning model.

Data analysis in this study began with prerequisite tests, including normality and homogeneity tests, followed by hypothesis testing. The normality test was conducted to determine whether the data were normally distributed, using the Shapiro Wilk test at a 5% significance level through SPSS version 25. The data were considered normally distributed if the significance value was greater than 0.05 and not normally distributed if the significance value was less than 0.05. Subsequently, a homogeneity test was performed to examine the equality of variances between the experimental and control groups using Levene's test at a 5% significance level. The data were considered homogeneous if the significance value was greater than 0.05 and not homogeneous if the significance value was less than 0.05.

After the prerequisite tests were satisfied, hypothesis testing was conducted to determine whether there was a significant effect of the Guided Inquiry learning model on students' spatial thinking

and problem-solving abilities. This analysis was performed using an independent samples t-test at a 5% significance level through SPSS 25. The hypotheses tested included H_1, which stated that the Guided Inquiry learning model has an effect on students' spatial thinking and problem-solving abilities, and H_0, which stated that the Guided Inquiry learning model has no effect on these abilities. The decision criteria were defined such that H_0 was not rejected if the sig. (2-tailed) value was ≥ 0.05 and the mean score of the experimental group was lower than that of the control group, whereas H_0 was rejected if the sig. (2-tailed) value was ≤ 0.05 and the mean score of the experimental group was higher than that of the control group, indicating a significant effect of the Guided Inquiry learning model on students' spatial thinking and problem-solving abilities. Overall, the research design based on diagram in Figure 2.

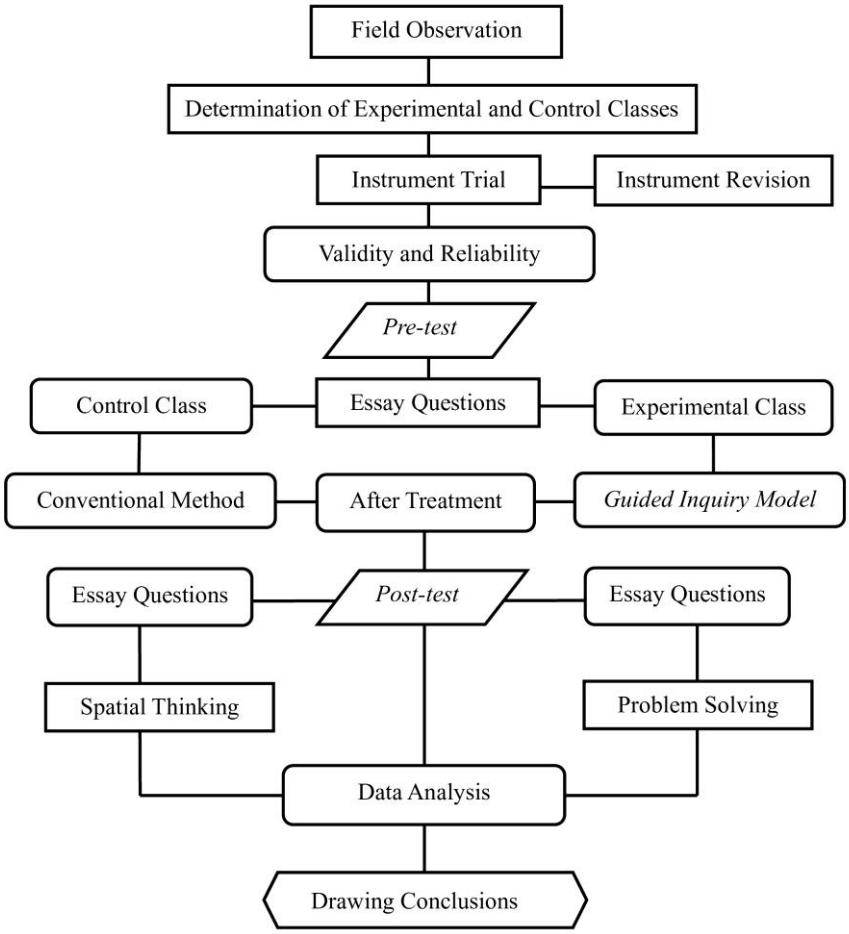

Figure 2. Research Flow Diagram.

RESULT AND DISCUSSION

Data Description

This study utilized data representing the spatial thinking skills and problem-solving abilities of students in the Geography Education Study Program. The data were obtained from the final scores of students' responses to essay questions and were subsequently converted into gain scores. The determination of gain scores was based on each student's final achievement level, thereby representing the levels of spatial thinking and problem-solving abilities of students in both classes involved as research subjects. Accordingly, these scores provide a quantitative description of students' achievement in spatial thinking and problem-solving skills within the context of geography learning. The measurement of spatial thinking and problem-solving abilities was conducted by administering a research instrument consisting of ten essay questions to both research subject classes. Of the ten items, five were designed to measure spatial thinking skills, while the remaining five were intended to assess problem-solving abilities. The

construction of the test items was based on previously established indicators of spatial thinking and problem-solving skills, ensuring that each question specifically measured the relevant aspects of each variable.

Prior to being used as research instruments, the test items underwent several stages of revision to address identified weaknesses related to language use and clarity of sentence construction. Following the revision process, the instrument was piloted on a limited sample with characteristics similar to those of the research subjects. The pilot testing stage included analyses of item difficulty, discrimination index, content validity, construct validity, and overall instrument reliability. The results of the pilot testing were used to ensure that the instrument was capable of accurately and consistently measuring students' spatial thinking and problem-solving abilities. Thus, the data obtained from the final scores of students' essay responses validly and reliably reflect the levels of spatial thinking and problem-solving abilities of Geography Education students in both research classes. These data were subsequently used as the basis for analyzing students' academic achievement in the cognitive aspects that constituted the focus of this study.

Table 2. Results of the Validity and Reliability (r) Analysis, Item Difficulty Level, and Discrimination Index of the Spatial Thinking Ability Test.

Item	Validity	Category	R	Reliability Category	Difficulty Level	Discrimination	Category
1a	977	Very Valid			2.64	0.968	Excellent
1b	977	Very Valid			2.64	0.968	Excellent
2a	902	Very Valid			2.59	0.870	Excellent
2b	678	Valid			2.64	0.599	Good
3a	878	Very Valid	0.901	Very Reliable	2.59	0.836	Excellent
3b	646	Valid			2.45	0.537	Good
4a	838	Very Valid			2.55	0.787	Excellent
4b	396	Fairly Valid			2.32	0.275	Fair
5a	503	Fairly Valid			2.27	0.393	Fair
5b	460	Fairly Valid			2.27	0.361	Fair

Source: Primary Data (2025)

Based on Table 2, it can be seen that the spatial thinking ability test instrument developed has undergone analyses of validity, reliability, difficulty level, and discrimination index. The results of the analysis show that, in general, the quality of the test items falls within the good to very good categories. In terms of validity, most test items have high validity coefficients. Items 1a and 1b have a validity value of 0.977, which falls into the very valid category. Similarly, items 2a (0.902), 3a (0.878), and 4a (0.838) are also classified as very valid. Meanwhile, items 2b (0.678) and 3b (0.646) fall into the valid category. Items 4b (0.396), 5a (0.503), and 5b (0.460) are categorized as fairly valid, meaning they can still be used with certain considerations or after minor item revisions. Based on the reliability test results, the spatial thinking ability test instrument obtained a reliability coefficient of 0.901, which is classified as very reliable. This indicates that the instrument has a very high level of consistency and is suitable for measuring students' spatial thinking abilities.

In terms of difficulty level, all test items fall within the range of 2.27 to 2.64. These values indicate that most items are of moderate difficulty, meaning they are neither too easy nor too difficult for students. Therefore, these items are considered capable of measuring spatial thinking ability proportionally. Furthermore, the discrimination index analysis shows that most test items have good discriminating power. Items 1a and 1b have a discrimination index of 0.968, which falls into the excellent category. Items 2a (0.870), 3a (0.836), and 4a (0.787) are also classified as excellent. Meanwhile, items 2b (0.599) and 3b (0.537) fall into the good category. However, some items, such as 4b (0.275), 5a (0.393), and 5b

(0.361), have relatively low discrimination indices, making them less optimal in distinguishing between high-ability and low-ability students. Therefore, this instrument is deemed suitable for use as a measurement tool in research, although some items with low validity and discrimination indices require attention and improvement in future studies.

These results align with international research emphasizing the importance of item difficulty analysis and discrimination index as part of assessing the quality of exam instruments, especially in higher education. For instance, a study in the International Journal of Applied Research (Kim et al., 2023) stated that difficulty index and discrimination index are two key measures in item analysis and are crucial for determining whether an item can distinguish between high- and low-ability respondents in an exam (Bahuguna, 2025) Other studies also indicate that in many assessment instruments, items with moderate difficulty and good discrimination contribute to the overall validity and reliability of the instrument, providing a more accurate depiction of student learning achievement.

Table 3. Results of Calculations for Validity, Reliability (R), Difficulty Level, and Discrimination Power of Problem-Solving Ability Questions.

Question	Validity	Category	R	Category	Difficulty Level	Discrimination Power	Category
1	0.797	Valid			2.36	0.600	Good
2	0.520	Fairly Valid			2.55	0.283	Fair
3	0.535	Highly Valid	0.700	Reliable	2.50	0.301	Fair
4	0.600	Valid			2.64	0.396	Fair
5	0.860	Highly Valid			2.32	0.722	Very Good

Source: Primary Data (2025).

Based on Table 3, the analysis of the quality of the problem-solving ability test items shows that, in general, the questions used have met the criteria for good quality in terms of validity, reliability, difficulty level, and discriminative power. In terms of validity, items 1 and 4 fall into the valid category, item 2 is in the fairly valid category, while items 3 and 5 are categorized as highly valid. This indicates that most of the test items are capable of measuring problem-solving ability in accordance with the intended assessment objectives. Therefore, the instrument used shows a good level of alignment between the test items and the constructs being measured. The reliability test results show a coefficient value of 0.700, which falls into the reliable category.

This indicates that the problem-solving ability test has good internal consistency and can be used reliably to measure students' abilities. Based on the difficulty level analysis, all test items have values ranging from 2.32 to 2.64, which fall into the moderate category. This suggests that the questions are neither too easy nor too difficult, allowing them to accommodate variations in students' problem-solving abilities. In terms of discriminative power, items 1 and 5 have discriminative indices of 0.600 and 0.722, respectively, categorized as good and very good. Items 2, 3, and 4 fall into the fair category. This indicates that most of the items can differentiate between students with high and low problem-solving abilities, although some items still require improvements in their discriminative power. The analysis results indicate that the problem-solving ability test instrument used in this study is suitable for use, as it meets the criteria of being valid, reliable, moderately difficult, and having discriminative power ranging from fair to very good.

Students Spatial Thinking Ability

Students spatial thinking ability refers to an individual s capacity to understand, manipulate, and visualize objects or information in spatial dimensions. Assessment of this ability was conducted through a pre-test and a post-test. The pre-test was used to determine students' initial ability levels before the learning treatment was given, while the post-test was used to measure their ability after the treatment.

Spatial thinking ability indicators designed for geography learning can serve as an effective

evaluation tool because they are considered representative of the skills being assessed. The use of these indicators is based on several considerations: the ability to develop indicators grounded in research in learning that emphasizes spatial thinking, the ability to organize indicators to create more structured and innovative geography learning, and the ability to apply these concepts and examples in the teaching and learning process In addition, spatial intelligence is influenced by various factors, one of which is the environment, particularly the school environment, since students' interactions with their learning environment play an important role in the development of spatial thinking skills (Aliman., 2023)

Table 4. Description of Spatial Thinking Ability Pretest and Posttest of the Control Class and Experimental Class

Class	Test Result	Mean	Median	Std. Dev.	Min	Max	Sum	N	Gain Score
Control	Pretest	52.43	53.00	5.547	40	63	1467	28	Control
	Posttest	70.18	70.00	8.318	57	87	1970	28	0.38
Experimental	Pretest	69.79	70.00	6.202	57	87	1815	28	Experimental
	Posttest	83.54	83.00	6.489	70	97	2475	28	0.57

Source: Primary Data (2025).

Table 4 presents data on students' spatial thinking and problem-solving abilities in the Geography Education program for both the control class and the experimental class, measured through pretests and posttests. The data include mean, median, standard deviation, minimum and maximum scores, total scores (sum), sample size (N), and gain scores. Based on the pretest results, the control class obtained a mean score of 52.43, a median of 53.00, and a standard deviation of 5.547. The minimum score achieved by students in the control class was 40, while the maximum score was 63. This indicates that the initial spatial thinking and problem-solving abilities of students in the control class were in the moderate category, with relatively homogeneous score variation. After the conventional learning treatment was applied, the posttest results of the control class showed an increase in the mean score to 70.18, with a median of 70.00 and a standard deviation of 8.318. The minimum score increased to 57 and the maximum score reached 87. The gain score obtained by the control class was 0.38, indicating a moderate improvement in students' spatial thinking and problem-solving abilities.

Meanwhile in Figure 3, the experimental class showed a pretest mean score of 69.79, a median of 70.00, and a standard deviation of 6.202. The minimum and maximum scores were 57 and 87, respectively. These results indicate that the initial ability of students in the experimental class was already at a higher level compared to the control class. In the posttest results of the experimental class, the mean score increased to 83.54, with a median of 83.00 and a standard deviation of 6.489. The minimum score obtained was 70 and the maximum score reached 97. The gain score of the experimental class was 0.57, which falls into the moderate-to-high improvement category. This shows that the application of the learning treatment in the experimental class was more effective in improving students' spatial thinking and problem-solving abilities compared to the learning applied in the control class.

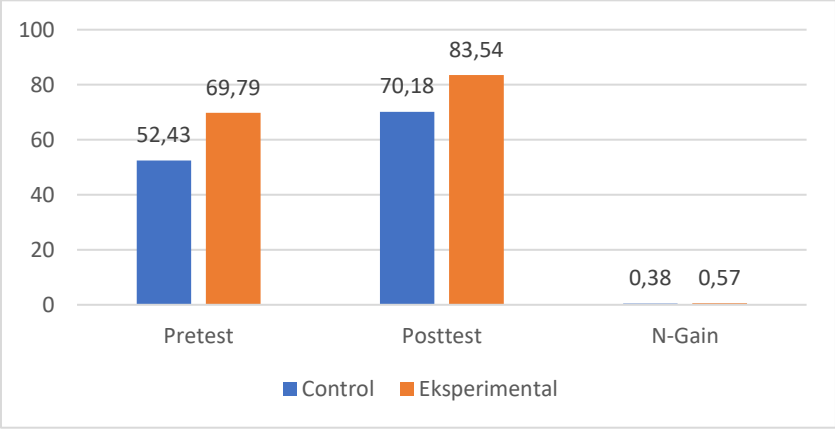

Figure 3. Average Score and N-gain Score of Students' Spatial Thinking Ability.

ProblemSolving Ability

Data on problem-solving ability in both classes were obtained from five test items that had been completed by the students. The data consist of scores before the treatment and after the treatment in both classes. The data on students' problem-solving ability are presented in Table 5.

Table 5. Description of Problem Solving Ability Pretest and Posttest of the Control Class and Experimental Class.

Class	Test Result	Mean	Median	Std. Dev.	Min	Max	Sum	N	Gain Score
Control	Pretest	55.71	55.00	8.467	40	70	1560	28	Control
	Posttest	56.61	55.00	6.391	45	70	1585	28	0.23
Experimental	Pretest	64.82	65.00	8.219	50	85	1815	28	Experimental
	Posttest	88.39	90.00	6.244	75	100	2475	28	0.65

Source: Primary Data (2025).

Based on Table 5, the problem-solving ability of Geography Education students was analyzed using the pretest and posttest results from the control class and the experimental class. The descriptive statistical data presented include the mean, median, standard deviation, minimum and maximum scores, as well as the gain score. In the control class, the pretest results showed a mean score of 55.71, a median of 55.00, and a standard deviation of 8.467. The minimum and maximum scores were 40 and 70, respectively, indicating a fairly wide variation in students' initial abilities. After the learning process, the posttest scores in the control class showed a relatively small increase, with a mean of 56.61, the median remaining at 55.00, and the standard deviation decreasing to 6.391. The decrease in standard deviation indicates that students' abilities became slightly more homogeneous; however, the increase in the average score was low. This is further supported by a gain score of 0.23, which falls into the low improvement category. Thus, the learning implemented in the control class did not provide a significant impact on improving students' problem-solving ability.

In contrast, in the experimental class, the pretest results showed a mean score of 64.82, a median of 65.00, and a standard deviation of 8.219 based on diagram in Figure 4. The minimum and maximum scores were 50 and 85, respectively, indicating that students' initial abilities were relatively better than those in the control class. After the learning treatment was applied, the posttest results of the experimental class showed a very significant improvement. The mean score increased to 88.39, with a median of 90.00, and the standard deviation decreased to 6.244. The minimum and maximum scores also increased to 75 and 100, indicating that almost all students achieved a high level of problem-solving ability. This significant improvement in the experimental class is reinforced by a gain score of 0.65, which falls into the moderate-to-high improvement category. This indicates that the learning model or strategy applied in the experimental class was effective in improving the problem-solving ability of Geography Education students.

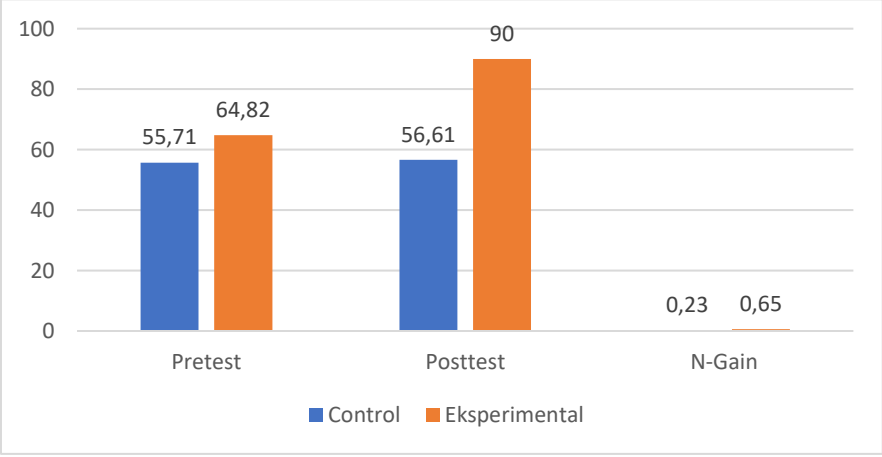

Figure 4. Average Score and N-gain Score of Students Problem Solving Ability.

The decision rule for hypothesis testing is as follows: If the significance value (Sig. 2-tailed) ≥ 0.05 and the mean score of the experimental class is lower than that of the control class, then H_0 cannot be rejected. This indicates that the Guided Inquiry model has no effect on students' spatial thinking and problem-solving abilities. Conversely, if the significance value (Sig. 2-tailed) ≤ 0.05 and the mean score of the experimental class is higher than that of the control class, then H_0 is rejected. This indicates that the Guided Inquiry model has an effect on students' spatial thinking and problem-solving abilities.

Data Analysis

Data on spatial thinking ability and problem-solving ability obtained from the control class and the experimental class were analyzed using the Independent Samples T-test with the assistance of SPSS version 25 for Windows. The data used for hypothesis testing were the gain scores of spatial thinking ability and problem-solving ability from the control class, which applied a conventional learning model, and from the experimental class, which applied the guided inquiry learning model. Before conducting hypothesis testing, prerequisite analyses were carried out, including tests of normality and homogeneity.

Normality Test

The normality test is one of the prerequisite analyses aimed at determining whether the data to be analyzed are normally distributed. In this study, the Shapiro–Wilk test was used because the sample size was less than 50. The decision criteria for this test are as follows:

a) If the significance value > 0.05, then H_0 is accepted, and the data are considered to be normally distributed.
b) If the significance value < 0.05, then H_0 is rejected, and the data are considered not normally distributed.

Table 6. Normality Test Results for Spatial Thinking Ability.

Group	Shapiro-Wilk Statistic	df	p-value
Pretest Control	0.941	28	0.120
Posttest Control	0.945	28	0.145
Pretest Experimental	0.956	28	0.276
Posttest Experimental	0.945	28	0.149

Source: Primary Data (2025)

Based on the results of the Shapiro Wilk test presented in Table 6, the significance values obtained were as follows: 0.120 for the control group pretest, 0.145 for the control group posttest, 0.276 for the experimental group pretest, and 0.149 for the experimental group posttest. All of these values are greater than 0.05. This indicates that all research data, both pretest and posttest in the control and experimental groups, are normally distributed. Therefore, the data meet the normality assumption, and parametric statistical analyses, such as the t-test, can be applied to compare spatial thinking ability between groups.

Table 7. Calculation of the Normality Test of Problem-Solving Ability.

Group	Shapiro-Wilk Statistic	df	p-value
Pretest Control	0.947	28	0.162
Posttest Control	0.943	28	0.134
Pretest Experimental	0.960	28	0.350
Posttest Experimental	0.945	28	0.148

Source: Primary Data (2025)

Based on Table 7, the following results were obtained: the pretest of the control group has a significance value of 0.162, the posttest of the control group 0.134, the pretest of the experimental group 0.350, and the posttest of the experimental group 0.148. All significance values are greater than 0.05. Therefore, the problem-solving ability data in all groups, both pretest and posttest, are normally

distributed. This normal data allows the study to proceed to parametric statistical analysis, such as the t-test, to compare problem-solving abilities between groups.

Homogeneity Test

The homogeneity test is one of the prerequisite tests used to evaluate whether the data used have uniformity (homogeneous). The homogeneity of variance test was conducted using SPSS 25 for Windows at a confidence level of 0.05. The decision-making criteria based on the significance value are as follows:

a) If the significance value > 0.05, then H_0 is accepted, meaning the data are homogeneous.
b) If the significance value < 0.05, then H_0 is rejected, meaning the data are not homogeneous.

Table 8. Calculation of the Homogeneity Test of Spatial Thinking Ability.

Variable	Levene Statistic	df1	df2	p-value
Learning Outcomes	3.196	1	54	0.079

Source: Primary Data (2025)

Table 8 shows the results of Levene's test for the homogeneity of variance in spatial thinking ability. All significance values (Sig.) exceed 0.05, with the mean-based method yielding p = 0.079. This indicates that the variances across groups do not differ significantly, confirming that the assumption of homogeneity of variance is satisfied.

Table 9. Calculation of the Homogeneity Test of Problem-Solving Ability.

Variable	Levene Statistic	df1	df2	p-value
Learning Outcomes	0.068	1	54	0.796

Source: Primary Data (2025)

Table 9 presents the results of Levene's test for the homogeneity of variance in problem-solving ability. All significance values (Sig.) exceed 0.05, with the mean-based method showing p = 0.796. This suggests that the variances across groups do not differ significantly, confirming that the assumption of homogeneity of variance is met.

Hypothesis Testing

Decision-making in hypothesis testing is as follows: If the sig. (2-tailed) value ≥ 0.05 and the mean score of the experimental class is lower than that of the control class, then H_0 cannot be rejected. This indicates that the Guided Inquiry model has no effect on students' spatial thinking and problem-solving abilities. Conversely, if the sig. (2-tailed) value ≤ 0.05 and the mean score of the experimental class is higher than that of the control class, then H_0 is rejected. This indicates that the Guided Inquiry model has an effect on students' spatial thinking and problem-solving abilities.

Table 10. Hypothesis Test Results for Spatial Thinking Ability.

Variable	t	df	p (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper
Learning Outcomes	-6.700	54	.000	-13.357	-17.354	-9.360

Source: Primary Data (2025)

Based on the results of the Independent Samples Test in Table 10:

a) The results of Levene's Test for Equality of Variances show an F value of 3.196 with a Sig. value of 0.079, which is greater than 0.05. This indicates that the variances between groups can be considered homogeneous.
b) The results of the t-test for Equality of Means show a t value of −6.700, with df = 54 and Sig. (2-tailed) = 0.000. This significance value is less than 0.05; therefore, H_0 is rejected.
c) The mean difference (Mean Difference = −13.357) indicates that the average score of the experimental class is higher than that of the control class, because the difference is calculated as the experimental class score minus the control class score.

The results of hypothesis testing indicate that the Guided Inquiry learning model has a significant

effect on the spatial thinking ability of Geography Education students. This is evidenced by the Independent Samples T-Test, which shows a significance value of 0.000 (< 0.05), leading to the rejection of the null hypothesis (H_0). This means there is a significant difference in spatial thinking ability between students who participated in Guided Inquiry learning and those who experienced conventional learning.

Descriptively, the N-Gain analysis shows that the improvement in spatial thinking ability in the experimental class was higher than in the control class. The experimental class achieved an N-Gain score of 0.57 (moderate category), while the control class obtained an N-Gain score of 0.38 (moderate category but lower). This indicates that the Guided Inquiry model is more effective in improving spatial thinking ability.

This improvement occurs because Guided Inquiry emphasizes active student involvement in observing, analyzing, and drawing conclusions from geographical phenomena, thereby training students to understand spatial patterns, distributions, and relationships. In addition, this model encourages students to construct knowledge independently through spatial reasoning and analysis. Thus, it can be concluded that the Guided Inquiry learning model is empirically proven to be effective in enhancing the spatial thinking ability of Geography Education students and supports meaningful and contextual learning.

Table 11. Calculation of the Hypothesis Test for Problem-Solving Ability

Variable	t	df	p (2-tailed)	Mean Difference	95% CI Lower	95% CI Upper
Learning Outcomes	-18.825	54	.000	-31.786	-35.171	-28.400

Source: Primary Data (2025).

Based on the results of the Independent Samples Test in Table 11:

a) The results of Levene's Test for Equality of Variances show an F value of 0.068 with a Sig. value of 0.796, which is greater than 0.05. This indicates that the variances between groups can be considered homogeneous.
b) The results of the t-test for Equality of Means show a t value of −18.825, with df = 54 and Sig. (2-tailed) = 0.000. This significance value, which is less than 0.05, indicates that H_0 is rejected.
c) The mean difference (Mean Difference = −31.786) indicates that the average score of the experimental class is higher than that of the control class, because the difference is calculated as the experimental class score minus the control class score.

The data analysis results indicate that the Guided Inquiry learning model has a significant effect on the problem-solving ability of Geography Education students. This is evidenced by the Independent Samples T-Test, which produced a significance value of 0.000 (< 0.05), leading to the rejection of the null hypothesis (H_0). This indicates a significant difference in problem-solving ability between the experimental and control groups. Descriptively, the N-Gain score for the experimental group was 0.65 (moderate to high category), while the control group achieved an N-Gain score of 0.23 (low category). These results show that conventional learning is less effective than the Guided Inquiry model.

The improvement in problem-solving ability in the experimental group is attributed to the characteristics of Guided Inquiry, which emphasize systematic scientific thinking, including problem identification, hypothesis formulation, data analysis, and conclusion drawing. This model also encourages the application of geographic concepts to real-world problems, enabling students to integrate conceptual knowledge with analytical skills. Thus, it can be concluded that the Guided Inquiry learning model is significantly effective in enhancing the problem-solving ability of Geography Education students and in developing higher-order thinking skills.

CONCLUSION

Based on the research results, it can be concluded that the Guided Inquiry Learning Model significantly improves the spatial thinking and problem-solving abilities of Geography Education students at Tadulako University. This model addresses the main research problem, namely students' difficulties in

integrating and analyzing geospatial data and applying GIS concepts to real-world case studies. Statistical tests showed that the experimental class using Guided Inquiry achieved higher spatial thinking (N-Gain = 0.57) and problem-solving (N-Gain = 0.65) scores than the control class, demonstrating the model's effectiveness in building both conceptual understanding and practical skills.

Practical implications of these findings include that Guided Inquiry enables students to connect theory with field practice, develop systematic data analysis, Spatial thinking, and problem solving skills, as well as enhance collaboration and communication. The model also supports contextual learning relevant to real environmental issues, such as spatial planning, natural resource management, and disaster mitigation.

Based on these findings, the following recommendations are proposed

1. Learning Implementation: Lecturers are advised to apply Guided Inquiry more broadly in GIS and applied geography courses, focusing on field data integration and geospatial analysis to enhance students' spatial thinking and problem-solving skills.
2. Curriculum Development: The curriculum should incorporate Guided Inquiry activities emphasizing observation, geospatial data analysis, case studies, and group collaboration to support contextual learning and professional skill development.
3. Facilities and Resources: Institutions need to provide GIS tools, access to geospatial data, and sufficient time for students to conduct experiments, field observations, and data analysis.
4. Further Research: Future studies can explore the effectiveness of Guided Inquiry in complex problem-solving contexts, its impact on collaboration and decision-making skills, and the development of more comprehensive, practice-based assessment instruments for spatial thinking and problem-solving.

With these conclusions and recommendations, the study not only addresses the initial research questions but also provides practical guidance for the development of context-based geography learning and directions for research supporting students' skill improvement.

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