Journal of Science and Technological Education, Vol. 3 No. 1, 2024
ISSN: 2830-5043 (Print) 2830-4829 (Online)

Journal of Science and Technological Education
(META)

journal homepage: www.meta.amiin.or.id

Article history: Received December 31, 2023; Accepted June 03, 2024; Published June 16, 2024

The Effect of the Group Investigation Learning Model on High School Grade X Students' Analytical Thinking Skills and Learning Outcomes on Environmental Pollution Subject

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Abstract Indonesian students' science skills are generally low, ranking 71st out of 79 countries in the 2018 PISA survey. Interviews with biology teachers at Jenggawah State Senior High School found that many students struggle with problem-solving and can't explain their answers well, despite having theoretical knowledge. To improve this, education should focus more on student-centered learning. One effective method is using the group investigation learning model, which can boost students' analytical thinking skills and improve their grades. The objective of this study is to assess the impact of the Group Investigation instructional model on the critical thinking skills of students, as well as the academic performance of grade X students in relation to environmental pollution. The research employed a quantitative methodology, specifically utilizing a quasi experimental design known as nonequivalent control group design. The sample approach employed was purposive sampling, where class X6 was chosen as the experimental group and X5 as the control group in Jenggawah state senior high school. Data gathering strategies employ assessment methods such as multiple-choice quizzes and essay writing. The Z test is employed as the data analysis approach. The research findings indicate a significant impact of the Group Investigation learning model on students' analytical thinking skills, with a significant p-value of 0.012. In addition, it was discovered that the Group Investigation learning model had also a significant impact on student learning outcomes, as shown by a significant value of 0.004.

Keywords: Group investigation learning model, Analytical thinking skills, Learning outcomes, Environmental pollution

INTRODUCTION

Education is crucial in shaping a promising future for humans. Education plays an important role in shaping human views, character, and skills. Education is a crucial factor in assessing a nation's level of advancement. Therefore, it is imperative that the nation prioritizes its efforts to enhance the quality of education (Mutiara, 2014). Science education is a type of education that enhances the intellectual development of a country. Science is the acquisition of knowledge by humans via a process of learning. Science contributes to influencing the future of the Indonesian country by developing high-quality human resources (Samudera et al., 2017). Education serves as both a means of preparing for future life and as a crucial factor in the growth of a child's journey towards maturity.

Students in the modern era must possess the ability to think analytically in order to excel in their education. By employing their aptitude for analytical thinking, students can readily discern the underlying reasons of an issue and devise effective strategies to overcome it. Analytical thinking refers to the capacity to discern and elucidate the underlying factors that contribute to the connection between various elements, with the objective of identifying the root cause (Nisa et al., 2018).

An individual's capacity for analytical thinking is shaped by both internal and external circumstances. Internal elements are determined by the individual's physical state, level of motivation, and age. External influences in the context of the learning process at school encompass several elements such as models, methodologies, learning approaches employed, teacher competence, and infrastructure (Setiawaty et al., 2019).

Indeed, the proficiency of students in the disciplines of science or scientific knowledge in Indonesia remains significantly limited. This is evidenced by the findings of the PISA (Program for International Student Assessment) survey in the domain of scientific literacy, which reveal that Indonesian students' abilities are still below the global average. In 2018, Indonesian students were ranked 71st out of 79 countries. The results indicate that the cognitive abilities and thinking skills of Indonesian students in mathematics and science are notably inferior compared to pupils in other OECD countries (Nasution et al., 2023).

The issue is also prevalent in Jenggawah State High School. Through interviews performed by researchers with biology teachers of class 10, it has been shown that classroom instruction frequently employs strategies such as group discussion and presentation. Nevertheless, the proficiency of the majority of students in class 10 to tackle the problem remains inadequate. Students possess the capacity to respond in a theoretical manner, but they lack the ability to provide a comprehensive explanation of their answers. In addition, a significant number of students lack the ability to effectively summarize the learning content, and the majority of students fail to cultivate an interest in the subject matter due to the perception that learning is monotonous. Therefore, it is necessary to acquire diverse learning strategies that may effectively address these

challenges, thereby enhancing students' cognitive capacities, particularly in subjects that need them to propose solutions to issues such as environmental contamination.

Selecting the appropriate learning model can effectively address the challenges faced by students during the learning process. An effective approach to address the aforementioned issues is the implementation of the group investigation (GI) cooperative learning paradigm. The group investigation learning model is a collaborative learning environment where students engage in interactive exploration of complex problems, devise plans, deliver presentations, and assess the outcomes of their efforts (Listina, 2013). Sharan's group investigation learning syntax is comprised of six distinct steps, 1) identifying the topic; 2) preparing for the inquiry; 3) inquiry; 4) analysis; 5) displaying the findings of the analysis; and 6) evaluation (Al-Tabany, 2014).

The primary objective of the group investigation learning approach is to impart knowledge, concepts, skills, and comprehension to students (Kumbaraningtyas et al., 2019). This educational style offers students the chance to refine their ideas, as they are instructed to cultivate the capacity for autonomous thinking and active engagement in the learning process from beginning to conclusion (Primarinda et al., 2012). This research is essential to ascertain the effectiveness of the group investigation model in teaching and learning processes. Consequently, it enables educators to make informed decisions regarding the integration of the group investigation model into their instructional practices. Given the significance of lesson planning, such insights empower teachers to make deliberate choices regarding the adoption of the group investigation model within their subject matter (Romdaniyah et al., 2023).

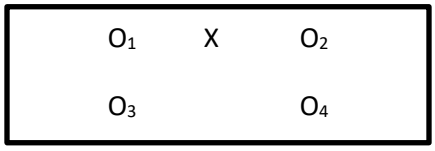
Students can attain analytical knowledge by mastering the fundamental cognitive stages of knowledge, understanding, and application. Bloom's taxonomy organizes cognitive elements in a hierarchical manner, with increasing levels of complexity. These elements include knowledge, understanding, application, analysis, synthesis, and evaluation. The final three components are specifically designed to assess problem-solving skills (Sabaruddin, 2019). The cognitive talents of students are also correlated with the educational achievements attained by kids. Learning outcomes are a quantitative assessment of the comprehensive proficiency that students are required to attain in the subject matter. One part of this competency focuses on the cognitive domain, which involves increased mental and physical activity.

Learning outcomes are a comprehensive assessment of the level of proficiency achieved by students in their learning, as documented in a report (Andriani & Rasto, 2019; Afriza & Nasution, 2022). Learning outcomes represent the culmination of students' learning endeavors following the completion of a specific instructional unit (Hidayah et al., 2022; Harahap et al., 2019). According to Bloom's taxonomy, learning outcomes are attained through three domains: cognitive, emotional, and psychomotor. This research exclusively concentrates on a single domain, specifically the cognitive domain. Environmental pollution is an important study topic in the biology curriculum,

and further research is needed. Students who understand environmental issues well are more likely to acquire a strong environmental consciousness and the ability to protect their surroundings. This emphasizes the need of incorporating environmental information into education (Febriani et al., 2020), which has the ability to prevent environmental disasters, particularly in students' locales, such as floods caused by river pollution or excessive waste disposal (Nasution et al., 2024; Farihah et al., 2024; Conilie et al., 2021). Based on the given description, researchers intend to conduct a study to understand the effect of the group investigation learning model on high school grade X students' analytical thinking skills and learning outcomes on environmental pollution subject.

METHOD

The research employed a quantitative approach utilizing a quasi experimental design with a nonequivalent control group design. This research method involved administering two distinct treatments to each group, with a pretest and posttest conducted for each treatment. The research design can be illustrated in Figure 1.



Source: Sugiyono (2019)

Description:

O1 : Pretest measurement results of the experimental group.
O2 : Posttest measurement results of the experimental group.
O3 : Pretest measurement results of the control group.
O4 : Posttest measurement results of the control group.
X : The treatment in the experimental group was the application of the group investigation learning model.

The research employed tests and documentation as the data gathering instruments. This research utilizes two distinct types of tests: an essay test consisting of 3 questions to assess students' analytical thinking skills, and a multiple choice test including 20 questions to evaluate student learning results. Documentation is utilized to finalize study data.

The participants of this study consisted of 288 students from class 10 at SMAN Jenggawah Jember. The selected samples consisted of class X6 as the experimental group and class X5 as the control group. The sampling technique employed is purposive sampling, which involves selecting the sample based on specific criteria or considerations (Sugiyono, 2019). Methods of gathering data to assess analytical skills

and educational achievements by administering pretests and posttests. Each item measuring analytical thinking ability is standardized on a scale of 1-4. The students' scores are then calculated using the following formula.

$$\textbf{Score} = \frac{\text{Score obtained}}{\text{Maximum score}} \text{ x } 100$$

Table 1. Analytical thinking ability assessment scale.

Indicator	Description	Score
Differentiating	Able to detect information completely and correctly	4
	Able to detect information correctly but it is not complete	3
	Able to detect complete information but incorrect	2
	Not able to detect any information	1
Attributing	Able to detail information completely and correctly	4
	Able to detail information correctly but it is not complete	3
	Able to detail complete information but incorrect	2
	Not able to detail any information	1
Organizing	Able to conclude information completely and correctly	4
	Able to conclude information correctly but it is not complete	3
	Able to conclude complete information but incorrect	2
	Not able to conclude any information	1

Table 2. Interpretation criteria for analytical thinking skills scores and learning results.

Number Range	Category
81 - 100	Very high
61 - 80	High
41 - 60	Moderate
21 - 40	Low
<20	Very low

Quantitative research data is analyzed using both descriptive analysis and inferential analysis, as stated by Sugiyono (2019). Descriptive analysis seeks to provide a detailed account of the acquired data. There are two types of inferential analysis: parametric and non-parametric statistics. Prior to doing these two statistical analyses, it is necessary to assess the data for normality and homogeneity using appropriate tests. The data analysis was conducted using the SPSS v25 software.

The normality test was conducted on the instrument data for the analysis of the thinking skills of students in the experimental and control classes. The Kolmogorov-Smirnov test revealed significance values greater than the predetermined threshold α (0.05). Specifically, the significance values were 0.074 for the experimental class pretest, 0.087 for the control class pretest, 0.062 for the experimental class posttest, and 0.072 for the control class posttest. The normality test of the data collected from the experimental and control class student learning outcomes instrument indicated a significance value greater than the predetermined threshold α (0.05). Specifically, the significance values were 0.060 for the experimental class pretest, 0.073 for the control

class pretest, 0.103 for the experimental class posttest, and 0.055 for the control class posttest. The data is classified as having a normal distribution.

The homogeneity test of the data from the analytical thinking ability test instrument for both the experimental and control class students revealed a significant value greater than the predetermined threshold α (0.05), namely 0.958 for the pretest and 0.622 for the posttest. The homogeneity test of the data from the experimental and control class student learning outcomes test instrument also revealed a significant value more than α (0.05), namely 0.949 for the pretest and 0.751 for the posttest. The data is classified as homogenous.

The Z test is used for hypothesis testing, specifically in the form of an independent sample t-test (Fitri et al., 2023). The decision-making process involves accepting the null hypothesis (H0) and rejecting the alternative hypothesis (Ha) if the significance value is greater than 0.05. Conversely, if the significance value is less than 0.05, the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is accepted.

FINDINGS AND DISCUSSION

Findings

The research findings include scores that measure students' analytical thinking skills and their learning outcomes. The conducted data analysis attempted to determine the scores of students' analytical thinking capability and their learning outcomes in both the experimental and control classes. To determine the impact of the group investigation learning model on the analytical thinking skills and learning outcomes of 10th grade students studying environmental pollution at SMAN Jenggawah Jember during the 2022/2023 academic year.

After obtaining the pretest and posttest findings of students' analytical thinking skills in both the experimental class and control class, descriptive analysis is able to be conducted using SPSS v25 which can be seen in Table 3.

Table 3. Descriptive analysis test results of students' analytical thinking skills.

Descriptive Analysis	Experimental Class		Control Class	
	Pretest	***Posttest***	***Pretest***	***Posttest***
Mean	47,47	81,53	45,11	74,97
Standard deviation	11,93	10,877	11,513	10,724
Lowest score	25	67	25	58
Highest score	67	100	67	100

According to the data in Table 3 for the analytical thinking skills test, the mean pretest score for the experimental class is 47.47, with a standard deviation of 11.93. The lowest score recorded was 25, while the highest score was 67. Meanwhile, the posttest score achieved by the experimental class had a mean of 81.53, a standard deviation of 10.877, a lowest score of 67, and a top score of 100. The control class had a pretest score with

a mean of 45.11, a standard deviation of 11.513, a lowest score of 25, and a highest score of 67. The control class had a mean pottest score of 74.97, with a standard deviation of 10.724. The lowest score recorded was 58, while the highest score reached 100. The pretest and posttest results of student learning outcomes acquired in the experimental class and control class can be analyzed using descriptive analysis with the assistance of SPSS v25 which can be seen in Table 4.

Table 4. Descriptive analysis test results of students' learning outcomes.

Descriptive Analysis	Experimental Class		Control Class	
	Pretest	***Posttest***	***Pretest***	***Pretest***
Mean	50,83	83,61	47,5	77,5
Standard deviation	11,557	8,669	11,741	8,494
Lowest score	35	70	30	65
Highest score	70	100	70	90

The data in Table 4 reveals that the experimental class learning outcomes pretest score has a mean of 50.83, a standard deviation of 11.557, a lowest score of 35, and a highest score of 70. Meanwhile, the learning outcomes posttest score achieved by the experimental class had a mean of 83.61, a standard deviation of 8.669, a lowest score of 70, and a top score of 100. The learning outcomes pretest score for the control class had a mean of 47.50, a standard deviation of 11.741, a lowest score of 30, and a top score of 70. The control class had a mean learning outcomes pottest score of 77.50, with a standard deviation of 8.494. The lowest score recorded was 65, while the highest score was 90.

The normality test was conducted using SPSS v25 using the Kolmogorov-Smirnov test, with a sample size of at least 50 and a significance level of 5%. The decision-making criteria in this test are as follows: 1) If the significance value is greater than or equal to 0.05, then the data is considered to be normally distributed. 2) If the significance value is less than 0.05, then the data is considered not to be normally distributed. The findings of the normality test calculation for the analytical thinking capacity of students in the experimental and control classes are reported in Table 5.

Table 5. Data normality test results for students' analytical thinking skill.

No	Class	Kolmogorov–Smirnov Test Result		α	Decision
		Pretest	**Posttest**		
1	Experimental Class	0,074	0,062	0,05	Normally distributed
2	Control Class	0,087	0,072	0,05	Normally distributed

According to the data presented in the Table 5, all the data has a significance value greater than the predetermined threshold α (0.05). Therefore, it can be inferred that the data about students' analytical thinking skills follows a normal distribution. Table 6 displays the results of the normality test calculation for the learning outcomes data of students in both the experimental and control classes.

Table 6. Data normality test results for students' learning outcomes.

No	Class	Kolmogorov–smirnov test result		α	Decision
		Pretest	Posttest		
1	Experimental Class	0,060	0,103	0,05	Normally distributed
2	Control Class	0,073	0,055	0,05	Normally distributed

According to the data presented in the Table 6, all the data points have a significance value greater than the predetermined threshold α (0.05). Therefore, it can be inferred that the data on student learning outcomes follows a normal distribution.

Subsequently, a homogeneity test was conducted on the data. This test is a subsequent examination conducted when the data follows a normal distribution. The purpose of the Homogeneity Test is to ascertain the uniformity of the data. This test includes a provision in its application where if the significance value is more than 0.05, the data is determined to be homogeneous. The homogeneity test calculation results of student data received from the experimental and control classes are shown in Table 7 below.

Table 7. Homogeneity test results data from the analytical thinking ability test and student learning outcomes.

Data	*Pretest*	*Posttest*	α	Decision
Analytical thinking skills	0,958	0,622	0,05	Homogeneous variance
Learning outcomes	0,949	0,751	0,05	Homogeneous variance

According to the significance value found in Table 7, it is evident that the significance value is greater than 0.05. Therefore, it can be concluded that the data is homogeneous. The experimental class and control class are both reported to have identical variances.

Parametric statistical tests are used for hypothesis testing when the acquired data is normally distributed and homogeneous. The current test being utilized is the Z test, with a significance level of 0.05. The findings of the independent sample t-test hypothesis test are reported in Table 8 for analytical thinking skills and in Table 9 for learning outcomes.

Table 8. Z Test results of students' analytical thinking skills.

Test	Z table value	Z count value	df	α	Sig. (2-tailed)	Decision	Description
Pretest	1,96	0,854	70	0,05	0,396	H_0 accepted	Not significant
Posttest	1,96	2,575	70	0,05	0,012	H_a accepted	Significant

Table 9. Z Test results of students' learning outcomes.

Test	Z table value	Z count value	df	α	Sig. (2-tailed)	Decision	Description
Pretest	1,96	1,214	70	0,05	0,229	H_0 accepted	Not significant
Posttest	1,96	3,021	70	0,05	0,004	H_a accepted	Significant

The data from the Table 8 indicates that the two-tailed significance (Sig) value of the hypothesis test for the pretest in both the control and experimental classes is 0.396, which is more than the significance level of 0,05. Therefore, it can be concluded that there is no significant difference in the analytical thinking abilities of students in the control and experimental classes before being treated with the group investigation learning model. The two-tailed significance value in the posttest for both the control and experimental groups was 0.012, which is less than the threshold of 0.05. Therefore, we can conclude that there is a significant difference in the posttest scores of students' analytical thinking abilities between the control and experimental classes after implementing the group investigation learning model. This demonstrates that the group investigation learning model has an impact on the analytical thinking skills of the students.

The data from the Table 9 indicates that the two-tailed significance (sig) value of the hypothesis test for the control and experimental class pretest is 0.229, which is more than the significance level of 0,05. Therefore, it can be concluded that there is no significant difference in the pretest student learning outcomes between the control and experimental classes before implementing the group investigation learning model. The two-tailed significance (sig) value in the posttest for both the control and experimental classes was 0.004, which is less than the threshold of 0.05. This implies that there is a notable disparity in the posttest results of student learning outcomes between the control and experimental classes after implementing the group investigation learning model. This demonstrates the impact of the group investigation learning model on the learning outcomes of the students.

Discussion

According to the data obtained from the test of analytical thinking skills, it was discovered that the average score of the experimental class in the pretest was nearly identical to that of the control class. The experimental class had an average score of 47.47, while the control class had an average score of 45.11. Conversely, the experimental class achieved a higher average posttest score of 81.53 for analytical thinking skills, as contrast to the control class which scored 74.97. According to the data obtained from the analysis of learning outcomes, it was discovered that the average pretest score for the experimental class was nearly identical to that of the control class. Specifically, the experimental class had an average score of 50.83, while the control class had a score of 47.5. Conversely, the experimental class achieved a higher average posttest score of 83.61 for learning outcomes, while the control class scored 77.5. The experimental class employed the group investigation learning model, whereas the control class just utilised the Problem Based Learning learning model. The group investigation learning model exerts a greater influence on enhancing students' analytical thinking skills and learning outcomes compared to the Problem Based Learning learning model. Granting students the freedom to explore subjects, devise research plans, and conduct investigations can significantly influence the development

of students' critical thinking skills. In addition, the students' proactive engagement in gathering knowledge can enhance their cognitive capacities, thereby impacting the enhancement of their academic achievements.

Theoretical problem-solving models might enhance students' analytical thinking abilities by necessitating their comprehension of problems via the lens of a matrix in their daily lives. Constructivism theory posits that knowledge is not a mere accumulation of facts derived from an external reality under investigation, but rather a cognitive construction by individuals of things, experiences, or their surrounding environment (Sabaruddin, 2019). In order to enhance students' cognitive skills, it is important to foster their analytical thinking by engaging them in problem-solving activities that involve researching the root cause of a problem and devising appropriate solutions.

Based on hypothesis testing, it has been established that the use of the group investigation learning model has a substantial impact on students' analytical thinking skills. The obtained significance value is 0.012, which is less than the critical threshold of 0.05. Therefore, the null hypothesis (H0) is rejected and the alternative hypothesis (Ha) is accepted. Furthermore, the implementation of the group investigation learning model has a substantial impact on student learning outcomes. The obtained significance value is 0.004, which is smaller than the predetermined threshold of 0.05. Therefore, the null hypothesis (H0) is rejected, and the alternative hypothesis (Ha) is accepted.

There is a notable disparity in the analytical thinking skills of students and the learning outcomes between the control and experimental groups following the implementation of the group investigation learning model for the topic of environmental pollution in class 10 at Jenggawah Jember senior high school during the 2022/2023 academic year. In 2022, Amalia Nur Azazi did research which found that using the group investigation learning approach had a beneficial impact on students' critical thinking abilities in the context of ecological content (Azazi, 2022). A further study conducted by Syahrul Mubarok in 2020 found that using the group investigation cooperative learning approach had a significant impact on students' learning outcomes on the reproductive system concept (Mubarok, 2020).

According to Slavin, the group investigation learning model can develop student competences such as synthesis, analysis, and data collection, which enhance higher-level thinking skills during the learning process (Wijayanti, 2016). The syntax of this learning model facilitates the enhancement of students' analytical thinking abilities and their academic achievements, particularly by means of 1) subject identification, 2) preparing for enquiries, 3) enquiries, 4) Examination or study of anything in order to understand its components, structure, or nature, 5) delivering findings of the analysis, and 6) assessment (Al-Tabany, 2014). Students are encouraged to actively participate and assume accountability for the acquisition of knowledge during the learning process.

CONCLUSION

The research and data analysis indicate that students who were taught using the Group Investigation learning model exhibit better analytical thinking skills in comparison to the control class. The disparity in the mean score of the analytical thinking aptitude examination is evident, with the experimental group achieving an average of 81.53 while the control group obtained an average of 74.97.

The learning outcomes of students who utilized the Group Investigation learning model were better in comparison to the control class. The disparity in the mean scores of the learning outcomes examination is evident, with the experimental class achieving an average score of 83.61, while the control class obtained a score of 77.5.

Therefore, the adoption of the Group Investigation learning model has a substantial impact on the development of critical thinking skills in the class, and also the application of the Group Investigation learning model has a substantial impact on the learning outcomes of the class.

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