

Effect of the 5E inquiry learning model with a SETS approach on junior high school students' science learning outcomes and motivation

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Abstract: This study aimed to examine the effect of the 5E Inquiry learning model integrated with the Science, Environment, Technology, and Society (SETS) approach on junior high school students' science learning outcomes and learning motivation. A quantitative design with a pretest-posttest non-equivalent control group. The population consisted of all eighth-grade students, and the samples were selected through cluster random sampling. Learning outcomes data were collected using an objective test, while learning motivation data were obtained through a questionnaire. Data were analyzed using one-way MANCOVA after meeting the required assumptions. The results revealed a significant simultaneous difference in science learning outcomes and learning motivation between students taught using the 5E Inquiry model with the SETS approach and those taught through conventional instruction. Partially, the 5E Inquiry model with the SETS approach had a significant positive effect on both science learning outcomes and students' learning motivation. In conclusion, the 5E Inquiry learning model integrated with the SETS approach is effective in improving the quality of science learning at the junior high school level.

Keywords: 5E Inquiry, SETS Approach, Learning Outcomes, Learning Motivation, Science

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INTRODUCTION

Science education at the junior high school level is expected to equip students with scientific literacy, critical thinking skills, and learning motivation needed to face the challenges of the 21st century (Ningrum et al., 2021; Wibawa, 2014; Yanti et al., 2022). However, international assessments such as the Programme for International Student Assessment (PISA) consistently indicate that Indonesian students' science literacy remains below the OECD average. The PISA 2022 results show that most Indonesian students only achieve basic proficiency levels and experience difficulties in applying scientific concepts to real-life contexts (OECD, 2023). This condition reflects learning practices that are still dominated by teacher-centered approaches and emphasize memorization rather than inquiry and contextual understanding.

Low science achievement is often accompanied by low learning motivation. Previous studies report that monotonous instructional methods, limited student engagement, and abstract presentation of scientific concepts contribute to students' lack of interest and motivation in

learning science (Saud et al., 2021). Motivation is a critical affective factor influencing learning outcomes, as motivated students tend to be more engaged, persistent, and active in the learning process (Harahap et al., 2025; Khamima et al., 2023; Pratiwi et al., 2024).

Inquiry-based learning has been widely recommended as an effective approach to address these challenges (Nasir et al., 2023). One prominent inquiry framework is the 5E Inquiry learning model, consisting of Engage, Explore, Explain, Elaborate, and Evaluate phases. This model actively involves students in scientific investigation and concept construction (Damayanti et al., 2019). Empirical evidence suggests that the 5E Inquiry model improves conceptual understanding, science process skills, and higher-order thinking (Anggi et al., 2019; Dewanti et al., 2022; Istiqomah et al., 2019).

In addition, integrating inquiry learning with the Science, Environment, Technology, and Society (SETS) approach enables students to connect scientific concepts with environmental issues, technological applications, and social contexts (Rohmah et al., 2018). The SETS approach emphasizes meaningful and contextual learning, which has been shown to enhance scientific literacy and learning motivation. However, empirical studies examining the combined implementation of the 5E Inquiry model and the SETS approach, particularly in Indonesian junior high schools, are still limited. Therefore, this study aims to examine the effect of the 5E Inquiry learning model integrated with the SETS approach on students' science learning outcomes and learning motivation at the junior high school level.

METHODS

This study employed a quantitative approach using a quasi-experimental design, specifically the pretest–posttest non-equivalent control group design (Dantes, 2017). This design was selected to examine the causal effect of the 5E Inquiry learning model integrated with the SETS approach on students' science learning outcomes and learning motivation while controlling for initial differences between groups through pretest scores.

Participants

The research was conducted during the 2024/2025 academic year. The population consisted of all eighth-grade students. Samples were selected using cluster random sampling, resulting in two intact classes. One class was assigned as the experimental group and the other as the control group. The experimental group was taught using the 5E Inquiry learning model integrated with the SETS approach, while the control group received conventional teacher-centered instruction.

Instruments

Two research instruments were used in this study. Science learning outcomes were measured using an objective multiple-choice test developed based on the science curriculum and learning indicators. Students' learning motivation was measured using a Likert-scale questionnaire covering aspects of attention, relevance, confidence, and satisfaction. Prior to implementation, both instruments were tested for content validity, construct validity, and reliability to ensure their appropriateness for data collection.

Research Procedure

The research procedure consisted of three main stages: preparation, implementation, and evaluation. In the preparation stage, lesson plans based on the 5E Inquiry model integrated

with the SETS approach were developed, and research instruments were validated. During the implementation stage, both groups were administered a pretest to measure initial learning outcomes and motivation. The experimental group then received instruction using the 5E Inquiry model with SETS integration, while the control group was taught using conventional methods. At the end of the instructional period, a posttest and motivation questionnaire were administered to both groups.

Data Analysis

Data analysis in this study was conducted to examine the effect of the 5E Inquiry learning model integrated with the SETS approach on students' science learning outcomes and learning motivation, both simultaneously and partially. The analysis employed one-way Multivariate Analysis of Covariance (MANCOVA), as the study involved one independent variable (learning model), two dependent variables (science learning outcomes and learning motivation), and pretest scores as covariates.

Table 1. Research design pretest-posttest non-equivalent control group

Group	Pretest	Treatment	Posttest
Experimental (E)	O1	X	O2
Control (C)	O3	-	O4

Prior to hypothesis testing, several assumption tests were performed to ensure that the data met the requirements for MANCOVA analysis. First, the normality of data distribution for each dependent variable was tested using the Kolmogorov–Smirnov test. Second, the homogeneity of variance was examined using Levene's test to confirm that the variance of each dependent variable was equal across groups. Third, the homogeneity of covariance matrices was tested using Box's M test to ensure that the covariance matrices of the dependent variables were equal between the experimental and control groups. Fourth, linearity tests were conducted to verify the linear relationship between the covariates (pretest scores) and the dependent variables.

After all assumptions were fulfilled, the one-way MANCOVA test was conducted with the learning model as the fixed factor, posttest scores of science learning outcomes and learning motivation as dependent variables, and pretest scores as covariates. The multivariate test results (Wilks' Lambda) were used to determine the simultaneous effect of the learning model on both dependent variables. Subsequently, follow-up univariate ANCOVA tests were performed to examine the partial effect of the learning model on each dependent variable separately.

All statistical analyses were conducted using a significance level of $\alpha = 0.05$. The results of the analysis provided empirical evidence regarding the effectiveness of the 5E Inquiry learning model integrated with the SETS approach in improving students' science learning outcomes and learning motivation.

RESULTS AND DISCUSSION

Descriptive statistical analysis was conducted to provide an overview of students' science learning outcomes and learning motivation before and after the implementation of the learning model. The analysis showed that both groups experienced an increase in posttest scores; however, the experimental group demonstrated higher mean scores compared to the control group.

The mean posttest score of science learning outcomes in the experimental group was higher than that of the control group, indicating better conceptual understanding among students who were taught using the 5E Inquiry learning model integrated with the SETS approach. Similarly, students' learning motivation in the experimental group showed a higher average score compared to students who received conventional instruction. These findings suggest that inquiry-based and contextual learning activities contributed positively to students' cognitive and affective development.

Assumption Testing Results

Before conducting the multivariate analysis, several prerequisite tests were performed to ensure that the data met the assumptions required for one-way Multivariate Analysis of Covariance (MANCOVA). These prerequisite tests included tests of normality, homogeneity of variance, homogeneity of covariance matrices, and linearity between the covariates and the dependent variables. The fulfillment of these assumptions is essential to ensure the validity and reliability of the multivariate statistical results.

The normality of the data distribution was examined using the Kolmogorov–Smirnov test on the posttest scores of sciences learning outcomes and learning motivation for both the experimental and control groups. The results showed that all significance values were greater than 0.05, indicating that the data for each dependent variable were normally distributed. Thus, the assumption of normality required for MANCOVA was satisfied.

The homogeneity of variance was tested using Levene's test to determine whether the variances of the dependent variables were equal across groups. The results indicated that the significance values for both sciences learning outcomes and learning motivation exceeded 0.05. This finding suggests that the variances of the dependent variables were homogeneous between the experimental and control groups.

To assess the equality of covariance matrices, Box's M test was conducted. The results revealed a significance value greater than 0.05, indicating that the covariance matrices of the dependent variables were equal across groups. Therefore, the assumption of homogeneity of covariance matrices was met, supporting the appropriateness of using one-way MANCOVA.

Furthermore, linearity tests were carried out to examine the relationship between the covariates, namely pretest scores of sciences learning outcomes and learning motivation, and the dependent variables in the posttest. The results demonstrated a linear relationship between each covariate and its corresponding dependent variable. This finding confirms that the use of pretest scores as covariates in the MANCOVA model was statistically appropriate.

In addition, a collinearity test was performed to evaluate the relationship between the covariates included in the analysis. The results showed that the tolerance values were greater than 0.280 and the Variance Inflation Factor (VIF) values were below 10. These results indicate that no multicollinearity existed between the covariates, allowing them to be included simultaneously in the MANCOVA model without violating statistical assumptions.

Based on the results of all assumption tests, it can be concluded that the data met the prerequisite conditions for conducting one-way MANCOVA. All statistical assumptions were fulfilled, ensuring the robustness of the analysis. Therefore, the data were suitable for further multivariate and univariate analyses to examine the effects of the learning model.

Multivariate Analysis Results

The results of the one-way MANCOVA revealed a significant multivariate effect of the learning model on students' science learning outcomes and learning motivation

simultaneously. The Wilks' Lambda value indicated that the learning model contributed significantly to differences in the combined dependent variables after controlling for pretest scores.

This finding demonstrates that the implementation of the 5E Inquiry learning model integrated with the SETS approach had a significant overall effect on improving students' science learning outcomes and learning motivation compared to conventional learning. The result supports the hypothesis that inquiry-based and contextual learning environments are more effective than traditional teacher-centered instruction.

Table 2. Research design pretest-posttest non-equivalent control group

Effect		Sig.
Group	Pillais's Trace	0.000
	Wilks' Lambda	0.000
	Hotelling's Trace	0.000
	Roy's Largest Root	0.000
	Pillais's Trace	0.000

Univariate Analysis of Science Learning Outcomes

Further univariate ANCOVA analysis showed that the learning model had a significant effect on students' science learning outcomes. Students in the experimental group achieved significantly higher posttest scores after controlling for their initial abilities. This improvement can be attributed to the characteristics of the 5E Inquiry learning model, which actively engages students in exploring phenomena, constructing concepts, and applying scientific knowledge through meaningful experiences.

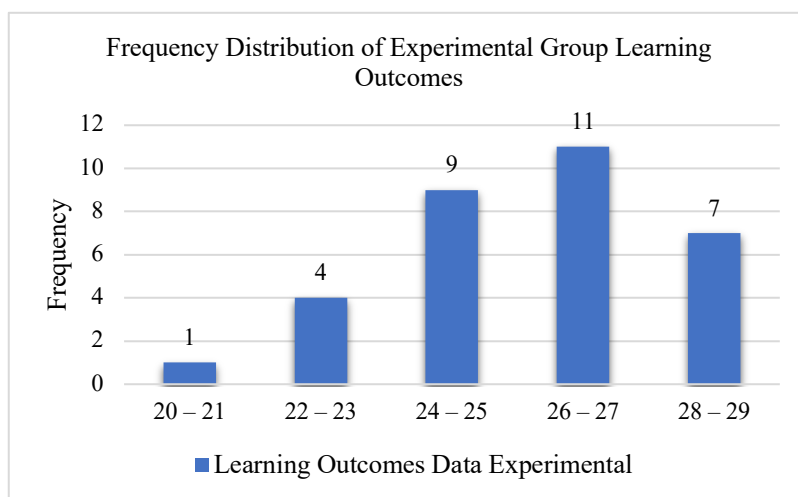


Figure 1. Frequency distribution of experimental group learning outcomes

The integration of the SETS approach allowed students to relate abstract science concepts to real-life environmental issues, technological applications, and social contexts. This contextualization facilitated deeper understanding and improved students' ability to apply scientific concepts, which is consistent with constructivist learning theory.

Univariate Analysis of Learning Motivation

The univariate analysis also revealed a significant effect of the learning model on students' learning motivation. Students who participated in the 5E Inquiry learning activities integrated with the SETS approach showed higher motivation compared to those in the control group. Learning activities that emphasized inquiry, discussion, experimentation, and real-world problem solving increased students' interest, engagement, and confidence in learning science.

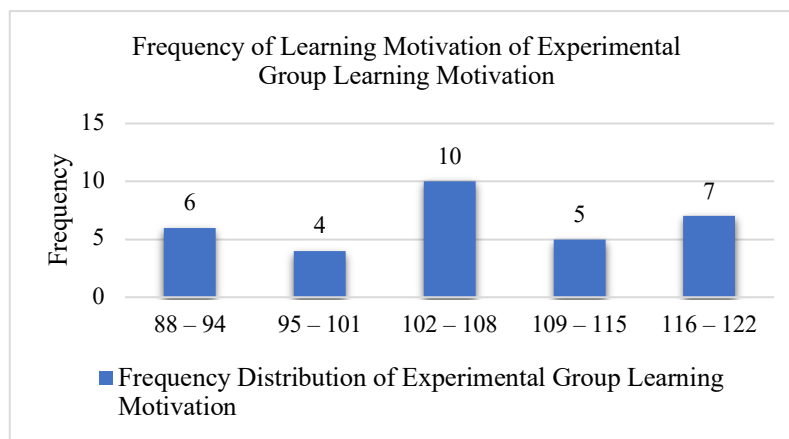


Figure 2. Frequency distribution of experimental group learning outcomes

This finding aligns with motivational theories that emphasize the importance of relevance and active participation in fostering intrinsic motivation. The SETS approach made learning more meaningful by linking science content to students' daily lives, thereby enhancing their motivation to learn.

Discussion

The results of this study demonstrate that the 5E Inquiry learning model integrated with the SETS approach has a significant effect on students' science learning outcomes and learning motivation, both simultaneously and partially. The significant multivariate effect indicates that the learning model influences cognitive and affective learning domains in an integrated manner (Anggi et al., 2019; Damayanti et al., 2019; Nasir et al., 2023). This finding confirms that instructional approaches combining inquiry-based learning and contextual integration are more effective than conventional teaching methods in science education.

The improvement in science learning outcomes among students in the experimental group can be attributed to the structured inquiry process embedded in the 5E learning model. The Engage and Explore phases encouraged students to actively interact with scientific phenomena, while the Explain and Elaborate phases supported conceptual understanding and knowledge application (Duran et al., 2004; Hansen, 2002). These learning stages are consistent with constructivist learning theory, which emphasizes that knowledge is actively constructed through experience, exploration, and reflection rather than passively received from teachers (Damayanti et al., 2019; Istiqomah et al., 2019).

Furthermore, the integration of the SETS approach played a crucial role in contextualizing scientific concepts and enhancing students' understanding. By linking science content with environmental issues, technological developments, and societal contexts, students were able to perceive science as relevant to their daily lives (Indriyati, 2019; Rohmah et al., 2018). This contextual relevance facilitated deeper conceptual understanding and strengthened students'

ability to apply scientific knowledge meaningfully, which explains the higher posttest scores achieved by the experimental group (Elistiana, 2024; Indriyati, 2019).

In terms of learning motivation, the findings indicate that students who were taught using the 5E Inquiry model integrated with the SETS approach demonstrated higher motivation compared to those taught using conventional methods. Inquiry-based activities such as experimentation, discussion, and problem solving provided students with opportunities to experience autonomy, competence, and active engagement in learning (Keller, 2000; Khamima et al., 2023). The SETS approach further enhanced motivation by making learning experiences meaningful, relevant, and socially connected, thereby fostering students' intrinsic motivation to learn science (Cheng et al., 2016; Indriyati, 2019).

These findings are consistent with previous studies reporting that inquiry-based learning and SETS-oriented instruction enhance students' engagement, motivation, and academic achievement (Anggi et al., 2019; Dewanti et al., 2022; Rohmah et al., 2018). However, this study extends previous research by providing empirical evidence of the simultaneous impact of the 5E Inquiry model integrated with the SETS approach on both learning outcomes and learning motivation at the junior high school level. The use of a rigorous multivariate statistical approach strengthens the validity of these findings and highlights the instructional potential of integrating inquiry and contextual learning strategies.

Overall, the results suggest that the integration of inquiry-based learning and contextual approaches not only improves students' academic performance but also fosters positive learning attitudes. These outcomes are essential for promoting sustainable science learning and developing students' long-term interest in science. Therefore, the 5E Inquiry learning model integrated with the SETS approach can be considered an effective and comprehensive instructional strategy for junior high school science education.

CONCLUSION

This study concludes that the 5E Inquiry learning model integrated with the SETS approach has a significant positive effect on junior high school students' science learning outcomes and learning motivation. Students taught using this model demonstrate higher achievement and stronger motivation compared to those taught through conventional instruction. Therefore, the 5E Inquiry model with the SETS approach is recommended as an effective alternative for improving the quality of science learning in junior high schools.

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