



COMPARING ILBIL, IBL, AND CONVENTIONAL MODELS: SELF-REGULATED LEARNING IN MATHEMATICS ACHIEVEMENT

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Abstract. Teaching models currently play a crucial role in enhancing educational quality and improving student learning outcomes. The purpose of this study was to compare the effectiveness of three learning models—ILBIL (Inquiry Learning Based on Information Literacy), IBL (Inquiry-Based Learning), and conventional learning — on students' mathematics learning outcomes in the topic of three-dimensional geometry. A quantitative approach was applied using a posttest control group design. The study population consisted of 143 students, and a cluster-random sampling technique was used to select 89 students from three classes. Data were collected through observations, questionnaires, and tests. The data were analyzed using analysis of variance (ANOVA) with a 5% significance level, as performed in SPSS 25.00 for Windows. The results revealed: (1) a significance value of 0.000, which is less than 0.05, indicating that the ILBIL model was more effective than both the IBL and conventional models in terms of students' learning outcomes; (2) a significance value of 0.196, which is greater than 0.05, suggesting that self-regulated learning did not significantly affect students' learning outcomes; and (3) a significance value of 0.306, which is greater than 0.05, showing that the interaction between self-regulated learning and the learning model did not significantly influence students' learning outcomes.

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INTRODUCTION

Mathematics learning aims to develop mathematical communication, mathematical thinking, problem-solving skills, inter-concept relationships, and positive attitudes towards mathematics (Marfu'ah et al., 2022), as well as to explain the relationships between concepts and apply them (Oktiningrum et al., 2016). Data from the Programme for International Student Assessment (PISA) in 2018, which ranked Indonesia 73rd out of 79 countries in students' mathematics ability, indicates that Indonesia has not shown improvement. PISA is used to measure mathematics, science, and literacy skills among 15-year-old students (Hewi & Shaleh, 2020). Furthermore, Indonesia also ranked low in the 2015 Trends in International Mathematics and Science Study (TIMSS), placing 45th out of 48 countries in mathematics and science achievement (Syamsul Hadi, 2013).

One reason students do not perform well in mathematics is learning difficulties. When students experience learning difficulties, teachers must assist them in understanding (Gilakjani & Sabouri, 2016). The success or failure of mathematical knowledge can be measured through students' mathematics learning outcomes (Lestari, 2015). Learning outcomes are the final results achieved by students after the learning process, usually expressed as letter grades or numbers, and are commonly used as a benchmark of learning success (Sembiring & Mukhtar, 2013). However, achieving these goals is not easy, given the many factors that influence learning outcomes (Winarso, 2016). One external factor that affects learning outcomes is the use of teaching models (Susanti et al., 2024). Using an appropriate learning model can provide experiences aligned with students' concrete thinking stages. Through such learning experiences, students develop a deeper, more accurate conceptual understanding, which in turn leads to better learning outcomes (Nababan et al., 2024). According to Schwartze (2024), boredom in mathematics learning may arise when students encounter tasks that are either too difficult (over-challenged) or too easy

(under-challenged). This indicates that if the learning model is not aligned with students' abilities and relevance, their engagement and learning achievement may decrease due to boredom.

In addition to external factors, internal factors such as self-regulated learning also play a crucial role in determining students' success. Self-regulated learning reflects students' ability to organize, monitor, and take responsibility for their own learning process (Zimmerman, 2002). Students with high levels of self-regulated learning tend to be more active in seeking information, setting goals, and evaluating their achievements (Ryan & Deci, 2017). The results of Dewi et al. (2020) study also indicate that learning independence has a positive and significant effect on students' mathematics learning outcomes. These findings suggest that the higher the students' learning independence, the better their mathematics achievement. Learning independence is essential to supporting students' academic performance, as it enables them to take responsibility for their learning and encourages initiative, creativity, and active engagement in learning without dependence on others (Hidayat, 2019).

Based on surveys and interviews with grade VIII mathematics teachers at SMP Negeri 1 Madiun, the average student mathematics score was around 60, indicating that the results remain below the Minimum Mastery Criteria. This problem has drawn the school's attention and requires improvement efforts. One way to improve learning outcomes is by creating an engaging classroom atmosphere that takes into account students' characteristics through appropriate learning models (Pardamean et al., 2022).

The learning process at SMP Negeri 1 Madiun still predominantly applies conventional models. Conventional teaching models are commonly used by teachers and typically include lectures, question-and-answer sessions, and assignments (Peranginangin et al., 2020). The lecture method is often used by teachers to provide information, guidance, and explanations, and it helps establish direct interaction between teachers and students (Mahmudah, 2016). The question-and-answer method allows questions to be posed and answered, primarily between teachers and students or among students themselves (Puspitasari, 2010). The assignment method involves tasks assigned by teachers that students complete and are accountable for, thereby reinforcing their understanding of the material (Purba, 2019). Learning models that can be used to improve outcomes through discussion include ILBIL (Inquiry Learning Based on Information Literacy) and IBL (Inquiry-Based Learning). These models encourage students to think critically, respond thoughtfully, and collaborate to understand the learning material (Fahim & Eslamdoost, 2014).

The Inquiry Learning Based on Information Literacy (ILBIL) model is an extension of inquiry-based learning, combined with information literacy skills (Susanti et al., 2024). Essentially, inquiry learning emphasizes students' active engagement in exploring problems, formulating hypotheses, and discovering solutions through systematic investigation (Pedaste et al., 2015). The integration of information literacy in this model enables students to identify their information needs, search for relevant sources, evaluate the validity of data, and utilize it to build a deeper understanding (ACRL, 2016). Thus, ILBIL not only develops critical thinking and problem-solving skills but also fosters self-regulated learning, as students are trained to manage information independently in the learning process. Research in Indonesia shows that the application of ILBIL can enhance mathematical literacy and support students in achieving better learning outcomes (Susanti et al., 2024).

On the other hand, the Inquiry-Based Learning (IBL) model is an approach that places students at the center of learning activities, emphasizing the process of investigation to construct knowledge independently. In IBL, students are encouraged to ask questions, formulate hypotheses, collect and analyze data, and draw conclusions through meaningful learning experiences (Hmelo-Silver et al., 2007). This process enables students to develop critical thinking, problem-solving, and logical reasoning skills, which are highly relevant to mathematics learning. Additionally, IBL can enhance students' learning motivation by providing opportunities to explore problems within real-life contexts (Prince & Felder, 2007). Research also indicates that IBL is effective in improving conceptual understanding and learning outcomes in mathematics compared to traditional methods (Artigue & Blomhøj, 2013). IBL serves as an essential foundation in the development of ILBIL, which further integrates information literacy.



Recent studies have highlighted the effectiveness of IBL in improving mathematics learning outcomes and skills. In Indonesia, [Nurlaili et al. \(2023\)](#) found that implementing IBL and Problem-Based Learning (PBL) significantly enhanced students' mathematical conceptual understanding, especially when learning motivation was considered. Similarly, [Farhan & Retnawati \(2014\)](#) investigated the effectiveness of IBL and PBL and concluded that both models improved achievement, mathematical representation skills, and learning motivation compared to conventional methods. These findings strengthen IBL's position as an innovative teaching model with the potential to enhance the quality of mathematics education. On a broader scale, [Maulinda et al. \(2023\)](#), through a literature review, confirmed that IBL remains relevant and adaptable in various mathematics education contexts at the elementary school level.

Based on the above description, it can be concluded that students' mathematics learning outcomes are influenced by various factors, both internal (e.g., self-regulated learning) and external (e.g., the learning model used). ILBIL, as a new approach that integrates inquiry learning with information literacy, is expected to provide a more effective alternative for improving mathematics learning outcomes. However, its effectiveness needs to be compared with IBL, which has been extensively studied, and conventional teaching, which is still widely used in schools. Therefore, this study aims to examine the effectiveness of ILBIL, IBL, and conventional models on students' mathematics learning outcomes, with self-regulated learning considered as a determining factor.

Theoretically, this study contributes to the development of learning theory by providing empirical evidence on the integration of inquiry learning and information literacy in mathematics education, enriching the understanding of how information literacy can strengthen the inquiry process and enhance students' conceptual comprehension. In practice, the findings offer valuable insights for teachers, curriculum developers, and policymakers by presenting the ILBIL model as an innovative alternative that fosters students' independence, critical thinking, and information management skills, and supports the inclusion of information literacy as an essential component of inquiry-based instruction.

RESEARCH METHODS

This study employed a quantitative, quasi-experimental design with a posttest-only control group. The purpose of the study was to examine the effectiveness of the ILBIL and IBL models in mathematics instruction on students' learning outcomes in terms of learning independence. The research was conducted at SMP Negeri 1 Madiun, which was selected because most teachers still used teacher-centered learning, students' learning outcomes remained unsatisfactory, and no previous study had examined the effectiveness of the ILBIL and IBL learning models in this school.

The subjects of this study were 143 eighth-grade students at SMP Negeri 1 Madiun in the 2024/2025 academic year. The research sample was selected using a cluster-random sampling technique, yielding three classes, as shown in [Table 1](#).

Table 1. Sample Description

Class	Total
VIII A (Convensional)	29
VIII C (IBL)	31
VIII D (ILBIL)	29
Total	89

Data were collected using three instruments: a mathematics achievement test, a learning independence questionnaire, and a learning implementation observation sheet. The researcher developed the mathematics test instrument based on the learning objectives and indicators in the mathematics curriculum. Content validity was examined through expert judgment involving two mathematics education lecturers and one mathematics teacher. Suggestions from the experts were used to revise the items before pilot testing. Empirical validity was analyzed using Pearson's product-moment correlation, and reliability was calculated using the KR-20 formula.



Meanwhile, the Learning Independence Questionnaire used a standardized instrument adapted from Sugiyono (2019) with minor modifications to suit the research context. Construct validity and reliability were assessed using Cronbach's alpha to ensure internal consistency. The observation sheet was designed by the researcher based on the syntax of the ILBIL and IBL models to monitor the implementation of each learning stage.

Data were analyzed both descriptively and inferentially. Descriptive analysis was used to describe students' learning outcomes and learning independence, and inferential analysis was performed using a two-way ANOVA in SPSS 25.00 for Windows. Before conducting ANOVA, prerequisite tests were conducted, including normality and homogeneity tests, as well as paired-samples t-tests.

RESULTS AND DISCUSSION

1. Assumption Tests

The normality test is a statistical procedure used to determine whether data follow a normal distribution (Hernandez, 2021). The Lilliefors method with the Kolmogorov-Smirnov test at a 5% significance level was employed. Table 2 presents the results of the normality test using SPSS, version 25.00 for Windows, for the three sample classes.

Table 2. Normality Test Results

Learning Model	Sig. Score	
	Pretest	Posttest
ILBIL	0,100	0,097
IBL	0,110	0,064
Conventional	0,108	0,093

Based on Table 2 at the initial value, for the ILBIL model class, a significant value was obtained in the Kolmogorov-Smirnov sample test of 0.100, the ILBIL model class of 0.110, and the Conventional model class of 0.108. While the table on the learning outcome test, for the IBL model class, a significant value was obtained in the Kolmogorov-Smirnov sample test of 0.097, the ILBIL model class of 0.064, and the Conventional model class of 0.093. It can be concluded that the table shows that the results of the normality test, the significance value in the Kolmogorov-Smirnov sample test shows all sig. values > 0.05 . This refers to the H_0 analysis being accepted, meaning that the three samples are normally distributed so they are worthy of being appointed as sample classes for research.

The homogeneity test is used to ensure that the variance between the groups being compared is consistent, so that the analysis results can be relied upon (Nurhaswinda et al., 2025). The homogeneity test was conducted using the F-test with a significance level of 5%. The following is a summary of the results of the data analysis using SPSS 25.00 for Windows for the homogeneity test. The results of the homogeneity test are presented in Table 3.

Table 3. Homogeneity Test Results

	Sig. Score	
	Initial Values	Learning Outcome Test
Based on mean	0,055	0,617

Based on Table 3, the significance value of the initial value in the based on mean row is $0.055 > 0.05$, while the significance value of the learning outcome test in the Based on Mean row is $0.617 > 0.05$. This can be interpreted as accepting H_0 , which means the three samples are homogeneous; there is no variance divergence between them. Therefore, the class is suitable for use as a sample in the study.

A paired samples t-test is used to determine whether there is a relationship between the pretest and posttest. The paired samples t-test uses a 5% significance level. The following is a summary of the data analysis results using SPSS 25.00 for Windows for the paired samples t-test. The results of the paired samples T-test are presented in Table 4.

Table 4. Paired Samples T-Test Results

		N	Sig.	Sig. (2-tailed)
Pair 1	IBL Initial Values & IBL Learning Outcomes	29	0,883	0,000
Pair 2	ILBIL Initial Values & ILBIL Learning Outcomes	31	0,100	0,000
Pair 3	Conventional Initial Values & conventional Learning Outcomes	29	0,918	0,412

Based on [Table 4](#), the sig. values for the TPS pretest and TPS posttest obtained a significance value of 0.883, the ILBIL pretest and posttest obtained a significance value of 0.100, and the conventional pretest and conventional posttest obtained a significance value of 0.918. The three models obtained a sig. value > 0.05 , indicating no relationship between the initial scores and the learning outcome test.

Meanwhile, the sig. values (2-tailed) for the initial scores and the IBL learning outcome test obtained a sig. value (2-tailed) of $0.000 < 0.05$ and for the ILBIL of $0.000 < 0.05$, indicating a significant effect of the differences in the treatments given. Meanwhile, the initial scores and the conventional learning outcome test obtained a sig. value (2-tailed) of $0.412 > 0.05$, indicating no significant effect of the differences in the treatments given. It can be concluded that the IBL and ILBIL models are suitable for use.

2. Hypothesis Testing

After conducting the prerequisite analysis test, the calculation results indicated that the data could be continued with a hypothesis test using a two-way analysis of variance with unequal cell sizes. This calculation used SPSS 25.00 for Windows, with a Scheffé-type post hoc analysis. The following summarizes the ANOVA test results at the 5% significance level. The results of the two-way ANOVA are presented in [Table 5](#).

Table 5. Two-Way ANOVA Results

Source	Sig.
Learning Model	0,000
Learning Independence	0,196
Learning Model*Learning Independence	0,306

Based on [Table 5](#), the learning model value is $0.000 < 0.05$, indicating a difference in effectiveness between the ILBIL learning model, the IBL learning model, and the conventional learning model on student mathematics learning outcomes.

Additionally, our study found a p-value of 0.196 (> 0.05) for the variable *learning independence*, indicating no significant effect on students' mathematics learning outcomes. A similar result was reported by [Ranti et al. \(2017\)](#), who found that learning independence has no influence on student learning outcomes. However, a meta-analysis by [Wahidiah & Rahman \(2021\)](#) found that self-regulated learning overall has a positive effect on mathematics learning outcomes, though this effect varies across instructional contexts, subject matter, and teaching methods.

For learning models and learning independence, the value is $0.306 > 0.05$, indicating no relationship (interaction) between learning models and learning independence on student learning outcomes. Because the value is < 0.05 for learning models, a post-ANOVA test is necessary. The post-ANOVA test was conducted to determine the differences in effectiveness between the IBL, ILBIL, and conventional learning models. Post ANOVA calculations using SPSS 25.00 for windows with Tukey HSD Post Hoc analysis. The marginal means are presented in [Table 6](#).

Table 6. Marginal Means

Learning Model	Average
IBL	76,052
ILBIL	82,297
Conventional	66,808

Based on [Table 6](#), there are significant differences in the mathematics learning outcomes of students who use the ILBIL, IBL, and conventional learning models. The marginal mean obtained by the IBL learning model is 76.052, the marginal mean obtained by the ILBIL learning



model is 82.297, and the marginal mean obtained by the conventional learning model is 66.808. Because there are three learning models, Multiple Comparisons are used. The following is a summary of the post-ANOVA results. The results of the post hoc test are presented in [Table 7](#).

Table 7. Post Hoc Test Results (Tukey HSD)

(I) Learning Model	(J) Learning Model	Sig.
IBL	ILBIL	0,005
	Conventional	0,000
ILBIL	IBL	0,005
	Conventional	0,000
Conventional	IBL	0,000
	ILBIL	0,000

Based on [Table 7](#), the IBL-ILBIL learning model obtained a sig. <0.05 , indicating a difference in effectiveness between the IBL and ILBIL learning models on students' mathematics learning outcomes. Based on the average, students using the ILBIL learning model achieved better mathematics learning outcomes than those using the IBL learning model.

For the IBL-Conventional learning model, a sig. <0.05 was obtained, indicating a difference in effectiveness between the IBL and Conventional learning models on students' mathematics learning outcomes. Based on the average, students using the IBL learning model achieved better mathematics learning outcomes than those using the conventional learning model.

For the IBL-Conventional learning model, a sig. <0.05 was obtained, indicating a difference in effectiveness between the ILBIL and Conventional learning models on students' mathematics learning outcomes. Based on the average, students using the ILBIL learning model achieved better mathematics learning outcomes than those using the conventional learning model.

Field evidence shows that students are more enthusiastic about learning materials using the ILBIL learning model because it provides them with the opportunity to argue and discuss in groups, solve problems in real-life situations, and build confidence by sharing the results of group discussions with other groups.

The findings of this study demonstrate that the ILBIL model is more effective than both IBL and conventional learning in improving mathematics learning outcomes. These results align with a study by [Lazonder & Harmsen \(2016\)](#), which confirmed that inquiry-based learning with scaffolding support can have a significant impact on students' conceptual understanding. Furthermore, a meta-analysis by [Furtak et al. \(2012\)](#), supported by recent research by [Farhan & Retnawati \(2014\)](#), shows that the inquiry model is effective in improving learning achievement, motivation, and mathematical representation skills compared to traditional learning. In Indonesia, [Baeti & Mikrayanti \(2021\)](#) also found that IBL significantly improved junior high school students' mathematics learning outcomes compared to conventional methods.

Meanwhile, strengthening ILBIL through the integration of information literacy enables students to more actively seek, evaluate, and use information to solve problems. This is relevant to a report [ACRL \(2016\)](#) which states that information literacy skills play a crucial role in supporting independent learning and data-driven decision-making. Therefore, ILBIL's greater effectiveness than IBL alone or conventional learning can be explained by its ability to combine an inquiry approach with systematic information literacy.

CONCLUSIONS AND SUGGESTIONS

The analysis and discussion presented yield the following conclusions. 1) The ILBIL (Inquiry Based on Literacy Information) learning model is more effective than the IBL (Inquiry Based Learning) learning model and conventional learning models on the mathematics learning outcomes of eighth-grade students at SMP Negeri 1 Madiun on the topic of flat-sided solid shapes. 2) At SMP Negeri 1 Madiun on the topic of flat-sided solid shapes, there is no effect of learning independence on the mathematics learning outcomes of eighth-grade students. 3) There is no interaction between the ILBIL, IBL, or conventional learning models with students' learning independence on the mathematics learning outcomes of eighth-grade students at SMP Negeri 1 Madiun on the topic of flat-sided solid shapes.



The following are suggestions put forward by the author based on these conclusions: 1) Students are expected to improve their ability to collaborate between teachers and other students so that the learning model runs effectively, 2) Students are expected to play an active role in interacting during the learning process so that learning outcomes are not only optimal but also help foster students' courage in expressing opinions and respecting differences of opinion.

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