International Journal of Social Science Research and Review

http://ijssrr.com
editor@ijssrr.com
Volume 5, Issue 9
September, 2022
Pages: 413-437

The Effect of Laboratory-Based Learning Strategies and Mathematic Logical Intelligence on Learning Outcomes of Linear Algebra Courses

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http://dx.doi.org/10.47814/ijssrr.v5i9.450

Abstract

This study aims to: (1) analyze the difference in the mean difference that laboratory-based learning is better than the RME (Realistic Mathematics Education) learning strategy and DL (Direct Learning) learning strategy. Methods This research uses quantitative research with experimental methods is 3×2 factorial with three levels of qualification of independent variables: laboratory-based learning strategies, Realistic Mathematics Education (RME) learning strategies, and Direct Instruction (DI) strategies. The results of this research are Differences in learning outcomes for linear algebra courses between students who are taught using laboratory-based learning strategies and students who are trained using DL (Direct Learning) learning strategies, and those prepared using RME (Realistic Mathematics Education) learning strategies. The average difference value (mean difference) that laboratory-based learning is better than the RME (Realistic Mathematics Education) learning strategy and DL (Direct Learning) learning strategy. Linear Jabar on students with high and low mathematical and logical intelligence. This is in line with the explanation that knowledgeable people will more readily accept or understand lessons. There is an interaction between learning strategies and logical-mathematical intelligence on linear algebra learning outcomes. Based on the study results, it is explained that the collaboration between learning strategies and logical-mathematical intelligence is a form of interaction or influence of learning strategies on learning outcomes of linear algebra courses on mathematical, logical intelligence, or vice versa.

Keywords: *Laboratory-Based Learning; Mathematic Logical Intelligence; Linear Algebra; Learning Outcomes*

Introduction

Education is the basis for preparing the nation's future generations to become moral human beings and develop their intellectual and mental abilities to become independent individuals as social beings and develop their creativity and potential. Therefore, it can be said that education contributes significantly to the progress of a country, is a vehicle for translating constitutional messages, and is a means of building national character (Ainulluluah et al., 2022).

Education can be done formally, informally, and non-formally. Still, a strategic place to improve human resources is formal education which is expected to contribute to the development of human resources in the face of any changes that occur due to advances in science and technology. This means that one of the factors causing the low quality of education is the low quality of learning. Improving the quality of learning begins with designing learning that is designed well and pays attention to conditions; choosing the right strategy will enhance the quality of education and automatically improve learning outcomes (Setiawan, Fanani, et al., 2022; Sumilat et al., 2022).

Science and technology have both positive and negative impacts. The development of this technology starts in developed countries, so Indonesia, as a developing country, needs to align itself with the developed countries. The story of science and technology increasingly encourages renewal efforts in using technological results in the learning process (Andayani et al., 2022). Educators have their way of determining the design of the sequence of learning activities. The ability to regulate the series of learning activities, the selection of specific methods and media, and the division of time in learning activities for educators will be the principal capital in systematically planning learning activities (Sumantri et al., 2022).

The material taught by educators must be relevant to the learning objectives, well-controlled by students, communicative and varied. Then apart from that, related to media use in learning, educators must use tools to meet the developments and demands of the times. Educators can at least use cheap and efficient tools even though they are simple and unpretentious but are a must to achieve the expected instructional goals. In addition to using the available tools, educators are also required to develop skills in making learning media that will be used in the media is not yet available. For this reason, educators must have sufficient knowledge and understanding of the learning media (Setiawan, Rachmadtullah, et al., 2022).

The quote explains that the media is a communication channel tool which means "intermediary," namely the intermediary of the message source (a source) with the recipient of the message (a receiver), such as films, television, diagrams, printed materials (printed materials), computers, and so on the instructor (Mujiati, 2020). Examples of these media can be considered learning media if they carry messages to achieve learning objectives. Heinrich also relates the relationship between the media with letters and methods (methods). The learning strategy by emphasizing the use of this media plays a significant role in determining the quality of learning, especially learning mathematics in higher education (Harsanti, 2018; Wantika, 2017).

Soeparna Darmawijaya (2006:19) Mathematics is one of the universal branches of science that becomes a means of deductive thinking in discovering and developing science and technology, one of which is the incredible result of human civilization in mathematics is the natural number system which provides many ideas and inspirations. For the development and development of mathematics itself, for example, function theory, operator theory, size theory, coding theory, and others. Negoro and B. Harahap (2005:3) that logic based on mathematics, apart from being the basis for the discovery and development of other sciences, is also a strong foundation for technology, including in modeling the phenomena that occur or are observed, then the definition of logic according to R. G. Soekardijo (1997:3) means a method or technique created to examine the accuracy of reasoning through empirical observation and psychological processes shown by symbols or language, then according to Rasdihan Rasyad (2003:68) suggests that the process of achievement to improve welfare Humans are a form of achieving the value of life, where value is obtained from a firm statement (a verbal assertion) and is interpreted as a set of symbols or words or sounds that can be true or false but not both.

So it can be said that the framework of learning mathematics at the university level is that students must be involved mentally, physically, and socially to prove themselves about the truth and theories or mathematical laws that are learned through the scientific process while still referring to the instructional objectives where The hope is that students have logical, analytical, systematic, numerical, critical and creative and collaborative abilities (Irawan & Iasha, 2021; Wahyudiana et al., 2021). Regarding the abilities of students, White (quote in Bruce Joye, 2009) explains that: Personality has undergone extraordinary evolution and continuous change since the beginning of our lives. However, we also have sufficient capacity to change and be “different”/unique. We can adapt to a broader climate, can love and be loved, have dreams and work to improve the standard of living.

Based on the above opinion that improving learning outcomes is centered on the abilities and capacities of students and educators, it is also necessary to make improvements to the strategies implemented so far so that they can motivate students' learning independence. Furthermore, reflecting on the results of observations and interviews with the Head of the Mathematics Education Study Program and the Dean of the Faculty of Teacher Training and Education, Ikhsanuddin Baubau University, Baubau City, Southeast Sulawesi Province, information was obtained that algebra, together with geometry, analysis, and number theory are the main branches of mathematics. From the information on the recommended courses, the researcher's attention is on the linear algebra course. The competencies expected after taking linear algebra courses are a basis for building the maturity of mathematical qualifications for teachers as a result of the Mathematics Education Study Program, Faculty of Teacher Training and Education, Dayanu Ikhsanuddin Baubau University. Students’ lack of understanding causes linear algebra to be considered an abstract, complicated, and boring subject, making them less motivated (Sudrajat et al., 2018, 2021).

The above causes the average learning outcomes of linear algebra courses to be still not as expected compared to other classes. This fact occurred in the Mathematics Education Study Program, Faculty of Teacher Training and Education, Dayanu Ikhsanuddin University Baubau, Baubau City, Southeast Sulawesi Province, reinforced by secondary data on increasing algebra learning outcomes over the last six years as shown in table 1.

Table 1. Description of Final Semester Exams for Linear Ajabar Courses, Unidayan Mathematics Education Study Program

No	**Semester Year**	**Semester Average**	**Semester Grade Conversion Average**	**Indicator**	**Value Interpretation**
1	2010	71.14	2.74	$2.5 \le RKN \le 3.0$	Intermediate
2	2011	81.42	3.03	$RKN > 3.0$	High
3	2012	71.29	2.79	$2.5 \le RKN \le 3.0$	Intermediate
4	2013	66.82	2.31	$RKN < 2.5$	Low
5	2014	68.79	2.42	$RKN < 2.5$	Low
6	2015	71.46	2.78	$2.5 \le RKN \le 3.0$	Intermediate
Jumlah		430.92	16.07		
Rata-rata		71.82	2.678	$2.5 \le RKN \le 3.0$	Intermediate

Source: Academic of Mathematics Education Study Program, FKIP Unidayan

Table 1 shows the results of the final semester exams in the last six years are isolated; even in 2013 and 2014, the interpretation of low scores, even though the average for the previous six years is in the medium value interpretation.

When observed in the learning process of linear algebra courses, generally, educators deliver lecture material that tends to be monotonous. So far, the strategy is still teacher-oriented; students are still relatively passive in the learning process and only accept and listen to what the educators explain. Educators still have not carried out meaningful learning for students, educators have not used teaching methods adapted to the ways of learning that students own, and when met with things that require numerical solutions, do not use computer laboratories as a means and learning infrastructure. Students find it difficult to express ideas because the role of educators is more dominant as a center in the learning process. Learning is more monologic and elaborating ways of solving and obtaining formulas in linear algebra, although sometimes it is interspersed with dialogue (Utomo et al., 2021).

For higher quality learning, intensive involvement of students is required in the learning process. The involvement of students can be seen from their active participation in the learning process. This involvement is based on the high motivation and interest of the students. Lecturers of linear algebra courses are required to have broad and in-depth knowledge of lecture material and are also required to master the use of various kinds of learning strategies that can generate interest and motivation of students in the learning process, including laboratory-based matters that allow students to empirically practice cognitive, affective, psychomotor abilities using laboratory facilities while taking into account the level of logical-mathematical intelligence of the students (Iasha et al., 2019; Suryanto et al., 2017).

Howard Anton (1987:303) suggests that in its application, linear algebra can be used as one of the motivations of students, including linear algebra that can be applied to the laws of physics, chemistry, biology, and economics in differential equations involving functions and derivatives. Derivatives lead to managing the potential of natural resources on the island of Buton. Besides mining also has forest products in the form of teak, so according to Howard Anton and Chris Rorres (1987:95), in the process of implementing harvesting carried out by the relevant agencies regarding selective logging, linear algebra theory can be used in a matrix model in forest management where trees are classified according to their height groups for a justifiable optimal yield of a periodic harvest will be calculated if trees of different height groups can have different economic values (Damayanti & Surjanti, 2022).

Students in the learning process do not just memorize, calculate, describe and analyze basic concepts in linear algebra but train them to improve understanding, reasoning power, analytical power, and optimizing abilities to prepare themselves to respond to demands as a ready-made workforce. In other words, a strategy is needed that provides more opportunities for initiative than just listening or receiving information (Subroto, 2022; Suryani & Selegi, 2022).

Many learning strategies can be applied to linear algebra courses. One of them is a laboratory-based learning strategy. Laboratory-based strategy is a learning strategy that allows students to empirically practice cognitive, affective, and psychomotor abilities using laboratory facilities. The laboratory-based strategy in its implementation is almost the same as the Hybrid, which is a combination of several methods relating to the way students adopt concepts, the syntax of which is expository learning, cooperative-inquiry-solutions-work-shop, virtual workshops using computers-internet, about computer technology used in laboratory-based learning strategies, Landauer (quote in Richard E. Mayer, 2009) proclaimed. From this description, it can be said that laboratory-based learning is better than some of the existing learning strategies. Still, even so, there is a need to strengthen the form of scientific evidence.

Richard E. Mayer (2009:17) says, "Computers and the information revolution have been widely predicted to be something that must exist as the industrial revolution two centuries before." Furthermore, he described two significant phases in using computer technology: making it automated (automation) and providing other results (augmentation).

Two aspects are prominent in laboratory-based learning: learning methods and learning media. The media plays a vital role and assists the teaching staff in achieving learning objectives. Media is everything that can be used to channel messages from the sender to the recipient so that it can stimulate students' thoughts, feelings, concerns, and interests, which leads to the learning process.

Hamzah B. Uno and Masri Quadrat (2014:11) stated that one of the essential factors that educators must consider in implementing laboratory-based learning strategies is the logical-mathematical intelligence factor. Mathematical, logical intelligence includes one's ability to think inductively and deductively, judge according to logical rules, understand and analyze patterns of numbers and solve problems using thinking skills.

Mathematical, logical intelligence in this context is more emphasized in terms of learning, both intellectual and physical potential. Optimizing students' ability will make them more active and dare to be challenged to apply the prior knowledge and new experiences, even in difficult conditions. Mathematical, logical intelligence gives an enormous contribution, especially in helping to give meaning quantitatively to the results carried out both in terms of using computers as learning media and improving student learning outcomes in linear algebra lectures.

The use of media, especially computers in learning, makes it very easy for teachers to present material. Therefore, researchers are interested in conducting experiments on applying laboratory-based learning strategies and logical-mathematical intelligence. As a comparison of the influence of the learning strategy, it will be seen the effect of direct instruction, RME (Realistic Mathematics Education), and laboratory-based learning carried out in different classes with the same abilities in students of the Mathematics Education Study Program, Faculty of Education and Teacher Training, University Dayanu Ikhsanuddin Baubau in the Linear Algebra course.

Research Method

This research is an experimental study with the dependent variable learning outcomes in linear algebra courses, the independent variable is the treatment of learning strategies, and the attribute variable in logical-mathematical intelligence. The experimental design is 3×2 factorial with three different variable qualification levels: laboratory-based learning strategies, Realistic Mathematics Education (RME) learning strategies, and Direct Learning Strategies (DI, Direct Instruction) as an attribute variable is logical-mathematical intelligence which is divided into two, namely high mathematical logical intelligence and low mathematical, logical intelligence. The experimental research design is presented in table 2.

Table 2. Factorial Experiment Design 3×2

Mathematical Logical Intelligence	**Learning Strategy**		
	Laboratory-based (A_1)	**RME (A_2)**	**DI (A_3)**
High (B_1)	A_1 B_1	A_2 B_1	A_3 B_1
Low (B_2)	A_1 B_2	A_2 B_2	A_3 B_2

Information:

A1 : Groups of students who are taught with laboratory-based learning strategies.
A2 : Groups of students who are taught with Realistic Mathematics Education (RME) learning strategies.
A3 : The group of students taught with direct learning strategies (DI, Direct Instruction).

A1B1: A group of students taught laboratory-based learning strategies with high logical-mathematical intelligence.
A2B1: A group of students taught with Realistic Mathematics Education (RME) learning strategies with high logical-mathematical intelligence.
A3B1: A group of students taught with direct learning strategies (DL, Direct Instruction) with high logical-mathematical intelligence.
A1B2: A group of students taught using laboratory-based learning strategies with low logical-mathematical intelligence.
A2B2: A group of students taught with Realistic Mathematics Education (RME) learning strategies with low logical-mathematical intelligence.
A3B2: The group of students taught with direct learning strategies (DL, Direct Instruction) with low logical-mathematical intelligence.

Result and Discussion

This section describes the research results that have been obtained based on descriptive and inferential analysis results. Descriptive analysis is intended to describe in general the characteristics of the research variables. In contrast, inferential analysis is used to test the requirements and research hypotheses, then the discussion and limitations of this study are presented.

Directions of Multiple Intelligences

From the number of students, as many as 145 people were given the multiple intelligence direction tests. The results were mixed. Only 43.45% or 63 students had logical-mathematical intelligence, and 21 students or 14.48% had numerous intelligence directions, one of which was logical-mathematical intelligence. Hence, the number of students with logical-mathematical intelligence is 84 or 57.93% of the 145 students separated by gender, according to table 3.

Table. 3 Directions of multiple intelligences tendency to logical-mathematical intelligence

Mathematical Logical Intelligence			
Gender	**Fa**	**Fr (%)**	**fr (n) (%)**
Male	32	38.10	22.07
Female	52	61.90	35.86
∑	84	100	57.93
N	145		

Based on the data in table 3, it can be seen that 84 students consisting of 32 men and 52 women. Furthermore, the direction of logical-mathematical intelligence is given a test question to measure the level of high and low ability to solve distributed linear algebra questions, as in table 4.

Table 4. High and low division of logical-mathematical intelligence as a research experiment

Mathematical Logical Intelligence					
Moderator Variables	**Value Interval**	**fa**	**study over again**	**Absent**	**Experiment**
Low	66 – 76	22	1	0	21
High	88 – 100	25	2	2	21
∑		47	3	2	42
Q1	76				
Q2	81				
Q3	88				

Table 4 data shows that from 84 data taken at the highest value in the interval 88 to 100 as many as 25 students and the lowest value being in the gap 66 to 76 as many as 22 students, this interval was obtained based on the value of the first quartile and third quartile, where the moderator variable low 25% of the test results for determining the high and low of logical-mathematical intelligence are below 76. The remaining 75% are above 76, the high moderator variable 75% of the test results for determining the high and low of logical-mathematical intelligence are below 88, and 25% are above 88.

Learning Outcomes of Linear Algebra Courses with Mathematical Logical Intelligence

Descriptive statistical analysis was carried out to describe the learning outcomes of students' linear algebra courses obtained from the treatment of learning strategies and logical-mathematical intelligence attributes, and the result scores obtained from the results of the questions described the size of the concentration and distribution of the overall data presented including the average, the number of samples, the cumulative amount of data, and variance are stated in table 5.

Table 5. Summary description of the distribution of research data

Mathematical Logical Intelligence	**Learning Strategy**		
	Laboratory Based (A_1)	**Realistic Mathematics Education (A_2)**	**Direct Learning (A_3)**
High (B_1)	n_{A1B1} = 7	n_{A2B1} = 7	n_{A3B1} = 7
	$\sum X_{A1B1}$ = 617	$\sum X_{A2B1}$ = 569	$\sum X_{A3B1}$ = 453
	$\sum X^2_{A1B1}$ = 380689	$\sum X^2_{A2B1}$ = 323761	$\sum X^2_{A3B1}$ = 205209
	$\bar{x}_{A1B1}$ = 88.14	$\bar{x}_{A2B1}$ = 81.29	$\bar{x}_{A3B1}$ = 64.71
Low (B_2)	n_{A1B2} = 7	N_{A2B2} = 7	N_{A3B2} = 7
	$\sum X_{A1B2}$ = 463	$\sum X_{A2B2}$ = 403	$\sum X_{A3B2}$ = 347
	$\sum X^2_{A1B2}$ = 214369	$\sum X^2_{A2B2}$ = 162409	$\sum X^2_{A3B2}$ = 120409
	$\bar{x}_{A1B2}$ = 66.14	$\bar{x}_{A2B2}$ = 57.57	$\bar{x}_{A3B2}$ = 49.57
Total	n_{A1} = 14	n_{A2} = 14	n_{A3} = 14
	$\sum X_{A1}$ = 1080	$\sum X_{A2}$ = 972	$\sum X_{A3}$ = 800
	$\sum X^2_{A1}$ = 1166400	$\sum X^2_{A2}$ = 944784	$\sum X^2_{A3}$ = 640000
	$\bar{x}_{A1}$ = 77.14	$\bar{x}_{A2}$ = 69.43	$\bar{x}_{A3}$ = 57.14

Based on the description of the research data (data tabulation) the score of learning outcomes for linear algebra subjects is described in the data for each group (A1, A2, A3, A1B1, A1B2, A2B1, A2B2, A3B1, A3B2) as follows:

Learning Outcomes Using Laboratory-Based Learning Strategies (A_1)

Student study groups that use laboratory-based learning strategies, both those with high and low mathematical and logical intelligence, empirically have a range of 28, with an average of 73.69, and the amount of accumulated data obtained is 1032, and the standard deviation is 9.24.

The frequency distribution of learning outcomes for linear algebra courses using laboratory-based learning strategies can be classified into five interval classes with an interval class distance of six. Overall the frequency distribution of learning outcomes for linear algebra courses using laboratory-based learning strategies is arranged in Table 6.

Table 6. Frequency distribution of learning outcomes for linear algebra using laboratory-based learning strategies

Interval Class	f_a	Middle value	f_r (%)	f_r cumulative
61 – 66	4	63.5	28.57	28.57
67 – 72	4	69.5	28.57	57.14
73 – 78	1	75.5	7.14	64.29
79 – 84	3	81.5	21.43	85.71
85 – 90	2	87.5	14.29	100
∑	14	-	100	

The distribution of scores for learning outcomes for linear algebra courses using laboratory-based learning strategies in the table above illustrates that the achievement of scores above the average is 35.72%, and the score below the average is 57.14%, meaning that the total score is 57.14%. Those below the average are also considered to be greater than those above the standard, but the average value obtained is higher when compared to the learning outcomes of linear algebra courses in the study group using Direct Learning (DL) and Realistic learning strategies. Mathematical Education (RME). Then from the table data, it can be described again in the form of particular frequency table data as well as determining the high and low value of learning outcomes for linear algebra courses using laboratory-based learning strategies based on frequency table 7.

Table 7. Frequency data category learning outcomes for linear algebra courses using laboratory-based learning strategies

No.	Category	Indicator	Students	
			Frequency	(%)
1	Very High	$88 \leq A_3$	2	14.29
2	High	$78 \leq A_3 < 88$	4	28.57
3	Intermediate	$69 \leq A_3 < 78$	3	21.43
4	Low	$60 \leq A_3 < 69$	5	35.71
5	Very Low	$A_3 < 60$	0	00.00
Total			14	100

Based on table 7 data, it can be seen that the average category of learning outcomes for linear algebra courses using laboratory-based learning strategies is high. It can be seen that of 14 students, no students fall into the deficient category. A very high number there are two students, 14.29 and as many as four students or by 28.57%, three students who get good learning outcomes or by 21.43%, and five students 57.71% who get low results. This proves that referring to the average value, the tendency of learning outcomes for linear algebra courses using laboratory-based learning strategies is high because there are 42.86% above the average.

Learning Outcomes Using Realistic Mathematics Education (RME) Learning Strategies (A_2)

Student study groups that use Realistic Mathematical Education (RME) learning strategies, both those with high and low mathematical logical intelligence, empirically have a range of 38, with an average of 69.4 and the amount of accumulated data obtained is 972, and a standard deviation of 13.36.

The frequency distribution of learning outcomes for linear algebra courses using Realistic Mathematical Education (RME) learning strategies can be classified into five interval classes with an interval class distance of eight. Overall, the frequency distribution of learning outcomes for linear algebra courses using Realistic Mathematical Education (RME) learning strategies is arranged in the following table 8.

Table 8. Frequency distribution of learning outcomes for linear algebra using realistic mathematical education (RME) learning strategies

Interval Class	f_a	Middle Value	f_r (%)	f_r Cumulative
50 – 57	3	53.5	21.43	21.43
58 – 65	4	61.5	28.57	50.00
66 – 73	1	69.5	7.14	57.14
74 – 81	2	77.5	14.29	71.43
82 – 89	4	85.5	28.57	100
$\sum$	14	-	100	

The distribution of scores for learning outcomes for linear algebra courses using the Realistic Mathematical Education (RME) learning strategy in the table above illustrates that the achievement of scores above the average is 42.86%, and the score is below the average by 50%. This means that the number below the average is also still quite large when compared to those above the average. Then from the table data, it can be re-described in the form of special frequency table data as well as determining the description of the high and low value of learning outcomes for linear algebra courses using Realistic Mathematical Education (RME) learning strategies based on frequency table 9.

Table 9. Frequency data category of learning outcomes for linear algebra courses using realistic mathematical education (RME) learning strategies

No.	Category	Indicator	Students	
			Frequency	(%)
1	Very High	$89 \leq A_2$	0	00.00
2	High	$76 \leq A_2 < 89$	6	42.86
3	Intermediate	$63 \leq A_2 < 76$	2	14.29
4	Low	$49 \leq A_2 < 63$	6	42.86
5	Very Low	$A_2 < 49$	0	00.00
Jumlah			14	100

Based on table 9 data, it can be seen that the average category of learning outcomes for linear algebra courses using the Realistic Mathematical Education (RME) learning strategy is sufficient, it can be seen that from 14 students there are no students who fall into the very high and very low categories, then the high and low numbers are balanced with each of six students or 42.86% and there are two students who get sufficient learning outcomes or 14.29%. This proves that referring to the average value, the tendency of learning outcomes for linear algebra courses using Realistic Mathematical Education (RME) learning strategies is sufficient.

Learning Outcomes Using Direct Learning (DL) Learning Strategies (A_3)

Data about linear algebra learning outcomes using Direct Learning learning strategies according to the data obtained the highest score is 71 and the lowest value is 43. Based on this value, it is known that the trend ranges from 28 with an interval class distance of six and five many interval classes, and the average linear algebra learning outcome using the Direct Learning learning strategy is 57.14 with a standard deviation of 8.92 and the total accumulation of linear algebra learning outcomes using Direct Learning learning strategies is 800 for a total of 14 students. Furthermore, the data is described in the form of frequency table data as shown in the following table 10.

Table 10. Frequency distribution of learning outcomes for linear algebra using direct learning (DL) learning strategies

Interval Class	f_a	Middle Value	f_r (%)	f_r Cumulative
43 – 48	3	45.5	21.43	21.43
49 – 54	4	51.5	28.57	50.00
55 – 60	1	57.5	7.14	57.14
61 – 66	3	63.5	21.43	78.57
67 – 72	3	69.5	21.43	100
$\sum$	14	-	100	

The distribution of scores for learning outcomes for linear algebra courses using Direct Learning (DL) Learning Strategies in the table above provides an illustration that the achievement of scores above the average is 42.86%, and below the score is below the average by 50%. This means that the number below the average is still relatively large when compared to those above the average. Then from the table data, it can be re-described in the form of special frequency table data as well as determining the description of the high and low value of learning outcomes for linear algebra courses using Direct Learning (DL) learning strategies based on frequency table 11.

Table 11. Frequency data category of learning outcomes for linear algebra courses using direct learning (DL) learning strategies

No.	Category	Indicator	Students	
			Frequency	(%)
1	Very High	$71 \leq A_1$	2	14.29
2	High	$62 \leq A_1 < 71$	3	21.43
3	Intermediate	$53 \leq A_1 < 62$	5	35.71
4	Low	$44 \leq A_1 < 53$	3	21.43
5	Very Low	$A_1 < 44$	1	7.14
Jumlah			14	100

Based on the table data above, it can be seen that the average category of learning outcomes for linear algebra courses using the Direct Learning (DL) learning strategy is sufficient, it can be seen that from 14 students there are two students who fall into the very high category or 14.29%, three students or 21.43% are in the high category, five students or 35.71% are in the moderate category, three students or 21.43% are still low and one student or 7.14% are in the very low category. This proves that referring to the average value, the tendency of learning outcomes for linear algebra courses using Direct Learning (DL) learning strategies is sufficient, although 35.71% is an accumulation above the average and 28.57% below the average with the difference is 7.14%, meaning that above the average and below the average are almost the same.

Learning Outcomes on High Mathematical Logical Intelligence

Learning Outcomes Using Laboratory-Based Learning Strategies

The study group of students who learn to use laboratory-based learning strategies and have high logical-mathematical intelligence theoretically has a score range of 0 – 95. This means that the highest score is 95 and the lowest score is 0. Empirically from the data obtained the highest score is 95 and the lowest score was 83. This group had an average score of 88.14 with a standard deviation of 4.22.

The frequency distribution of learning outcomes for linear algebra courses using laboratory-based strategies and having high logical-mathematical intelligence is overall classified into four class intervals with each absolute, relative percent, and cumulative relative frequency. The overall distribution of scores for learning outcomes for linear algebra courses using laboratory-based strategies and having high logical-mathematical intelligence can be seen in table 12.

Table 12. Frequency distribution of learning outcomes for linear algebra courses using laboratory-based strategies and having high mathematical logical intelligence (A_1B_1)

Interval Class	**f_a**	**Middle Value**	**f_r (%)**	**f_r Cumulative**
83 – 86	2	84.50	28.57	28.57
87 – 90	3	88.50	42.86	71.43
91 – 94	1	92.50	14.29	85.71
95 – 98	1	96.50	14.29	100.00
$\sum$	7	-	100	

Based on table 4.12 when viewed from the average value, the number of students who are below the average is the same as the number of students above the average, namely two students each or 28.57% while those with an average score are three students or equivalent to 71.43%. The results of the score using a laboratory-based strategy on students who have high logical-mathematical intelligence are very high because the lowest score in this study group is the highest score in the other study groups. Furthermore, the data presented in the table above can be clarified in the form of a histogram, as shown in the following figure.

Learning Outcomes Using Realistic Mathematics Education (RME) Learning Strategies

Study groups of students who learn to use Realistic Mathematical Education (RME) learning strategies and have high logical-mathematical intelligence theoretically have a score range of 0 – 88. This means that the highest score is 88 and the lowest score is 0. Empirically from the data obtained the highest score was 88 and the lowest score was 70. This group had a mean score of 81.29 with a standard deviation of 6.34.

The frequency distribution of learning outcomes for linear algebra courses using the Realistic Mathematical Education (RME) strategy and having high logical-mathematical intelligence overall is classified into four class intervals with each absolute, relative percent, and relative cumulative frequency. Overall, the distribution of scores for learning outcomes for linear algebra courses using the Realistic

Mathematical Education (RME) strategy and having high logical-mathematical intelligence can be seen in table 13.

Table 13. Frequency distribution of learning outcomes for linear algebra courses using realistic mathematical education (RME) strategies and having high mathematical logical intelligence (A_2B_1)

Interval Class	**f_a**	**Middle Value**	**f_r (%)**	**f_r Cumulative**
70 – 74	1	72.00	14.29	14.29
75 – 79	2	77.00	28.57	42.86
80 – 84	2	82.00	28.57	71.43
85 – 89	2	87.00	28.57	100.00
∑	7	-	100	

Based on table 4.11, when viewed from the average value, there are students who are below the average value, namely three students, who are at the average value of two students and above the average value of two students. Furthermore, it can also be interpreted that students who are below the average score are 42.86% and those who are in the average score and those who are above the average score are 28.57.

Learning Outcomes Using Direct Learning (DL) Learning Strategies

The study group of students who learn to use Direct Learning (DL) learning strategies and have high logical mathematical intelligence theoretically has a score range of 0 - 71. This means that the highest score is 71 and the lowest score is 0. Empirically from the data obtained a score of the highest score was 71 and the lowest score was 58. This group had a mean score of 64.71 with a standard deviation of 5.06.

The frequency distribution of learning outcomes for linear algebra subjects using the Direct Learning (DL) strategy and having high logical-mathematical intelligence is classified into four class intervals with each absolute, relative percent, and cumulative frequency. The overall distribution of scores for learning outcomes for linear algebra subjects using the Direct Learning (DL) strategy and having high logical-mathematical intelligence can be seen in table 14.

Table 14. Frequency distribution of learning outcomes for linear algebra courses using direct learning (DL) strategy and having high mathematical, logical intelligence (A_3B_1)

Interval Class	**f_a**	**Middle Value**	**f_r (%)**	**f_r Cumulative**
58 – 61	2	59.50	28.57	28.57
62 – 65	2	63.50	28.57	57.14
66 – 69	1	67.50	14.29	71.43
70 – 73	2	71.50	28.57	100.00
∑	7	-	100	

Based on table 4.12, when viewed from the average value, some students are below the middle value, namely several two students, who are at the average value of two students, and above the average value of three students. Furthermore, it can also be interpreted that students who are below the average score and those who are in the average score are 28.57%, and those who are above the average score are 42.86%.

Learning Outcomes on Low Mathematical Logical Intelligence

Learning Outcomes Using Laboratory-Based Learning Strategies

Student study groups who learn to use laboratory-based learning strategies and have low logical-mathematical intelligence theoretically have a score range of 0 – 71. This means that the highest score is 71, and the lowest is 0. Empirically from the data obtained, the highest score was 71 and the lowest score was 61. This group had a mean score of 66.14 with a standard deviation of 3.67.

The frequency distribution of learning outcomes for linear algebra subjects using laboratory-based strategies and having low logical-mathematical intelligence overall is classified into four class intervals with each absolute, relative percent, and cumulative frequency. Overall, the distribution of scores for learning outcomes for linear algebra subjects using laboratory-based strategies and having low logical-mathematical intelligence can be seen in table 15.

Table 15. Frequency distribution of learning outcomes for linear algebra courses using laboratory-based strategies and having low mathematical logical intelligence (A_1B_2)

Interval Class	f_a	Middle Value	f_r (%)	f_r Cumulative
61 – 63	2	62.00	28.57	28.57
64 – 66	2	65.00	28.57	57.14
67 – 69	1	68.00	14.29	71.43
70 – 72	2	71.00	28.57	100.00
$\sum$	7	-	100	

Based on the table above, when viewed from the average value, the number of students who are below the average is two students or 28.57%, and the number of students above the average is three students or 42.86% while being at an average value of two students or equivalent to 28.57%. The results of obtaining scores using laboratory-based strategies for students with low logical-mathematical intelligence are quite high compared to other study groups at low levels of logical-mathematical intelligence.

Learning Outcomes Using Realistic Mathematical Education (RME) Learning Strategies

Student study groups who learn to use Realistic Mathematical Education (RME) learning strategies and have low logical-mathematical intelligence theoretically have a score range of 0 – 63. This means that the highest score is 63, and the lowest is 0. Empirically from the data obtained, the highest score was 63, and the lowest was 50. This group had a mean score of 57.57 with a standard deviation of 4.72.

The frequency distribution of learning outcomes for linear algebra courses using the Realistic Mathematical Education (RME) strategy and having low logical-mathematical intelligence overall is classified into four class intervals with each absolute frequency, relative percent, and relative cumulative. Overall, the distribution of scores for learning outcomes for linear algebra courses using the Realistic Mathematical Education (RME) strategy and having low logical-mathematical intelligence can be seen in table 16.

Table 16. Frequency distribution of learning outcomes for linear algebra courses using realistic mathematics education (rme) strategies and having low mathematical logical intelligence (A_2B_2)

Interval Class	f_a	Middle Value	f_r (%)	f_r Cumulative
50 – 53	2	51.50	28.57	28.57
54 – 57	1	55.50	14.29	42.86
58 – 61	2	59.50	28.57	71.43
62 – 65	2	63.50	28.57	100.00
∑	7	-	100	

Based on the table above, when viewed from the average value, some students are below the middle value, namely several three students, who are at an average value of two students and above the average value of two students. Furthermore, it can also be interpreted that students who are below the average score are 42.86%, and those who are in the average score and those who are above the average score are 28.57.

Learning Outcomes Using Direct Learning (DL) Learning Strategies

The study group of students who learn to use Direct Learning (DL) learning strategies and have low logical-mathematical intelligence theoretically has a score range of 0 - 54. This means that the highest score is 54, and the lowest is 0. Empirically from the data obtained, a score of the highest score was 54, and the lowest score was 43. This group had a mean score of 49.57 with a standard deviation of 3.99.

The frequency distribution of learning outcomes for linear algebra subjects using the Direct Learning (DL) strategy and having low logical-mathematical intelligence overall is classified into four class intervals with each absolute, relative percent, and cumulative frequency. Overall, the distribution of scores for learning outcomes for linear algebra subjects using the Direct Learning (DL) strategy and having low logical-mathematical intelligence can be seen in table 17.

Table 17. Frequency distribution of learning outcomes for linear algebra courses using direct learning (dl) strategy and having low mathematical logical intelligence (A_3B_2)

Interval Class	f_a	Middle Value	f_r (%)	f_r Cumulative
43 – 45	1	44.00	14.29	14.29
46 – 48	2	47.00	28.57	42.86
49 – 51	1	50.00	14.29	57.14
52 – 54	3	53.00	42.86	100.00
∑	7	-	100	

Based on the table above, when viewed from the average value, the number of students below the average value is the same as the number of students above the middle value, namely three students each and those with an average score of one. Student. Furthermore, it can also be interpreted that students who are below the average score and those above the average score are 42.86%, then those who are at an average value of 14.29%.

Testing Requirements Analysis

Normality Test

One of the basic assumptions that must be met before performing parametric statistical tests is the normality test. This test is used to see if the data that has been collected is spread out following a normal distribution or not. The easy way is to look at the significance of the Kolmogorov-Smirnov Test and the Lilifors test, where the residual variables are normally distributed. The assumption of normality of the data is met so that the data can be continued with other statistical tests. On the other hand, the testing process cannot be carried out if the normality test is not met. If forced to do so, the results will certainly not be valid alias biased. Testing the normality of the data for each sample is pushed through the following hypotheses:

H_0 : The data in the sample is normally distributed
H_1 : The data in the sample is not normally distributed

Through the SPSS application with existing provisions, the criteria for data normality are if the p-value (Sig.) > 0.05, then accept H0 with the meaning that the data in the sample is normally distributed, as well as in the Lilifors test the criteria for accepting H_0 are accepted if the value is L_o (L_{count}) < value L_t (L_{table}). The following is a summary of the results of the normality test of learning outcomes for linear algebra courses which are depicted in the following table 18.

Table 18. Data normality test

Group	**N**	**Kolmogorov-Smirnov Test**		**Lilifors Test**	
		Asymp. Sig. (2-tailed)	**alfa**	**L_o**	**L_t**
A1	14	0.717	0.05	0.131	0.227
		0.717 > 0.05		0.131 < 0.227	
		Test distribution is Normal		Normal distributed data	
A2	14	0.731	0.05	0.175	0.227
		0.731 > 0.05		0.175 < 0.227	
		Test distribution is Normal		Normal distributed data	
A3	14	0.956	0.05	0.193	0.227
		0.956 > 0.05		0.193 < 0.227	
		Test distribution is Normal		Normal distributed data	

Based on the table recapitulation above, it can be stated that all data groups in this study came from a normally distributed population.

Homogeneity Test

A homogeneity test is a test of whether or not the variances of two or more distributions are equal. The homogeneity test in this study was carried out in six data groups, namely:

a. Learning outcomes of linear algebra courses using laboratory-based strategies and having high logical-mathematical intelligence (A_1B_1),
b. Learning outcomes for linear algebra courses using Realistic Mathematical Education (RME) strategies and having high logical-mathematical intelligence (A_2B_1),
c. Learning outcomes of linear algebra courses using Direct Learning (DL) strategies and having high mathematical, and logical intelligence (A_3B_1),

d. Learning outcomes of linear algebra courses using laboratory-based strategies and having low mathematical, logical intelligence (A_1B_2)
e. Learning outcomes of linear algebra courses using Realistic Mathematical Education (RME) strategies and having low mathematical, logical intelligence (A_2B_2), and
f. The learning outcomes of linear algebra courses use the Direct Learning (DL) strategy and have low mathematical, and logical intelligence (A_3B_2).

For more details, the homogeneity test of the six groups can be seen in the following summary table 19.

Table 19. Data homogeneity test]

Group	**db**	**S^2**	**db (S^2)**	**Log (S^2)**	**db Log (S^2)**
A_1B_1	6	16.83	100.99	1.23	7.36
A_2B_1	6	40.48	242.86	1.61	9.64
A_3B_1	6	24.27	145.63	1.39	8.31
A_1B_2	6	13.39	80.36	1.13	6.76
A_2B_2	6	22.09	132.54	1.34	8.07
A_3B_2	6	16.87	101.19	1.23	7.36
$\sum$	36	133.93	803.57	7.92	47.50
$S^2_{combination}$			22.32143		
Nilai Satuan Bartlett (B)			48.55399		
X^2_{Count}			2.429122024		
X^2_{tabel}			11,07049769		
Karena $X^2_{hitung} < X^2_{tabel}$ maka homogen					

Based on the results obtained using the Bartlett Homogeneity Assumption Test, the results obtained by Bartlett are 48.55 with Chihitung = 2.43 and Chitabel = 11.07 at the 95% confidence level. So through these results, it can be seen that $Chi_{count} < Chi_{table}$, which means that the overall sample comes from a homogeneous population.

Research Hypothesis Testing

There are differences in the learning outcomes of linear algebra courses between students who are taught using laboratory-based learning strategies and students who are taught using DL (Direct Learning) learning strategies and students who are taught using RME (Realistic Mathematics Education) learning strategies).

To find out the difference in learning outcomes for linear algebra courses between students who are taught using laboratory-based learning strategies (A_1) and students who are taught using DL (Direct Learning) learning strategies (A_3) and students who are taught using learning strategies RME (Realistic Mathematics Education) (A_2) is described in the summary table of the results of the two-way ANOVA calculation as table 20.

Table 20. Summary of Two Paths Anava Calculation Results Laboratory-based learning strategies (A1), RME (Realistic Mathematics Education) learning strategies (A2), and DL (Direct Learning) learning strategies (A3)

Variance Source	**JK**	**db**	**RJK**	**F Count**	**F tabel α=0,05**	**Information**
Between	2847.75	2	1423.88	10.6482	3.2381	Ho Reject
Inside	5215.08	39	133.72			
Total	8062.83	41	-			

Based on the analysis of the data in the table at the significance level = 0.05, it is obtained that the calculated F is 10.65 which is greater than the F table of 3.24. Thus, it is concluded that there is a difference in average learning outcomes between those using laboratory-based learning strategies (A1), RME (A2), and DI (A3). Furthermore, the magnitude of the influence of learning strategies on learning outcomes for linear algebra courses is 35.32% and the rest is influenced by other factors. The value of the average difference (mean difference), can be seen in the following table 21.

Table 21. Summary of results of calculation of mean differences (mean difference) laboratory-based learning strategies (A_1), RME (realistic mathematics education) learning strategies (A_2), and DL (direct learning) learning strategies (A_3)

Mean		**n**	**Mean Differences (μi - μj)**		
			μA_1	**μA_2**	**μA_3**
			77.14	69.40	57.14
μA_1	77.14	14	0.00	7.74	20.00
μA_2	69.40	14		0.00	12.26
μA_3	57.14	14			0.00

Judging from the difference in the average value of learning outcomes for linear algebra courses between students who are taught using the laboratory-based learning strategy (A_1) and the average value of students who are taught using the RME (Realistic Mathematics Education) learning strategy (A_2) of 7.74 as well as the average value of students who are taught with the DL (Direct Learning) (A_3) learning strategy of 20.00. In contrast to the average value of learning outcomes for linear algebra courses between students who are taught using the RME (Realistic Mathematics Education) (A_2) learning strategy (A_2) with the average value of students who are taught using the DL (Direct Learning) learning strategy (A_3) of 12.26. This proves that the group $A_1 > A_2 > A_3$.

There Are Differences In The Learning Outcomes Of Linear Algebra Courses For Students Who Have High And Low Logical-Mathematical Intelligence.

To find out the difference in learning outcomes for linear algebra courses between students who have high logical-mathematical intelligence (B_1) and those who have low logical intelligence (B_2), is described in the summary table of the results of two-way ANOVA calculations as follows:

Table 22. Summary of ANAvA Calculation Results Two Paths of high mathematical logical intelligence (B_1) with those with low logical intelligence (B_2)

Variance Sources	**JK**	**db**	**RJK**	**F $_{count}$**	**F $_{table}$ α=0,05**	**Information**
Between	4266,93	1	4266,93	44,964	4,085	Tolak Ho
Inside	3795,90	40	94,90			
Total	8062,83	41	-			

Based on the analysis of the data in the table at the significance level = 0.05, it is obtained that the calculated F is 44.96 which is greater than the F table of 4.09. Thus, it is concluded that there is a difference in average learning outcomes between those who have high mathematical logical intelligence (B_1) and those who have low mathematical logical intelligence (B_2). Furthermore, the magnitude of the influence of mathematical logical intelligence on learning outcomes for linear algebra courses is 52.92% and the rest is influenced by other factors. The value of the average difference (mean difference), can be seen in the following table:

Table 23. Summary of Calculation Results of Average Differences (Mean Difference) of high mathematical logical intelligence (B_1) with those who have low logical intelligence (B_2)

Mean		**n**	**Mean Dinferences (μi - μj)**	
			μB_1	**μB_2**
			77,98	57,82
μB_1	77,98	21	0,00	20,16
μB_2	57,82	21		0,00

Judging from the difference in the average value of learning outcomes for linear algebra courses between students who have high logical-mathematical intelligence (B1) and the average value of students who have low logical-mathematical intelligence (B2) of 20.16. This proves that group $B_1 > B_2$.

There Is an Interaction Between Learning Strategies and Mathematical Logical Intelligence on Linear Algebra Learning Outcomes.

The results of data analysis using two-way ANOVA at a significance level of = 0.05, obtained F count of 4.780 which is greater than F table = 3.259. It can be concluded that there is a very significant interaction effect between learning strategies and logical-mathematical intelligence on the learning outcomes of linear algebra courses.

Table 24. Summary of Anava Calculation Results of Two Paths of Interaction of Learning Strategies and Mathematical Logical Intelligence on Learning Outcomes of Linear Algebra Courses

Variance Sources	**JK**	**db**	**RJK**	**F $_{count}$**	**F $_{table}$ α=0,05**	**Information**
Between (A) Coloumn	2847,75	2	1423,88	68,418	3,259	Terdapat Interaksi
Between (B) Row	4266,93	1	4266,93	205,028		
Interaction (AXB)	198,94	2	99,47	4,780		
Inside	749,21	36	20,81			
Reduction total	8062,83	41				

In Students Who Have High Logical-Mathematical Intelligence, Students Who Are Taught With Laboratory-Based Learning Strategies Are Better Than Students Who Are Taught With DI (Direct Instruction) Learning Strategies.

Based on data analysis on the determination between students who have high logical-mathematical intelligence in students who are taught using laboratory-based learning strategies and students who are taught with DI (direct instruction) learning strategies, the following results are obtained:

Table 25. Summary of Differentiating Learning Outcomes for Linear Algebra Courses on High Mathematical Logical Intelligence Using Laboratory-Based Learning Strategies with DI (Direct Instruction) learning strategies

Group	Difference μA_1B_1 - μA_3B_1	Standard error (Se)	t'	t'(0,05)	Decision
Laboratory vs DI (Direct Instruction)	23.45	2.2435	10.454	2.447	Reject Ho, Accept H1

With the average difference between the learning outcomes of linear algebra courses on high logical-mathematical intelligence using laboratory-based learning strategies with DI (Direct Instruction) learning strategies of 23.45, the t count is 10,454 which is greater than t table of 2,447 at a confidence level of 95 % it can be said that in students who have high logical-mathematical intelligence, students who are taught using laboratory-based learning strategies are better than students who are taught using Direct Instruction learning strategies.

For students who have high logical-mathematical intelligence, students who are taught using laboratory-based learning strategies are better than students who are taught using RME (Realistic Mathematics Education) learning strategies.

Based on data analysis on the determination between students who have high logical-mathematical intelligence in students who are taught using laboratory-based learning strategies and students who are taught using RME (Realistic Mathematics Education) learning strategies, the following results are obtained:

Table 26. Summary of Differentiating Learning Outcomes for Linear Algebra Courses in High Mathematical Logical Intelligence Using Laboratory-Based Learning Strategies with RME (Realistic Mathematics Education) learning strategies

Group	Difference μA_1B_1 - μA_3B_1	Standard error (Se)	t'	t'(0,05)	Decision
Laboratory vs RME (Realistic Mathematics Education)	6.90	2.649	2.607	2.447	Reject Ho, Accept H1

With the average difference between the learning outcomes of linear algebra courses on high mathematical logical intelligence using laboratory-based learning strategies with RME (Realistic Mathematics Education) learning strategies of 6.9, the t count is 2.607, which is greater than the t table of 2.447 at the confidence level. 95% can be said that in students who have high logical-mathematical intelligence, students who are taught with laboratory-based learning strategies are better than students who are taught with RME (Realistic Mathematics Education) learning strategies.

For students who have high logical-mathematical intelligence, students who are taught with RME (Realistic Mathematics Education) learning strategies are better than students who are taught with DI (direct instruction) learning strategies.

Based on data analysis on the determination between students who have high logical-mathematical intelligence in students who are taught using the RME (Realistic Mathematics Education) learning strategy and students who are taught using the DI (Direct Instruction) learning strategy, the following results are obtained:

Table 27. Summary of Differentiating Learning Outcomes for Linear Algebra Courses in High Mathematical Logical Intelligence Using RME (Realistic Mathematics Education) Learning Strategies with DI (Direct Instruction) learning strategies

Group	Difference $\mu A_1B_1 - \mu A_3B_1$	Standard error (Se)	t'	t'(0,05)	Decision
RME (Realistic Mathematics Education) vs DI (Direct Instruction)	16.55	2.816	5.877	2.447	Reject Ho, Accept H1

The average difference between the learning outcomes of linear algebra courses on high logical-mathematical intelligence using the RME (Realistic Mathematics Education) learning strategy and the DI (Direct Instruction) learning strategy of 16.55, the t-count is 5.877, which is greater than the t-table of 2.447. at the 95% confidence level, it can be said that in students with high logical-mathematical intelligence, students who are taught with RME (Realistic Mathematics Education) learning strategies are better than those taught with DI (Direct Instruction) learning strategies.

For students with low logical-mathematical intelligence, students taught using laboratory-based learning strategies are better than those taught using DI (direct instruction) learning strategies.

Based on data analysis on the determination between students who have low logical-mathematical intelligence in students who are taught using laboratory-based learning strategies and students who are taught with DI (direct instruction) learning strategies, the following results are obtained:

Table 28. Summary of Differentiating Learning Outcomes for Linear Algebra Courses in High Mathematical Logical Intelligence Using Laboratory-Based Learning Strategies with DI (Direct Instruction) learning strategies

Group	Difference $\mu A_1B_1 - \mu A_3B_1$	Standard error (Se)	t'	t'(0,05)	Decision
Laboratory vs DI (Direct Instruction)	16.55	1.9249	8.597	2.447	Reject Ho, Accept H1

With the average difference between learning outcomes for linear algebra courses on low mathematical logical intelligence using laboratory-based learning strategies with DI (Direct Instruction) learning strategies of 16.55, the t-count is 8.597, which is greater than t-table of 2.447 at a confidence level of 95. % it can be said that in students who have low logical mathematical intelligence, students who are taught using laboratory-based learning strategies are better than students who are taught using Direct Instruction learning strategies.

For students who have low logical-mathematical intelligence, students who are taught using laboratory-based learning strategies are better than students who are taught using RME (Realistic Mathematics Education) learning strategies.

Based on data analysis on the determination between students who have low logical-mathematical intelligence in students who are taught using laboratory-based learning strategies and students who are taught using RME (Realistic Mathematics Education) learning strategies, the following results are obtained:

Table 29. Summary of Differentiating Learning Outcomes for Linear Algebra Subjects in Low Mathematical Logical Intelligence Using Laboratory-Based Learning Strategies with RME (Realistic Mathematics Education) learning strategies

Group	Difference $\mu A_1B_1 - \mu A_3B_1$	Standard error (Se)	t'	t'(0,05)	Decision
Laboratorium vs RME (Realistic Mathematics Education)	8.57	2.084	4.112	2.447	Reject Ho, Accept H1

With the average difference between the learning outcomes of linear algebra courses on low mathematical logical intelligence using laboratory-based learning strategies with RME (Realistic Mathematics Education) learning strategies of 8.57, the t-count is 4.112 which is greater than the t-table of 2.447 at the confidence level. 95% can be said that in students who have low logical mathematical intelligence, students who are taught with laboratory-based learning strategies are better than students who are taught with RME (Realistic Mathematics Education) learning strategies.

1. In students who have low logical mathematical intelligence, students who are taught with RME (Realistic Mathematics Education) learning strategies are better than students who are taught with DI (direct instruction) learning strategies.

Based on data analysis on the determination between students who have low logical mathematical intelligence in students who are taught using the RME (Realistic Mathematics Education) learning strategy and students who are taught using the DI (Direct Instruction) learning strategy, the following results are obtained:

Table 30. Summary of Differentiating Learning Outcomes for Linear Algebra Subjects in Low Mathematical Logical Intelligence Using RME (Realistic Mathematics Education) learning strategies DI (Direct Instruction) learning strategies

Group	Difference $\mu A_1B_1 - \mu A_3B_1$	Standard error (Se)	t'	t'(0,05)	Decision
RME (Realistic Mathematics Education) vs DI (Direct Instruction)	7.98	2.184	3.652	2.447	Reject Ho, Accept H1

With the average difference between the learning outcomes of linear algebra courses on low mathematical logical intelligence using the RME (Realistic Mathematics Education) learning strategy and the DI (Direct Instruction) learning strategy of 7.98, the t count of 3.652 is greater than the t table of 2.447 at the 95% confidence level, it can be said that in students who have low logical-mathematical intelligence, students who are taught with RME (Realistic Mathematics Education) learning strategies are better than students who are taught with DI (Direct Instruction) learning strategies.

Conclusion

Based on the results of research, data collection, tabulation, processing, assessment, and analysis of all data collected through logical-mathematical intelligence tests and test instruments for learning outcomes for linear algebra courses, as well as hypothesis testing, which includes data analysis, discussion, and statistical calculations, conclusions can be drawn. as follows:

1. There are differences in the learning outcomes of linear algebra courses between students who are taught using laboratory-based learning strategies and students who are trained using DL (Direct Learning) learning strategies, and students who are trained using RME (Realistic Mathematics Education) learning strategies). Based on the mean difference value, laboratory-based learning is better than the RME (Realistic Mathematics Education) learning strategy and DL (Direct Learning) learning strategy.
2. There are differences in linear algebra courses' learning outcomes for students with high and low logical-mathematical intelligence. This is in line with the explanation that highly intelligent people will more easily accept or understand lessons.
3. There is an interaction between learning strategies and logical-mathematical intelligence on linear algebra learning outcomes. Based on the study's results, it is explained that the collaboration between learning strategies and logical-mathematical intelligence is a form of interaction or influence of learning strategies on learning outcomes of linear algebra courses on mathematical, logical intelligence, or vice versa.
4. For students with high logical-mathematical intelligence, students taught using laboratory-based learning strategies are better than those taught using DI (direct instruction) learning strategies.
5. For students with high logical-mathematical intelligence, students taught using laboratory-based learning strategies are better than those taught using RME (Realistic Mathematics Education) learning strategies.
6. For students with high logical-mathematical intelligence, students taught with RME (Realistic Mathematics Education) learning strategies are better than those taught with DI (direct instruction) learning strategies.
7. For students with low logical-mathematical intelligence, students taught using laboratory-based learning strategies are better than those taught using DI (direct instruction) learning strategies.
8. For students with low logical-mathematical intelligence, students taught using laboratory-based learning strategies are better than those taught using RME (Realistic Mathematics Education) learning strategies.
9. For students with low logical-mathematical intelligence, students taught using the RME (Realistic Mathematics Education) learning strategy are better than those taught the DI (direct instruction) learning strategy.

References

Ainulluluah, A., Boeriswati, E., Rahmawati, Y., & Setiawan, B. 2022. Systematic Literature Review: Improving Self Regulated Learning Through The Flipped Classroom Model Based on Interactive E-Books. *Jurnal Basicedu*, *6*(3), 4681–4690.

Andayani, A., Saputra, A. H., Irianto, E., & Setiawan, B. 2022. GESAMSU (Gedrik Saruk Memang Seru) Based Environmental: Effectiveness Of Games On Mathematics Communication Ability Of Elementary School Students. *AL-ISHLAH: Jurnal Pendidikan*, *14*(2), 2359–2368.

Anton, Howard. Aljabar Linear Elementer . Jakarta: Erlangga, 1987.

Anton, Howard dan Chris Rorres. Penerapan Aljabar Linear .Jakarta: Erlangga, 1987.

Damayanti, F. A., & Surjanti, J. 2022. Application of PBL with ESD Context in Improving Learning Outcomes and Sustainability Awareness of Learners. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *18*(1), 93–105.

Darmawijaya, Soeparna. Pengantar Analisis Real. Yogyakarta: Matematika MIPA UGM Press, 2006.

Dewantara,K. H. Pendidikan, cetakan kedua. Yogyakarta: Majelis Luhur Persatuan Taman Siswa.

Harsanti, A. G. 2018. Pengembangan Perangkat Pembelajaran dengan Menggunakan Outbond untuk Peningkatan Perilaku Sosial Siswa Kelas IV SDN 01 Tawangrejo. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *14*(25), 21–29.

Iasha, V., Rachmadtullah, R., Sudrajat, A., & Hartanti, D. 2019. The impact interactive learning media on the learning outcomes of fifth grade social science knowledge in elementary schools. *ICTES 2018: Proceedings of the First International Conference on Technology and Educational Science, ICSTES 2018, November 21-22 2018, Bali, Indonesia*, 103.

Irawan, S., & Iasha, V. 2021. Core Learning Model and Mathematical Disposition, Against Mathematics Problem Solving Ability of Elementary School Students. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(2), 122–129.

Joice, Bruce., Marsha Weil dan Emily Calhoun. Models Of Teaching, Model-Model Pengajaran. terjemahan Achmad Fawaid dan Ateilla Mirza. Yogyakarta: Pustaka Pelajar, 2009.

Mujiati, S. 2020. Upaya Menjaga Kebersihan Sekolah Pada Saat Covid 19 Dengan Memberdayakan Tenaga Guru Di SDN Pekayon 03 Kec. Pasar Rebo Jakarta Timur. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *16*(30), 194–202.

Negoro, St dan B. Harahap. Ensiklopedia Matematika. Bogor: Ghalia Indonesia, 2005.

Rasyad, Rasdiyah. Logika Aljabar Untuk Umum. Jakarta: Grasindo, 2003.

Richard E. Mayer, Richard. E., Multi-Media Learning. Yogyakarta: Pustaka Pelajar, 2009.

Richard E. Mayer, Richard. E., Multi-Media Learning. Yogyakarta: Pustaka Pelajar, 2009.

Setiawan, B., Fanani, A., Wardani, I. S., & Triman Juniarso, M. P. 2022. *ILMU ALAMIAH DASAR*. CV. EUREKA MEDIA AKSARA.

Setiawan, B., Rachmadtullah, R., Sugandi, E., & Farid, D. A. M. 2022. Pelatihan Pembuatan Media Pembelajaran Berbasis Augmented Reality Pada Kelompok Kerja Guru Sekolah Dasar Desa Kemasantani Mojokerto. *Etos: Jurnal Pengabdian Masyarakat*, *4*(1), 72–79.

Smaldino, Sharon E., et. al., Instructional Technology and Media For Learning. New Jersey: Pearson-Merrill Prentice Hall, 1993.

Soekardijo, R. G. Logika Dasar, Tradisional, Simbolik, dan Induktif. Jakarta: Gramedia Pustaka Utama, 1997.

Subroto, W. T. 2022. The Effect of Time Management on Economics Learning Outcomes for Class X SMA Labschool Unesa During Online Learning. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *18*(1), 81–92.

Sudrajat, A., Iasha, V., & Femayati, F. 2018. The Influence of the Use of Cooperative Learning Model Jigsaw & Two Stay Two Stray and the Learning Interest Result on 5th Grade Social Science. *ICEAP*, *2*(2), 28–33.

Sudrajat, A., Lovienica, M., & Iasha, V. 2021. Pengaruh Model Resource Based Learning Terhadap Hasil Belajar Ilmu Pengetahuan Sosial (IPS) Siswa Kelas IV SD Sekolah Dasar. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(1), 70–75.

Sumantri, M. S., Gandana, G., Supriatna, A. R., Iasha, V., & Setiawan, B. 2022. Maker-Centered Project-Based Learning: The Effort to Improve Skills of Graphic Design and Student's Learning Liveliness. *Journal of Educational and Social Research*, *12*(3), 192–192.

Sumilat, J. M., Tuerah, R. M. S., & Setiawan, B. (2022). The Utilization of Online Media in Calculation Operations Mathematics Learning in Elementary School Students. *Journal of Educational and Social Research*, *12*(3), 90.

Suryani, A., & Selegi, S. F. 2022. Analysis of Mathematical Problem-Solving Ability Materials on the Volume of Building Spaces in Class V Students of SDN 176 Palembang. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *18*(1), 26–34.

Suryanto, S., Zulela, M. S., Noornia, A., & Iasha, V. 2017. Pengembangan Modul Pembelajaran Matematika Berbasis Penemuan Terbimbing tentang Pengukuran di Kelas IV Sekolah Dasar. *Jurnal Pendidikan Dasar*, *8*(2), 123–134.

Undang-Undang Republik Indonesia Nomor 20 Tahun 2003 tentang Sistem Pendidikan Nasional Bab II. Dasar, Fungsi dan Tujuan Pasal 3

Uno, Hamzah. B, dan Masri Kuadrat. Mengelola kecerdasan dalam Pembelajaran. Jakarta: Bumi Aksara, 2014.

Utomo, G. M., Setiawan, B., Rachmadtullah, R., & Iasha, V. 2021. What Kind of Learning Media do You Want? Need Analysis On Elementary School Online Learning. *Jurnal Basicedu*, *5*(5), 4299–4305.

Wahyudiana, E., Sagita, J., Iasha, V., Setiantini, A., & Setiarini, A. 2021. Problem-Based Learning-Based IPA Practicum Module to Improve Problem-Solving Ability. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan*, *17*(2), 161–167.

Wantika, R. R. 2017. Pembelajaran kooperatif tipe tai berdasarkan teori beban kognitif. *Buana Pendidikan: Jurnal Fakultas Keguruan Dan Ilmu Pendidikan Unipa Surabaya*, *13*(23), 41–46.

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