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HOW DISCOVERY LEARNING AFFECT STUDENTS' NUMERACY? A CASE ON STATISTICS MATERIAL

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ABSTRACT

The numeracy skills of students in Indonesia are an important focus, as reflected in the 2022 PISA results. Numeracy skills are a crucial part of the global curriculum, which aims to help learners develop the ability to think logically and understand data, graphs, and mathematical information increasingly relevant in modern life. This study was conducted to examine the impact of the discovery learning approach on students' numeracy skills, specifically within the context of learning statistical concepts. This research is quantitative research. With a non-equivalent control group and a posttest, this study employed a quasi-experimental design. The experimental class and the control class were conducted in classes X-5 and X-6 at one of the Jakartan high schools utilizing the researchers' sampling technique, purposive sampling. A written test with five questions is used as the data collecting tool in this study to get information on numeracy abilities. The result of this study used logit data processing show that discovery learning. Based on the results of logit data processing which shows that the average value of the experimental class (0.4039) is greater than the control class (0.0697) after treatment. T-test shows a significant difference between the experimental class and the control class with a Sig value. 0.001 <0.05. To strengthen the t-test, researchers analyzed the effect size, obtained a Cohen's d value of 0.835901 with strong criteria. it can be concluded that there is an effect of the discovery learning model through a numeracy approach on students' numeracy skills in statistics.

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INTRODUCTION

Today's education must produce graduates who are proficient in 21st century skills, an educational process that is able to produce human resources with critical thinking skills is now a major concern at the global level. Learners need to be skilled in two key areas, namely literacy and numeracy (Sani, 2021). The numeracy skills of students in Indonesia are an important

focus, as reflected in the 2022 PISA results released (OECD, 2022), with math achievement dropping to 366 points and only 18% of learners reaching the minimum standard of numeracy, reflected a major challenge in Indonesia's education system. However, according to data from Indonesia's Education Report Card for 2024 (Kemendikbudristek, 2024), Students' numeracy skills increased by 18.68% to 66.3%. However, this figure is still in the medium category, so strategic steps are needed to improve the overall numeracy quality.

Numeracy is one of the essential skills in facing the data and information era. Various aspects of life, including education, require numeracy, which is the ability to absorb, understand, and critically analyze facts. Numeracy is essential in education as it equips learners with the skills to use mathematics confidently in a variety of contexts encouraging critical thinking, problem solving, and informed citizenship, ultimately preparing them to face challenges in the real world and improving overall academic success (Goos & Sullivan, 2016). Numeracy skills are a crucial part of the global curriculum, which aims to help learners develop the ability to think logically and understand data, graphs, and mathematical information increasingly relevant in modern life (OECD, 2022). Related to the Indonesian education system, statistics is one of the basic skills that must be possessed by students (Tenny et al., 2021).

Learners often find it difficult to understand statistical material, due to various challenges. One of the main challenges is their inability to understand basic statistical concepts, such as mean, median and mode. Many students find it difficult to apply these formulas to given data, especially when dealing with group data. Findings from a number of studies show that the percentage of students who can answer correctly is still minimal, while the average ability to solve problems only reaches 68% (Nahdia & Kirana, 2023). This problem is also influenced by an approach that is still too conceptual and does not sufficiently link the material with its application in real life. Because of this problem, students are less motivated and interested in learning statistics (Putri et al., 2023). This causes many students to have difficulty understanding the topic and often make mistakes when working on problems related to statistics (Hafizh & Ramadoni, 2023).

According to probondadi (Ilfa et al., 2023) each learner has different types of intelligence, including logical-introspective, existential and naturalistic intelligence. Therefore, educators need to understand these differences to ensure each learner gets the right approach. To achieve learning objectives, educators must be adept at organizing and guiding their learners' learning activities (Sa'dijah et al., 2023). The discovery learning technique is one of the learning strategies that has been shown to maximize teaching and learning activities. To guarantee that the learning process yields the best results, educators must find the appropriate answers when putting it into practice. Experts claim that the discovery learning model is a procedure in which students must actively engage in learning new ideas or concepts while the material is being delivered in its entirety (Lisbeth, 2023).

Discovery learning has become one of the most popular approaches in education. This approach emphasizes students' active involvement in the learning process, where they are expected to pick up knowledge through research and practical application (Juandi & Khairunnisa, 2022). Learning is an active process in which students build new ideas or concepts using both new and old knowledge. Students that participate in discovery-based learning typically have a deeper and better understanding of the course materials (Sulaiman, 2022).

Discovery learning is a method of instruction that promotes pupils to investigate and learn on their own, making the content more enduring and memorable (Ardelina et al., 2021). Research at SD Swasta Free Methodist 1 Medan showed how the use of a discovery learning approach significantly improved the mathematical numeracy literacy of grade V students in terms of data processing and presentation of material (Marpaung et al., 2024). In addition, research conducted

at MTs Negeri Gantiwarno, Klaten, showed that the discovery learning approach can improve students' mathematical literacy (Mulyati et al., 2024).

This study's major purpose is to find out how the discovery learning paradigm influences students' numeracy abilities in the context of statistics training. The study explicitly intends to determine whether employing discovery learning significantly boosts students' grasp of statistical concepts and their ability to apply these concepts in real problem-solving contexts. Additionally, this study intends to empirically support the integration of discovery-based instructional approaches in mathematics education by emphasizing the importance of numeracy as a critical component of 21st-century capabilities.

METHOD

This research is quantitative research. This research involves observing a specific sample population, where data is collected using research measurement tools, then analyzed numerically and statistically to validate the hypotheses that have been formulated at the beginning of the research (Sugiyono, 2015). With a non-equivalent control group and a posttest, this study employed a quasi-experimental design. The experimental class and the control class were conducted in classes X-5 and X-6 at one of the Jakartan high schools utilizing the researchers' sampling technique, purposive sampling. both samples are given treatment without a pretest, so that the posttest results will be used to see the state of students' numeracy skills after treatment, and will be measured by effect size, which is a test used to measure the extent of the effect of treatment on students' numeracy skills with the cohen's d effect size formula.

Table 1. Post-test with non-equivalent control group design

Class		**posttest**
Experiment	X	O_e
Control		O_k

Keterangan:

X : Discovery Learning Methode

O_e : Experiment Class

O_k : Control Class

A written test with five questions is used as the data collecting tool in this study to get information on numeracy abilities. Where the questions are arranged based on 3 indicators of numeracy skills, namely knowing, applying, and reasoning (Sani, 2021). Since excellent research questions are ones that have undergone validity and reliability testing, the Rasch model (Winstep) was then used to conduct the validity and reliability tests of the 5 questions

Winstep was used to process the data from the Rasch model study. More than 75 respondents' data can be processed by this software. There were 136 responders to the five question items that made up this numeracy skills tool. Consequently, Winstep software can be used to produce the data collected from the respondents.

Up to 136 respondents participated in the validity and reliability tests conducted at validation schools for this studyThe correlation values of the outfit mean squares, outfit z-standards, and point measurements can be used to account for normal item functioning in research that uses validity testing with the Rasch model. Table 5 lists the criteria that were used to test item fit. The object can be deemed "appropriate" and its quality and suitability for usage are assured if the three requirements listed in Table 2. The item may be kept in order for it to be categorized and used if only two or one of the requirements are satisfied. The item is "inappropriate" and has to be fixed or replaced if none of the three requirements are satisfied.

Table 2. Criteria for Validity

Criteria	Score
Outfit mean square (MNSQ)	0.5 < MNSQ < 1.5
Outfit Z-standart (ZSTD)	-2.0 < ZSTD < +2.0
Point Measure Corr.	0.4 < Pt Measure Corr < 0.85

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
1	1127	136	-.15	.04	1.01	.1	1.09	.8	A .77	.78	15.6	15.6	P1
4	1123	136	-.15	.04	1.02	.2	1.06	.6	B .79	.78	14.8	15.3	P4
3	728	136	.43	.04	.94	-.4	1.04	.3	C .71	.70	14.8	18.2	P3
5	1369	136	-.46	.04	1.03	.3	1.04	.3	b .83	.83	12.5	15.6	P5
2	784	136	.33	.04	.79	-1.6	.84	-1.2	a .74	.72	19.5	18.0	P2
MEAN	1026.2	136.0	.00	.04	.96	-.3	1.01	.1			15.5	16.5	
S.D.	238.6	.0	.33	.00	.09	.7	.09	.7			2.3	1.3	

Figure 1. Item Order (Validity)

Figure 1 shows that the results of the 5 question items meet all outfit value criteria, both MNSQ, ZSTD, and Pt Measure Corr. So it can be concluded that the 5 items are valid and suitable to be used as measuring instruments in this study.

Table 3. Interpretation Reliability

Score	Intepretation
a > 0.8	Very high
0.7 < a ≤ 0.8	High
0.6 < a ≤ 0.7	Fair
0.5 < a ≤ 0.6	Low
a < 0.5	Very low

The updated student numeracy test is used to evaluate the numeracy skills of grade X SMA students in order to determine the instrument's reliability. The interpretation is shown in Table 3. The dependability of this study is demonstrated by the Cronbach Alpha, item reliability, and person reliability values. The presented summary data are used to evaluate the instrument's reliability.

SUMMARY OF 136 MEASURED (EXTREME AND NON-EXTREME) Person

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	37.7	5.0	-.58	.26				
S.D.	16.9	.0	.91	.26				
MAX.	66.0	5.0	.51	1.27				
MIN.	5.0	5.0	-3.31	.17	.07	-2.4	.10	-2.3
REAL RMSE	.39	TRUE SD	.83	SEPARATION	2.14	Person RELIABILITY		.82
MODEL RMSE	.37	TRUE SD	.84	SEPARATION	2.27	Person RELIABILITY		.84
S.E. OF Person MEAN = .08								

Person RAW SCORE-TO-MEASURE CORRELATION = .93
CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .87

SUMMARY OF 5 MEASURED (NON-EXTREME) Item

	TOTAL SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	1026.2	136.0	.00	.04	.96	-.3	1.01	.1
S.D.	238.6	.0	.33	.00	.09	.7	.09	.7
MAX.	1369.0	136.0	.43	.04	1.03	.3	1.09	.8
MIN.	728.0	136.0	-.46	.04	.79	-1.6	.84	-1.2
REAL RMSE	.04	TRUE SD	.33	SEPARATION	8.63	Item RELIABILITY		.99
MODEL RMSE	.04	TRUE SD	.33	SEPARATION	8.68	Item RELIABILITY		.99
S.E. OF Item MEAN = .17								

Figure 2. Summary Statistic (Reliability)

Figure 2, The findings are higher than 0.8 or can be considered extremely good, according to the values of Person Reliability, Cronbach Alpha, and Item Reliability, respectively. Therefore, it may be said that the instrument's dependability test for item quality is highly dependable.

RESULTS AND DISCUSSION

Results

The study's conclusions are based on quantitative data from the posttest of the numeracy abilities of 72 students in the experimental and control classes. The person measure or logit data, which will be used as the study's analytical data, is subsequently obtained by processing the posttest results using the Rasch model.

The data of this research is quantitative data obtained from the numeracy test instrument. Before the posttest, the researcher gave the treatment of discovery learning model with numeracy approach for experimental class and conventional model for control class. Data analysis in the study used logit data. Where the logit data is obtained from the results of the instrument that has been done by students, which then the score is processed through the Rasch model to find the person measure. The degree to which persons and items can be combined to approximate this type of invariance determines the utility of person measures and the item calibrations that make them possible (Wright & Masters, 1982). The person measure is the logit location that best predicts the observed response pattern (D. Wright & H. Stone, 1979).

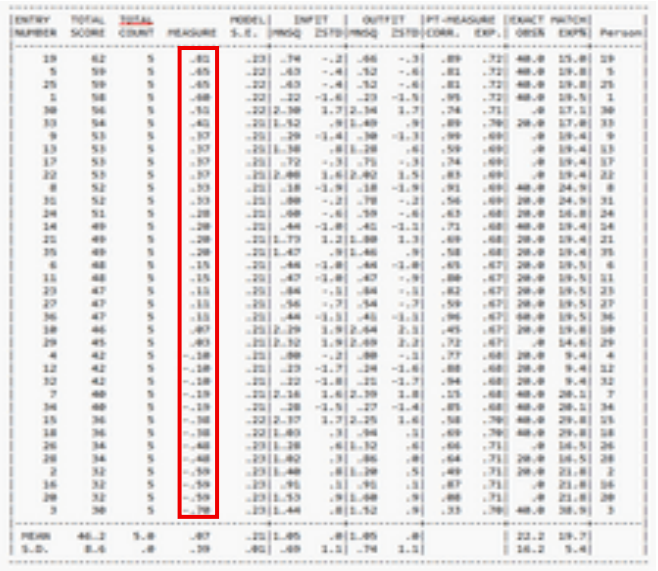

Figure 3. Person Measure control class

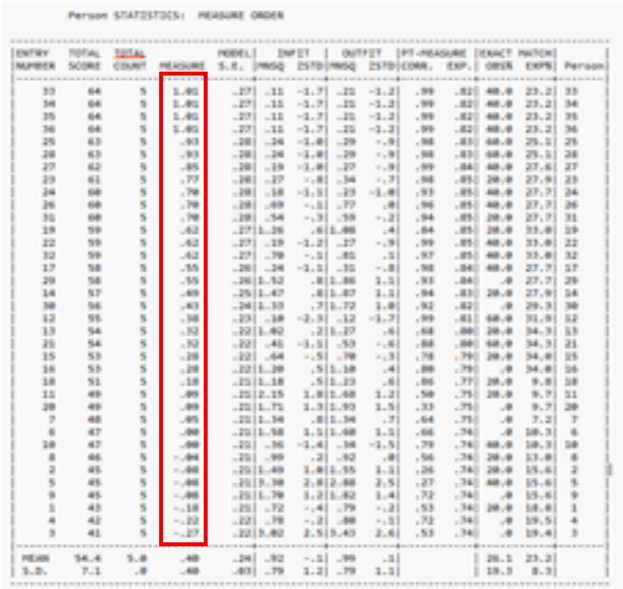

Figure 4. Person Measure Experiment Class

Additionally, the data measure of both classes was used to perform the necessary analytical tests, the Levene homogeneity test and the Kolmogorov-Smirnov normality test, using IBM SPSS Statistics 26.

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Kontrol_Logit	.124	36	.181
Eksperimen_Logit	.116	36	.200*

Figure 5. Normality Test

According to Figure 5. The Sig. Given that the experimental class's Sig. value is 0.200 and the control class's is 0.181, it can be said that both sets of data are normally distributed.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nilai_Logit	Equal variances assumed	.214	.645	-3.546	70	.001	-.33417	.09424	-.52211	-.14622
	Equal variances not assumed			-3.546	69.996	.001	-.33417	.09424	-.52211	-.14622

Figure 6. Homogeneity Test

Based on figure. 6. The Sig. 0.645>0.05 is Levene's test for equality of variance. This indicates that there is a uniform data variance between the experimental and control classes. The requirements are satisfied since the two classes' prerequisite test scores are homogeneous and normally distributed, allowing the t-test to be performed and the effect size to be determined.

Figure. 6. Assuming equal variances, the t-test for equality of means is performed when the Sig. (2-tailled) value is 0.001 <0.05. The average statistical value of the experimental class and the control class differs significantly, as indicated by the rejection of H0 and acceptance of Ha. The Cohen's d effect size test was then performed to support the findings of the t-test.

	Kelas_Logit	N	Mean	Std. Deviation	Mean
Nilai_Logit	1.00	36	.0697	.39826	.06638
	2.00	36	.4039	.40135	.06689

Figure 7. Statistical group

Based on Figure. 7 . The mean score of the control class was 0.0697, whereas the experimental class achieved a mean score of 0.4039. Descriptive analysis indicates a difference in the average numeracy skill scores between the two groups. To assess the significance of this difference, an effect size analysis was conducted using Cohen's d formula (Cohen, 1977).

Table 4. Effect size criteria

d-value	**criteria**
0,8 < d <2,0	Strong
0,5 < d < 0,8	Medium
0,2 < d < 0,5	weak

$$Cohen's\ d = \frac{M_2 - M_1}{\sqrt{\frac{(SD_1^2 + SD_2^2)}{2}}}$$

Using the previously mentioned formula, M_2 represents the experimental class mean, M_1 represents the control class mean, SD_1 represents the control class standard deviation, and SD_2 represents the experimental class standard deviation. such that 0.835901 is the outcome of Cohen's d. Table 4. The findings indicate that the use of the discovery learning model has a

substantial effect on students' numeracy skills, as evidenced by a strong effect size according to the established criteria for Cohen's d.

Based on the statistical findings derived from the t-test, the value of F = 0.214 with Sig. 0,641. With this value, the data is said to be homogeneous because Sig.>0.05. In the equal variences assumed column which shows a t-value of -3.546 at df 70 with Sig. (2-tailled) 0.001, because the t-value obtained is negatively distributed, The Ha criterion is approved since the class employing the discovery learning approach is notably different from the class using the traditional methodology. In order to support this, researchers looked at the cohen's d value while analyzing the effect magnitude. The class that used the discovery learning model using the numeracy method and the class that used the conventional model differed significantly, as indicated by the cohen's d value of 0.835901 with high criteria.

Discussions

The implementation of the Discovery Learning model has been empirically shown to significantly enhance students' numeracy skills. This outcome is consistent with the findings of (Marpaung et al., 2024), who applied the same pedagogical model to develop mathematical numeracy literacy among elementary school students at SD Swasta Free Methodist 1 Medan. Their study reported meaningful improvement, particularly in areas such as data organization and presentation competencies central to statistical literacy. The alignment between these findings highlights the pedagogical consistency and effectiveness of Discovery Learning across diverse educational settings.

Furthermore, the research conducted by (Mulyati et al., 2024) at SMP Negeri 5 Pontianak further corroborates the positive impact of Discovery Learning on mathematical literacy. Although their investigation addressed broader dimensions of mathematical competence, the study also identified clear advancements in specific numeracy skills, including data interpretation and problem-solving. These results underscore the importance of adopting instructional approaches that support exploratory learning and foster learner independence in strengthening numeracy proficiency.

On a wider scale, (Gal et al., 2020) explored the significance of numeracy within adult education, particularly among marginalized groups. Their findings revealed that inadequate numeracy skills can severely limit individuals' ability to participate in vital socio-economic activities. This underscores the necessity of building strong numeracy foundations from an early age, with Discovery Learning emerging as a promising approach due to its focus on analytical reasoning, problem-solving, and learner autonomy—critical skills for addressing real-world challenges.

Similarly, the study by (Celemin, 2023), which focused on improving Grade 3 students' numeracy through Authentic Performance Tasks, emphasizes the effectiveness of contextualized, experiential learning. While differing in instructional design, both Authentic Tasks and Discovery Learning share a commitment to engaging students in meaningful, application-based learning experiences. This similarity reinforces the notion that Discovery Learning can foster deeper conceptual understanding through active, hands-on engagement.

Lastly, the research conducted by (P, 2023)examining student performance on PISA-type assessments further validates the global importance of numeracy. The study revealed that students accustomed to solving contextual, data-driven problems tend to demonstrate superior performance. This finding aligns with the foundational principles of Discovery Learning, which emphasize independent inquiry, critical thinking, and data analysis. Collectively, these studies establish Discovery Learning as an effective instructional framework for equipping students with practical, transferable numeracy skills that extend beyond academic settings.

CONCLUSION

The study's findings clearly demonstrate that using the discovery learning paradigm greatly improves students' numeracy skills in statistical curriculum areas. This teaching strategy encourages the growth of critical thinking abilities, problem-solving skills, and a deeper comprehension of statistical ideas in practical contexts by placing an emphasis on students' active engagement in independently discovering and producing knowledge. The efficacy of the strategy was demonstrated by the experimental group's students' notably higher numeracy scores compared to those of the control group. These results demonstrate how effective discovery learning can be as a teaching strategy for enhancing numeracy, particularly in domains like data interpretation, graphical analysis, and statistical reasoning.

Given these results, educators ought to incorporate discovery learning into math curricula more frequently, especially for topics like statistics that require a deep understanding of concepts and practical application. For implementation to be successful, teachers must have access to targeted professional development that equips them with the skills necessary to design and facilitate cognitively appropriate, discovery-oriented learning experiences. Further research is required to evaluate the discovery learning model's broader application across various topic domains and educational levels in order to provide a more thorough evaluation of its instructional efficacy.

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