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ENHANCING STUDENT NUMERACY AND LITERACY WITH GEOGEBRA: A CASE IN NUMERICAL METHODS

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ABSTRACT

Rapid advancement in technology has increased the significance of numerical literacy skills. The numerical methods course requires numerical literacy skills. The course enables students to solve a mathematical problem by interpreting the answer using an approximation rather than an actual value. This research used a descriptive quantitative method. The population of this study consisted of 80 university students enrolled in a numerical methods course. The sampling technique used a saturated sample, which involved everyone in the population as the sample. Data were collected from the learning outcomes test and questionnaire responses. The data were analyzed using a quantitative descriptive statistical analysis technique, and the data analysis computations were performed using SPSS Statistics 2. The study showed that the students' Numeracy and Literacy Skills improved when GeoGebra-assisted teaching materials were implemented in the numerical methods.

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INTRODUCTION

Rapid technological advancement makes improving students' numerical literacy skills crucial. GeoGebra is one of the technology tools that can be used in mathematics learning. In the Numerical Methods, GeoGebra can be used as an interactive learning tool to help students solve numerical problems more easily while displaying graphs. Geogebra can describe the surface of a graph using the Surface command, define the function f (x, y), or enter an equation with up to three variables (Hoffman, 2015). A study by Samura & Darhim (2023) indicated that students who learned mathematics using GeoGebra improved their mathematical critical thinking skills more than those who did not use GeoGebra.

GeoGebra can also be used for mathematical modeling of problems about numerical literacy. This numerical literacy ability is not only required by students in schools but is also needed by university students to solve mathematical problems. Therefore, numerical literacy needs to be developed systematically and continuously to achieve optimal results and comprehend and apply mathematical knowledge effectively in facing life's challenges (Putri Purwaningrum et al., 2022).

Literacy is understanding, evaluating, using, and engaging with written texts to participate in society, achieve certain goals, and develop one's knowledge and potential (OECD, 2012). Hartatik (2020) defined numerical literacy as the ability of students to describe information related to numbers or mathematics, then formulate a problem, analyze the problem, and find a solution to the problem. According to Tampa et al. (2022) and Ekowati et al. (2019), numerical literacy can be viewed as someone's ability to use reasoning, referring to understanding and analyzing a statement through activities involving the manipulation of symbols or mathematical language found in daily life. Similarly, Pangesti (2018) stated that numerical literacy encompasses three key abilities: (1) applying number concepts and arithmetic operations skills in everyday life, (2) interpreting quantitative information from their environment, and (3) appreciating and comprehending mathematically expressed information, such as graphs, charts, diagrams, and tables.

One indicator of a nation's educational quality could be viewed as the numeracy proficiency of its students, which could be measured by the PISA test results (Kurniawati & Kurniasari, 2019). Furthermore, the PISA test results showed that Indonesia students still faced difficulties solving levels 1 and 2 problems (Masfufah & Afriansyah, 2021). This issue

should be addressed immediately through mathematics education at the university level, which integrates problems related to mathematical literacy. This approach could help students acquire strong Numeracy and Literacy Skills for future teaching instructions.

One of the courses that emphasizes numerical literacy is the numerical methods course. In this course, students should solve numerical problems without having to find a definite solution; however, students are required to interpret the answer as an approximation. In the numerical methods course, real-life problems can be solved in six steps: modeling, model simplification, numerical formulation, programming, operations, and evaluation (Wulan, 2016). These stages are closely related to Numeracy and Literacy Skills indicators, which involve using various types of numbers and symbols from basic mathematics to solve practical daily-life problems in various contexts and analyzing information displayed in various forms (graphs, tables, charts, and so on) before interpreting the findings to make predictions, conclusions, and decisions (Han et al., 2017).

Based on the aforementioned explanation, the researcher is interested in conducting a study on students' numeracy and literacy skills through the implementation of Geogebra-Assisted teaching materials in numerical methods course. This study aims to determine students' Numeracy and Literacy Skills using GeoGebra-assisted teaching materials in a numerical methods course, which sets it apart from the previous studies. The teaching materials used in the problems came from a book on GeoGebra-Assisted Numerical Methods from a study developed by a team of authors (Listiana, Aklimawati, Wulandari, Suandana, et al., 2022). The outcomes of the numerical literacy test in the Numerical Methods course were used to gauge the student's numerical literacy abilities.

METHOD

This research used a quantitative descriptive method, which aims to describe, examine, and explain a phenomenon with the original data (numbers) without involving any hypothesis testing. The research site was in the Mathematics Education program at Malikussaleh University. The population in this study was 80 university students enrolled in a numerical methods course. The study used a saturated sampling technique in which all population members were included as samples.

Data were collected from tests and questionnaires. The learning process, which implemented GeoGebra-assisted teaching materials in the numerical methods course, was

carried out in two meetings. Following the two meetings, students were given a test to determine the ability of numerical literacy to solve the given problems. Subsequently, a questionnaire was given to students to evaluate their responses to the learning process by implementing teaching materials assisted by GeoGebra in the numerical methods course.

Data analysis in this research used a descriptive statistical analysis technique by calculating the frequency, percentage, mean, median, mode, standard deviation, maximum value, minimum value, and range (see figure 1). These variables were used to evaluate the characteristics, relationships, similarities, and differences in students' numerical literacy skills. The calculations in the data analysis were carried out by utilizing SPSS Statistics 26.

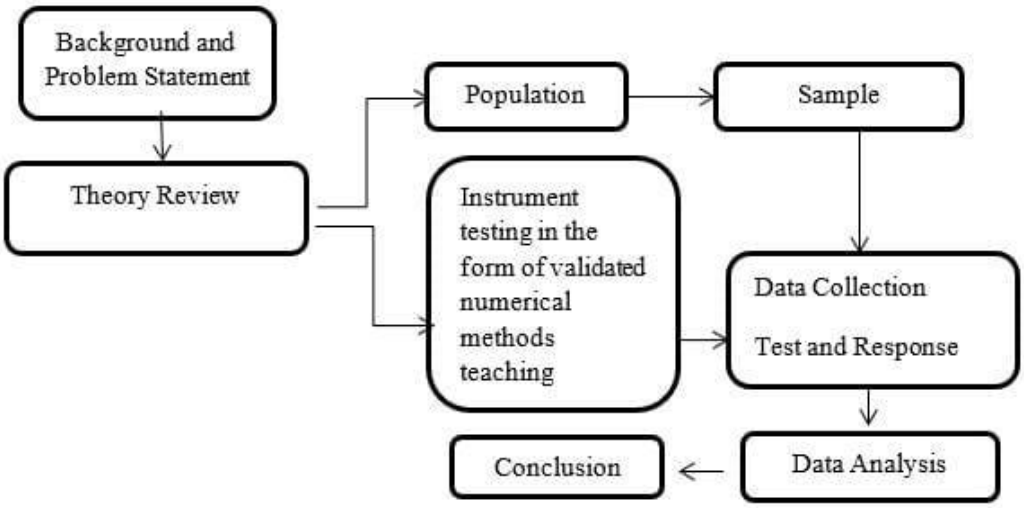

Figure 1. Research Methodology

The test items about numerical literacy skills, which consisted of five problems, were validated before being used in the study. Based on the validation results, only two problems were selected for the study. One problem was used for the first meeting, and another was used for the second. The following problem was used for the first meeting.

1. A company will make cube-shaped product packages in two different sizes. The company determined the total volume of the two packages to be $300 cm^3$, with the length of the first edge 5 cm longer than the second edge.
   a. Form an algebraic equation to solve the problem!
   b. Draw the function graph of the algebraic equation!
   c. Solve it using the Bisection Method with the interval [1,2], then compare your answer using the GeoGebra application.

d. What are the edges of each cube that can be used to make the product packages?

The following problem was used for the second meeting.

1. A company will make tube-shaped product packages in two different sizes with the following conditions: the volume of the two tubes has a ratio of 1:5, the radius of the second tube is 2 cm longer than the radius of the first tube, the height of the first tube is equal to 2 times its radius, and the height of the second tube is equal to 3 times the height of the first tube.
   a. Form an algebraic equation to solve the problem!
   b. Draw the function graph of the algebraic equation!
   c. Solve using the Falsi Regula Method with the interval [6,7], then compare your answer using the GeoGebra application
   d. What are the radii of each possible tube?

Table 1 presents the numerical literacy test grid based on the indicators.

Table 1. Numerical Literacy Test Grid

Numerical literacy Indicator	Problem Indicator	Problem Number
1. Use a wide variety of numbers and symbols related to basic mathematics to solve practical problems in a variety of daily life contexts	Able to use numbers and symbols in forming algebraic equations to solve problems	1a
2. Able to analyze information displayed in various forms (graphs, tables, charts, etc.).	Able to analyze information about algebraic equations in the form of function graphs	1b
3. Use the interpretation of the analysis results to predict and make conclusions and decisions.	Able to interpret the results of information analysis to predict the roots of algebraic equations using numerical method	1c
	Able to interpret the results of analyzing information about the roots of algebraic equations to draw conclusions	1d

Based on the numerical literacy instrument scoring guidelines, the minimum score is 1, the maximum score is 4, and not answering is 0.

RESULT AND DISCUSSION

Results of Students' numeracy and literacy tests

The results of students' numerical literacy tests during 2 meetings are displayed in Table 2.

Table 2**.** Table of Statistics for Numerical Literacy Test Results

Statistics

	Meeting 1	Meeting 2
N	80	80
Mean	74.8500	87.8875
Median	75.0000	88.0000
Mode	75.00	94.00
Std. Deviation	12.28573	10.25991
Minimum	25.00	44.00

Maximum	100.00	100.00
Sum	5988.00	7031.00

Based on the table above, the average test scores of 80 students in Meeting 1 and Meeting 2 were 74.85 and 87.88, respectively. The data median in Meeting 1 was 75, while the median value in Meeting 2 was 88. The data in Meeting 1 had a mode of 75, while in Meeting 2, the mode was 94. Based on these data, the results of the numerical literacy test from Meeting 2 were better than the results from Meeting 1. The percentage of the value of each meeting can be seen in Table 3.

Table 3. Table of Frequency Distribution of Numerical Literacy Skills

Meeting 1				Meeting 2			
		Frequency	Percent			Frequency	Percent
Value	25.00	1	1.3	Value	44.00	1	1.3
	44.00	2	2.5		56.00	1	1.3
	56.00	3	3.8		63.00	3	3.8
	63.00	8	10.0		69.00	1	1.3
	69.00	10	12.5		75.00	3	3.8
	75.00	29	36.3		81.00	10	12.5
	81.00	14	17.5		88.00	23	28.7
	88.00	7	8.8		94.00	31	38.8
	94.00	2	2.5		100.00	7	8.8
	100.00	4	5.0		Total	80	100.0
	Total	80	100.0				

Based on Table 3, one student had the lowest score of 25, with a percentage of 1.3%, in the first meeting. Four students (5%) obtained the highest score of 100. The most common score was 75, received by 29 students (36.3%). Meanwhile, one student (1.3%) got the lowest score of 44 in the second meeting. Only seven people (8.8%) received the highest score of 100. The most common score in the second meeting was 94, received by 31 students (38.8%).

An analysis of each item was carried out to evaluate the students' Numeracy and Literacy Skills based on the indicators. The analysis results of each item for Meeting 1 can be seen in Table 4.

Table 4. Test Results Based on Numeracy and Literacy Skills Indicators

Meeting 1					Meeting 2				
	1a	1b	1c	1d		1a	1b	1c	1d
N	80	80	80	80	N	80	80	80	80
Mean	2.96	2.53	3.01	3.46	Mean	3.91	2.93	3.55	3.64
Median	3.00	2.50	3.00	4.00	Median	4.00	3.00	4.00	4.00
Mode	3	2	3	4	Mode	4	3	4	4
Std. Deviation	.683	.795	.755	1.067	Std. Deviation	.326	.823	.614	.971
Minimum	1	0	1	0	Minimum	2	0	2	0
Maximum	4	4	4	4	Maximum	4	4	4	4
Sum	237	202	241	277	Sum	313	234	284	291

Table 4 indicated that the lowest average score in the first meeting was in Problem 1b, the second indicator analyzing the information displayed in graphical form, with an average

score of 2.53. The highest score resulted from Problem 1d with an average score of 3.46, which was the 3rd indicator using the interpretation of the analysis results to predict and draw conclusions and decisions.

In Meeting 2, the lowest average score resulted from Problem 1b with an average score of 2.93, indicator 2 analyzing the information displayed in the form graphs. Meanwhile, the highest score was obtained from Problem 1a with an average score of 3.91, which was the first indicator using various numbers and symbols related to basic mathematics to solve practical problems in various contexts of everyday life. Table 5 the analysis result on Problem 1b (2nd indicator of numerical literacy skills).

Table 5. Table of Frequency Distribution of Problem 1b Meeting 1

Problem 1b			
		Frequency	Percent
Score	0	1	1.3
	1	4	5.0
	2	35	43.8
	3	32	40.0
	4	8	10.0
	Total	80	100.0

Based on Table 5, one student (1.3%) did not answer any problems with a score of 0, and only 10% of students (8 students) answered problems with a maximum score of (4). Furthermore, the frequency distribution of Problem 1d can be seen in Table 6.

Table 6. Table of Frequency Distribution of Problem 1d Meeting 1

Problem 1d			
		Frequency	Percent
Score	0	3	3.8
	1	3	3.8
	2	8	10.0
	3	6	7.5
	4	60	75.0
	Total	80	100.0

Based on Table 6, three students (3.8%) did not answer any problems with a score of 0, and there were 75% of students (60 students) answered problems with a maximum score of (4). Therefore, it can be concluded that most students could solve the problems but could not describe the function graphs properly. Table 7 displays the results of the analysis on Problem 1b (2nd indicator of numerical literacy skills) in Meeting 2.

Table 7. Table of Frequency Distribution of Problem 1b Meeting 2

Problem 1b			
		Frequency	Percent
Score	0	2	2.5
	2	18	22.5
	3	42	52.5

Problem 1b			
		Frequency	Percent
	4	18	22.5
	Total	80	100.0

Based on the table above, 2.5% of the students (2) did not answer any problems, with a score of 0, and 22.5% (18) answered the problems with a maximum score of 4. Furthermore, the frequency distribution of Problem 1d can be seen in Table 8.

Table 8. Table of Frequency Distribution of Problem 1a in Meeting 2

Problem 1a			
		Frequency	Percent
Score	2	1	1.3
	3	5	6.3
	4	74	92.5
	Total	80	100.0

Based on Table 8, there are 1.3% of students (1 student) received a score of 2, 6.3% of students (5 students) obtained a score of 3, and 92.5% of students (74 students) answered problems with a maximum score of 4.

Results of the Student Response Questionnaire

Questionnaires were given during Meeting 2 to obtain an overview of student responses to teaching materials assisted by GeoGebra in numerical methods and learning activities using the teaching materials. The results of the students' questionnaire responses can be seen in Table 9.

Table 9. Results of the Students' Questionnaire Responses

Assessment indicators		Total Score	Average	Percentage
Response to Teaching Materials				
A. Interest	1. The appearance of this textbook is interesting	271	3,39	84,69
	2. This textbook makes me more enthusiastic about learning	277	3,46	86,56
	3. This textbook supports me to better master the material	284	3,55	88,75
	4. Picture illustrations motivate to learn the numerical methods	292	3,65	91,25
	5. With textbooks, I can study on my own	267	3,34	83,44
B. Material	6. This textbook presents word problems that hone my Numeracy and Literacy Skills	273	3,41	85,31
	7. This textbook presents illustrated pictures that relate material concepts to real life so that I can better understand the application of the material	274	3,43	85,63
	8. The material contained in the textbook is presented in a coherent and easy-to-understand manner	279	3,49	87,19
	9. This textbook contains practice questions that can test how far I understand the numerical methods material.	275	3,44	85,94

Assessment indicators		Total Score	Average	Percentage
Response to Teaching Materials				
C. Language	10. The practice problems contained in this textbook can train my numerical literacy skills.	277	3,46	86,56
	11. Sentences and paragraphs used are easy to understand.	281	3,51	87,81
	12. The language used is simple and easy to understand.	283	3,54	88,44
D. Using GeoGebra	13. Instructions for using GeoGebra in learning are easy to understand and implement	297	3,71	92,81
	14. Using GeoGebra makes it easier to learn numerical methods material	302	3,78	94,38
	15. Using GeoGebra shortens the time in solving problems	303	3,79	94,69
	Indicator Average	282,33	3,53	88,23
Response to Learning Activities with Teaching Materials				
	16. Happy when lecturers use applications that support and assist in lectures	302	3,78	94,38
	17. Enjoy lectures using GeoGebra	300	3,75	93,75
	18. Lectures become interesting because the illustrations use GeoGebra	305	3,81	95,31
	19. By using GeoGebra, I get results as well as images/illustrations that are more precise and accurate compared to images made manually	293	3,66	91,56
	20. I no longer have difficulty in graphing a function	297	3,71	92,81
	21. When working on the questions, I am more confident because I can compare the results using the manual method and the results using GeoGebra	303	3,79	94,69
	Average Indicator	300,00	3,75	93,75

The questionnaires were given to 80 respondents after implementing the learning using the developed teaching materials. The questionnaires had a scale of 1-4, wherein a score of 1 indicated “not agree," a score of 2 for “disagree," a score of 3 for “agree," and a score of 4 for “strongly agree." Based on the data above, the average response score to the teaching materials was 3.53, with a percentage of 88.23% of students giving a positive (very good) response. Then, the average score of responses to learning activities with the teaching materials was 3.75, with a percentage of 93.75% of students giving positive responses (very good). The highest percentage was in statement 18, where 95.31% of students gave a positive response to the statement, "Lecturing becomes interesting because the illustrations use GeoGebra." For more details, the analysis of the results of statement 18 can be seen in Table 10.

Table 10. Results of the Questionnaire Response to Statement 18

P18			
		Frequency	Percent
Valid	S	15	18.8
	SS	65	81.3

P18			
		Frequency	Percent
	Total	80	100.0

Based on table 10, 15 students (18.8%) gave a response “agree," and 65 students (81.3%) gave a response “strongly agree." The next highest percentage was in statement 21, wherein 94.69% of students responded positively with the statement, "When working on questions, I am more confident because I can compare the results using the manual method and the results using GeoGebra."

Table 11. Results of the Questionnaire Response to Statement 21

P21			
		Frequency	Percent
Valid	S	17	21.3
	SS	63	78.8
	Total	80	100.0

Based on Table 11, 17 students gave a response “agree” with a percentage of 21.3%, and 63 students gave a response “strongly agree” with a percentage of 78.8%.

The results showed that the students' Numeracy and Literacy Skills by implementing the teaching materials assisted by GeoGebra in numerical methods were in the "good” category for the first meeting, with an average score of 74.85. Meanwhile, in the second meeting, they were in the “very good” category with an average score of 87.88. These outcomes could be attributed to the textbook, which was equipped with steps to use GeoGebra to solve mathematical problems. These steps could help students compare their results obtained from the manual method with those from GeoGebra (Listiana, Aklimawati, Wulandari, & Isfayani, 2022).

The study's results also showed that the lowest numerical literacy skill was found in the second indicator, “analyzing information displayed in the graphical form." This finding contradicted the results of studies by Nasoha et al. (2022) and Hartatik (2020), which stated that students were worse in the first indicator, which was “writing numbers and symbols in solving mathematical problems."

Even though the Numeracy and Literacy Skills in the second indicator remained the lowest in Meeting 2, the average score increased. In the first meeting, the average score was 2.53, which increased to 2.93 in Meeting 2. This rise indicated that the students' ability to draw function graphs was better than before. Based on the results, most students agreed that the lectures became interesting because the illustrations used GeoGebra. Graphs can be

demonstrated using GeoGebra, as it can display graphs perfectly. This finding was similar to the results of the studies by Martín-Caraballo & Tenorio-Villalón (2021), Arceo-Díaz et al. (2020), and Listiana, Isfayani, Aklimawati, & Wulandari (2022) that GeoGebra had a positive effect on learning numerical methods and calculus.

CONCLUSION

While an average score of 74.85 (Good) was obtained from the results of the numerical literacy test during the first meeting, an average score of 87.88 (Very Good) was achieved during the second meeting. The participant's responses on the questionnaires regarding the teaching materials and learning process through the implementation of GeoGebra-assisted teaching materials were 88.23% (very good) and 93.75% (very good), respectively. According to test results, employing GeoGebra-assisted teaching materials in numerical methods improved the participating students' Numeracy and Literacy Skills in the second meeting compared to the first one. The lowest numerical literacy skill was found in the second indicator, “analyzing information displayed in the graphical form." The highest indicator of numerical literacy was in the first indicator, namely “using various numbers and symbols related to basic mathematics to solve practical problems in various contexts of everyday life."

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