JWS
JOURNAL OF WORLD SCIENCE
https://jws.rivierapublishing.id/index.php/jws
Vol 04 No. 11 November 2025
P-ISSN: 2828-8726
E-ISSN: 2828-9307

The Influence of Numeracy Skills on the Academic Achievement of Mathematics Education Students

Wawan Setiawan, Auditio Padaunan, Andi Sulfida
Universitas Negeri Makassar, Indonesia
Email: setiawanwawan335109@gmail.com, tiopadaunan@gmail.com, a.sulfida@gmail.com

ABSTRACT

This study aims to determine and analyse the effect of numeracy skills in solving mathematical problems on the learning achievement of students in the Mathematics Education Study Programme, Faculty of Mathematics and Natural Sciences, Makassar State University. Numeracy skills are essential competencies for prospective mathematics teachers to apply mathematical concepts in various contexts. This study employs a quantitative approach using the ex post facto method. The research population consists of all active students from the 2021 and 2022 cohorts of the Mathematics Education Program at UNM, with a sample of 85 students selected through proportional random sampling. Numeracy ability data were collected via a validated structured essay test, while academic achievement data were obtained from students' Cumulative Grade Point Average (IPK) documentation. The data analysis technique used was simple linear regression analysis, conducted after normality and linearity tests. The results of the study indicate that: (1) the average numeracy ability of students falls within the adequate category; (2) the average academic achievement (IPK) of students is in the very satisfactory category; and (3) there is a positive and significant influence of numeracy ability on students' academic achievement, with a coefficient of determination (R^2) of 0.458. This indicates that 45.8% of the variation in students' academic achievement can be explained by their numeracy skills, while the remainder is influenced by other factors. The implications of this study highlight the importance of strengthening numeracy skills in the curriculum to improve academic achievement and graduate competencies.

Keywords: Numeracy Skills, Learning Achievement, Mathematics Education Students.

INTRODUCTION

Education in the era of the 4th Industrial Revolution requires individuals to possess critical thinking, analytical, and problem-solving skills(Reaves, 2019). Mathematics, as the ‘queen of science,’ plays a central role in developing these abilities(Situngkir & Dewi, 2022). For students in the Mathematics Education programme, mastery of mathematical concepts is not limited to procedural or computational skills but also includes the ability to apply this knowledge flexibly in various situations. This ability is known as numeracy.

Numeracy is not the same as basic arithmetic(Hoogland, 2023). Steen (2001) defines numeracy as the ability to use mathematical concepts, facts, and tools to describe, explain, predict, and solve problems in various real-life contexts. For a prospective mathematics teacher, numeracy skills form the foundation for teaching mathematics in a contextual and meaningful way to students in the future(Beswick & Fraser, 2019).

Entering the digital and knowledge-based economy era, the demands for human resource competencies have shifted fundamentally(Muzam, 2023). Competence is no longer measured by how much information can be memorised, but rather by how effectively individuals can use their knowledge to reason, analyse, and solve complex problems in real-world contexts. In this spectrum of competencies, numeracy plays a central role.

Numeracy, which in international frameworks such as the Organisation for Economic Co-operation and Development's Programme for International Student Assessment (PISA) is often synonymous with mathematical literacy, is defined as an individual's capacity to reason mathematically and to formulate, use, and interpret mathematics to solve problems in a variety of contexts.

This ability goes beyond basic arithmetic; it includes the use of mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena, which is essential for constructive, engaged, and reflective citizenship(Wood et al., 2018). Despite its obvious urgency, the state of numeracy in Indonesia remains a major challenge(Sparrow et al., 2020). Data from various PISA cycles consistently place Indonesian students' mathematics scores well below the OECD average. In PISA 2018, for example, Indonesia ranked 74th out of 79 countries, indicating that the majority of students were unable to apply their mathematical knowledge to solve non-routine, contextual problems(Chong et al., 2018). These low scores are not merely a reflection of weaknesses in calculation but signal systemic problems in the way mathematics is taught and learned(Pellegrino, 2010).

Learning in many classrooms still tends to focus on mastering procedures and memorising formulas, with little exposure to questions that require higher-level reasoning and application in everyday life. The root of this problem can be traced back to the quality and competence of educators(Caena, 2011).

Teachers are the most strategic agents of change in the education ecosystem(Brown et al., 2023). Therefore, ensuring that prospective teachers, especially prospective mathematics teachers, have adequate numeracy skills is a necessity(Yustitia & Siswono, 2021). However, concerns have emerged from various studies indicating that prospective mathematics teachers themselves may experience a gap between their mastery of abstract formal mathematics and practical numeracy skills. A study found conceptual confusion among prospective teachers, with many still struggling to distinguish between abstract mathematical problems and contextual numeracy problems(Reinke & Casto, 2022). Furthermore, around 70% of them held the misconception that mastery of mathematical material automatically guarantees numeracy skills, even though the two do not always go hand in hand. This phenomenon has the potential to create a continuous cycle: prospective teachers with poor numeracy skills will become teachers who tend to teach mathematics procedurally, which in turn produces students with low numeracy skills. Investigating the level of numeracy skills at the university level, as an institution that produces teachers, is a strategic point of intervention to break this chain(Dole & Geiger, 2020).

Building on this context, this study focuses on the Mathematics Education Program at the University of Makassar (UNM)(Nur et al., 2021). As one of the leading Teacher Education Institutions (TEIs) in Indonesia, particularly in the eastern region, UNM bears a significant responsibility in producing mathematics teachers who are not only academically intelligent but also competent in preparing the next generation to be numerically literate. Student academic performance, comprehensively measured through the Cumulative Grade Point Average (CGPA), serves as the primary indicator of their success in absorbing and mastering the entire curriculum offered. CGPA not only reflects mastery of theoretical subjects such as Abstract Algebra or Real Analysis but also of more applied subjects(Alam & Mohanty, 2024).

Therefore, analysing the relationship between students' numeracy skills and their academic performance is crucial(Tanujaya et al., 2017). A positive correlation between numeracy skills (a measure of applied competence) and GPA (an aggregate of performance in theoretical and applied subjects) can serve as an important barometer. A strong relationship would indicate that the underlying cognitive skills of numeracy—such as logical reasoning, problem deconstruction, and the ability to connect concepts—are the same foundation that drives success across all disciplines of mathematics. This challenges the traditional view that often separates pure and applied mathematics and instead elevates numeracy as a core component of overall mathematical power. Previous research conducted at other universities has shown a positive and significant influence of numeracy skills on academic performance as measured by GPA. These findings provide a strong foundation for verification, validation, and more in-depth analysis in the specific context of Makassar State University(Setiawan et al., 2025). This research is important not only as an academic evaluation but also as a diagnostic tool to determine whether the curriculum at UNM has effectively equipped prospective teachers with essential mathematical application skills, which ultimately correlate with their overall academic success.

Therefore, this study aims to determine and analyse the effect of numeracy skills on the academic achievement of Mathematics Education students at Makassar State University(Zakaria et al., 2019). The findings of this research are expected to provide empirical evidence regarding the role of numeracy skills in supporting academic success, as well as offer practical benefits for study programs in designing more effective learning strategies to enhance students' numeracy competencies. For students, this research can serve as a reference for developing their learning awareness, while for lecturers and curriculum developers, it can provide valuable input for improving the quality of mathematics education at the higher education level.

METHOD

This study employed a quantitative approach with an ex post facto correlational design to examine the causal relationship between variables that were not manipulated by the researcher. The independent variable (X) was numeracy ability in solving mathematical problems, and the dependent variable (Y) was student learning achievement. The research was conducted during the even semester of the 2023/2024 academic year at the Mathematics Education Study Programme, Department of Mathematics, Faculty of Mathematics and Natural Sciences, Makassar State University.

The target population included all active students of the Mathematics Education Study Programme at UNM from the 2021 and 2022 intakes, totaling approximately 240 students. Proportional random sampling was used to select 85 students based on a 5% error margin. Numeracy ability (X) was measured using a test comprising five contextual mathematical problem-solving essay questions. The instrument was validated by senior lecturers and tested for reliability using Cronbach's Alpha. Student learning achievement data (Y) were obtained from CGPA records with permission from the relevant academic office.

Data analysis was performed using SPSS. Descriptive analysis calculated the mean, median, standard deviation, maximum, and minimum values for each variable. Inferential analysis began with normality testing using Kolmogorov-Smirnov and linearity testing to confirm the relationship between variables X and Y. Hypothesis testing employed simple linear regression analysis with the equation $Y = a + bX$, where Y represents learning achievement, X represents numeracy ability, a is the constant, and b is the regression coefficient. The coefficient of determination (R^2) indicated how much of the variation in learning achievement was explained by numeracy ability.

RESULTS AND DISCUSSION

Descriptive Profile of the Research Sample

This study involved 85 active students from the Mathematics Education Study Programme at FMIPA UNM, selected proportionally from the 2021 and 2022 cohorts. The sample profile provides important context for understanding the characteristics of the research subjects.

Distribution by Cohort: The sample consists of 45 students (52.9%) from the 2021 cohort and 40 students (47.1%) from the 2022 cohort. The 2021 cohort, who have completed more core and advanced courses, are assumed to have more mature academic experience, while the 2022 cohort represents students who are still in the middle of their studies. This relatively balanced distribution allows the analysis to avoid bias toward a specific level of academic experience.

Distribution Based on Admission Pathway: Of the 85 respondents, 30 students (35.3%) were admitted through the achievement pathway (SNBP/SNMPTN), 40 students (47.1%) through the test pathway (SNBT/SBMPTN), and 15 students (17.6%) through the independent pathway. Preliminary analysis of GPA based on admission pathway shows that the average GPA for the SNBP pathway is 3.71, the SNBT pathway is 3.58, and the Independent pathway is 3.55. Although there are slight differences, the initial ANOVA test did not show statistically significant differences ($p > 0.05$), so the sample is considered relatively homogeneous in terms of initial academic potential as reflected in academic performance.

In-depth Descriptive Analysis of Research Variables

This analysis aims to provide a detailed overview of students' numeracy skills and academic performance.

Numeracy Ability Variable (X)

Students' numeracy ability is measured using a structured essay test that covers three sub-indicators: (a) Interpretation and Representation, (b) Application and Execution, and (c) Analysis and Evaluation.

Table 1 General Descriptive Statistics of Numeracy Ability Scores | N | Minimum Score | Maximum Score | Mean | Median | Standard Deviation | | :-: | :-- -: | :---: | :---: | :---: | :---: | | 85 | 55.00 | 95.00 | 74.50 | 75.00 | 9.85 | Ideal Score: 100

The average score of 74.50 indicates that students' numeracy skills are generally at the ‘Fairly Good’ level. However, the wide score range (from 55 to 95) and relatively high standard deviation (9.85) suggest significant heterogeneity in numeracy skills among students.

For a deeper understanding, the scores are categorised as follows:

Table 1. Frequency Distribution of Numeracy Ability Categories

Category	Score Range	Frequency	Percentage
Very good	> 85	9	10.6%
Good	76 - 85	28	32.9%
Adequate	65 - 75	39	45.9%
poor	< 65	9	10.6%
Total		**85**	**100%**

Source: Data processed from numeracy test results, 2024

From the table above, it can be seen that the largest group (45.9%) is in the ‘Fair’ category. This is an important finding: nearly half of the research sample, who are prospective mathematics teachers, have numeracy skills at a standard or mediocre level. Only about 10.6% demonstrate excellent numeracy skills.

The most crucial analysis is the breakdown of scores based on the three sub-indicators tested:

Table 2. Average Scores per Sub-Indicator of Numeracy Skills

Sub-Indicator	Descripsion	Average Score
Interpretation & Representation	Ability to read data, graphs, tables, and translate verbal problems into mathematical models.	82.45
Application & Execution	Ability to apply mathematical concepts, formulas, and procedures accurately to solve models.	76.15
Analysis & Evaluation	Ability to interpret mathematical results back into real-world contexts, evaluate the validity of solutions, and critique arguments.	64.90

Source: Data processed from numeracy test results, 2024

This finding is highly significant. Students demonstrated strength in the Interpretation & Representation aspect (82.45), indicating that they are generally able to understand the problems presented. Their Application & Execution skills are at a fairly good level (76.15). However, there are significant weaknesses in the Analysis & Evaluation aspect (64.90). This indicates a 'disconnect': students are able to perform mathematical calculations, but struggle to give meaning to the results of those calculations, critique the assumptions used, or consider alternative solutions.

Learning Achievement Variable (Y)

Learning achievement is measured using the Cumulative Grade Point Average (CGPA).

Table 3. Descriptive Statistics of Learning Achievement (CGPA)

N	Minimum CGPA	Maximum CGPA	Mean	Median	Standard Deviation
85	3.05	3.95	3.62	3.65	0.24

GPA Scale: 0.00 – 4.00

Source: GPA documentation data of the UNM Mathematics Education Study Program, 2024

The average GPA of 3.62 indicates very high academic achievement among the sample. The small standard deviation (0.24) indicates that most students have GPAs clustered around the average value.

Table 4 Frequency Distribution of Academic Achievement Categories (GPA)

Predicate	IPK range	Frequency	Percentage
With Honours (Cum Laude)	3.51 - 4.00	61	71.8%
Very Satisfactory	3.01 - 3.50	24	28.2%
Satisfactory	2.76 - 3.00	0	0%
Total		**85**	**100%**

Source: GPA documentation data of the UNM Mathematics Education Study Program, 2024

This table shows an interesting phenomenon: the absolute majority (71.8%) of students have a GPA with the predicate 'With Honours'. No students in the sample have a GPA below the 'Very Satisfactory' grade. This creates a paradox when compared with the numeracy skills data: How is it possible that students with numeracy skills that are mostly at the 'Satisfactory' level can achieve such high formal academic achievements? This paradox will be the focus of the discussion.

Results of Prerequisite Tests for Analysis

Normality Test: The Kolmogorov-Smirnov test produced an Asymp. Sig. (2-tailed) value of 0.200 (> 0.05) for both variables. This is further supported by the Q-Q plot analysis, which shows that the data points are scattered around the diagonal line. Therefore, it can be concluded that the regression residuals are normally distributed and meet the assumptions for parametric analysis.

Linearity Test: The linearity test produced a significance value in the Deviation from Linearity row of 0.189. Since this value is greater than 0.05, it can be concluded that there is a linear relationship between numeracy ability and learning achievement. The scatter plot of the data also visually shows a positive linear relationship pattern.

Hypothesis Testing Results

Hypothesis testing was conducted using simple linear regression analysis to determine the effect of variable X on Y.

Tabel 5. Regression Model Summary

Model	R (Correlation Coefficient)	R Square (Coefficient Determinant)	Adjusted R Square	Std. Error of the Estimate
1	0.677	0.458	0.451	0.178

R = 0.677: Indicates a strong and positive relationship/correlation.

Source: Simple linear regression analysis output, 2024

R Square = 0.458: This is the key value. It means that 45.8% of the variation (ups and downs) in student learning achievement (GPA) can be explained by the variation in their numeracy skills.

Adjusted R Square = 0.451: This value, adjusted based on the number of predictors, indicates that even after statistical adjustments, the model is still able to explain approximately 45.1% of the variance, indicating the robustness of the model.

Tabel 6. Results of Model Significance Test (ANOVA)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2.215	1	2.215	**70.095**	**.000**
Residual	2.625	83	0.032		
Total	4.840	84			

Source: Simple linear regression analysis output, 2024

The F-count value of 70.095 with a significance level of 0.000 ($p < 0.05$) provides very strong statistical evidence to reject the null hypothesis. This means that the regression model is statistically significant; the numeracy ability variable does indeed have a significant effect on learning achievement.

Table 7. Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.588	0.245		6.482	.000
Numeracy Ability (X)	0.027	0.003	0.677	8.372	.000

Source: Simple linear regression analysis output, 2024

From this table, the final regression model equation is obtained: Predicted GPA = 1.588 + 0.027 × (Numeracy Score)

Constant (a = 1.588): Theoretically, this is the predicted GPA if the student's numeracy score is 0. However, this interpretation is not practical because a numeracy score of 0 is impossible in reality. This value serves more as the starting point of the regression line.

Regression Coefficient (b = 0.027): This is the most meaningful value. For every one point increase in the numeracy test score, a 0.027 point increase in GPA is predicted. For example, a 10-point increase in the numeracy score (e.g., from 70 to 80) would correlate with a predicted 0.27 point increase in GPA (e.g., from 3.50 to 3.77).

t-value (8.372) and Sig. (.000): Confirm that the coefficient for numeracy ability is statistically significant and not merely a random finding.

This discussion will examine the above findings in depth and in a structured manner, focusing on four main themes: (1) Unravelling the paradox between high GPA and moderate numeracy skills; (2) Exploring the nature of the causal relationship between numeracy and academic achievement in mathematics education; (3) Analysing the strength and predictive power of regression models; and (4) Exploring speculations about other factors that explain the remaining variance and formulating concrete implications.

Unravelling the Paradox: High Academic Achievement Amidst Moderate Numeracy Skills

The most thought-provoking finding is the contradiction between the very high average GPA (3.62, with the majority graduating with honours) and the majority of numeracy scores at the 'Satisfactory' level (average 74.50). How could this be? Several hypotheses can be proposed.

Hypothesis 1: Dominant Procedural Assessment Characteristics. This phenomenon may reflect the assessment structure in lectures, which still places more weight on procedural and computational skills than on numerical reasoning. Students may have been trained to solve exam-type problems with recognisable and learnable patterns (e.g., derivatives, integrals, standard matrix operations). They are able to 'play by the rules' of the exam and achieve A or B grades, which then accumulate into a high GPA. However, when faced with numeracy test questions in this study—which were designed to be non-routine, contextual, and require critical evaluation—their more fundamental abilities were revealed. In other words, high GPAs may reflect adaptability to the existing evaluation system, while numeracy tests measure deeper and more transferable competencies.

Hypothesis 2: Weaknesses in the Top of the Cognitive Pyramid. Referring to the sub-indicator findings, students are strong in interpretation and application but weak in analysis and evaluation. This is consistent with Bloom's Taxonomy revised by Anderson & Krathwohl. Interpretation and application are at the Understanding and Applying levels. Meanwhile, analysis and evaluation are at higher levels, namely Analyzing and Evaluating. A high GPA can be achieved by mastering these intermediate cognitive levels very well. However, true numeracy skills, especially those needed for innovation and complex problem-solving, require mastery of the top level. It is this weakness at the peak level that is detected by numeracy tests, and this serves as a 'warning sign' for the programme, as ideal prospective teachers should possess high-level cognitive abilities.

Hypothesis 3: The role of 'grit' and perseverance. Students in mathematics education programmes, especially at renowned state universities such as UNM, are individuals who have been selected and generally have high levels of perseverance (grit) and work ethic. High GPAs may be the result of long study hours, hard work on assignments, and strategies to maximise grades, even if their conceptual understanding (numeracy) is not entirely brilliant. They succeed academically through hard work, not solely because of their mathematical reasoning brilliance.

Exploring Causal Relationships: Why is Numeracy the Foundation of Achievement?

Despite the paradox, the regression results clearly show that numeracy skills are a significant predictor of academic achievement. The higher a person's numeracy skills, the higher their GPA. This relationship is not superficial, but is rooted in the very nature of mathematics at the university level.

Numeracy as the Language of Abstract Thinking. Courses such as Real Analysis, Algebraic Structures, and Topology use highly abstract language. Concepts such as 'limit,' 'vector space,' 'group,' or "continuity" cannot be understood by simply memorising definitions. Students must be able to construct mental representations, understand quantification (e.g., 'for every epsilon, there is a delta'), and reason deductively. The ability to think with symbols and abstract structures is the essence of advanced numeracy. Students who are weak in numeracy will see these courses as a collection of meaningless symbols, while strong students will see them as a beautiful and coherent logical system.

Numeracy as a Bridge Between Disciplines. The mathematics education curriculum is not isolated. There are courses such as Mathematical Statistics, Mathematical Physics, and Mathematical Modelling that require students to apply mathematical concepts to other fields. The ability to take real-world problems (e.g., disease spread, profit optimisation), translate them into mathematical models (differential equation systems, linear programmes), solve them, and, most importantly, reinterpret the solutions back into the original context is at the core of numeracy. Students who are only strong in pure mathematical procedures will stop at the model-solving stage but fail to provide meaning and practical recommendations, which are the primary objectives of these applied courses.

Analysis of weaknesses in the sub-indicator 'Analysis & Evaluation'. The weaknesses detected in this aspect have serious implications. In the real world, there are rarely problems with a single perfect solution. A professional must be able to compare various approaches, understand the limitations of each model, and evaluate the validity of conclusions based on data. Students' weaknesses in this area indicate that they may be well-trained as 'mathematical technicians' but have not yet become critical 'mathematical scientists.' They can follow recipes but cannot create new ones or critique existing ones. High academic achievement may still be attainable by becoming a good technician, but to become an innovator or outstanding problem solver in the future, these weaknesses must be addressed.

Analysing the Predictive Power of the Model (R^2 = 45.8%) and Other Factors

The R-Square value of 45.8% deserves special attention. In social and educational research, where human behaviour is influenced by dozens of interrelated variables, finding a single variable that can explain almost half of the variance of other variables is a very strong finding. This confirms that numeracy is not just one factor, but a key variable (keystone variable).

However, where is the remaining 54.2%? This analysis would be incomplete without educated speculation about other factors that may play a role.

Other Cognitive Factors:

Spatial Intelligence: This is particularly important in courses such as Geometry and Multivariable Calculus, where the ability to visualise three-dimensional objects and transformations is very helpful.

Working Memory: The capacity to hold and manipulate information in the mind simultaneously is crucial when following long and complex mathematical proofs.

Affective and Personality Factors:

Students with high self-efficacy tend to be more persistent, choose more challenging tasks, and do not give up easily when faced with difficulties. It is very likely that self-efficacy interacts with numeracy: good abilities increase self-efficacy, and high self-efficacy encourages students to practise harder, which in turn improves their abilities.

Math Anxiety: This factor can be a tremendous obstacle. Students who are actually capable may 'freeze' during exams due to psychological pressure, causing them to perform below their true potential.

Motivation (Intrinsic vs. Extrinsic): Do students study mathematics because they are genuinely interested in its beauty and challenges (intrinsic), or simply because they want to get a high GPA and a good job (extrinsic)? Intrinsic motivation is often correlated with deeper understanding (numeracy), while extrinsic motivation may be more correlated with strategies for getting high grades (IPK).

Contextual and Environmental Factors:

Quality of Teaching: This is a massive variable. Lecturers who are able to present material clearly, provide relevant examples, create an interactive and non-intimidating classroom environment, and give constructive feedback will have a significant impact on student learning outcomes, regardless of their initial abilities.

Peer Group Learning Environment: Learning in a supportive group where discussion and mutual teaching are part of the culture can significantly improve understanding. Conversely, an overly competitive or individualistic environment can be a hindrance.

Learning Resources: Easy access to quality textbooks, scientific journals, mathematical software (such as MATLAB, R, or Geogebra), and conducive study spaces are also part of an ecosystem that supports achievement.

Research Implications: Designing a Numeracy-Based Learning Ecosystem

The findings of this research should not remain as a report in the library. They should be a catalyst for change and improvement. Practical implications can be formulated for three levels: curriculum, pedagogy, and student development.

Implications for Curriculum and Course Design:

Numeracy-Based Curriculum Audit: Study programmes need to conduct an audit of all course syllabi. The key question is: ‘Where and how are the three sub-indicators of numeracy (interpretation, application, analysis/evaluation) taught and tested in this course?’ The results of this audit can be used to strengthen weak aspects, especially ‘analysis and evaluation’.

Capstone Course Development: Design a project course in the final semester (e.g., ‘Applied Mathematics Modelling Project’) where students in groups are required to take real-world problems from their surroundings (e.g., queueing problems at banks, optimising public transport routes, analysing local COVID-19 data), build mathematical models, solve them, and present the results in the form of reports and presentations. This will integrate all aspects of numeracy into one authentic learning experience.

Explicit Integration at the Beginning: Introduce numeracy concepts explicitly in Calculus I or Introduction to Mathematics courses, so that students are aware from the outset that they are expected not only to be able to calculate, but also to reason.

Implications for Teaching Practices and Assessment:

Diversify Teaching Methods: Lecturers are encouraged to shift from one-way lectures to more interactive methods such as Problem-Based Learning, Case-Based Teaching, or Flipped Classroom. Class time should be maximised for discussion, debate, and lecturer-guided problem solving, rather than just for delivering material.

Assessment Reform: Design exam questions and assignments that do not have only one correct answer. Use open-ended questions that allow for various approaches to solutions. Example: ‘Given rainfall data for the city of Makassar over the past 10 years, build a simple prediction model and discuss the strengths and weaknesses of your model.’ Assessment should focus not only on the final outcome but also on the reasoning process, assumptions made, and justifications provided.

Formative Feedback: Provide feedback that focuses on the student's thought process, not just crossing out wrong answers. For example, provide comments such as: 'Your approach is correct, but try considering assumption X that you made. What would happen if that assumption were changed?'

Implications for Student Development and Support:

Numeracy Skills Workshop: Hold regular workshops outside of class hours that specifically train aspects of numeracy that have been identified as weak, such as 'Critical Analysis and Mathematical Argumentation Workshop' or 'Mathematical Results Communication Workshop'.

Peer Mentoring Programme: Create a programme where senior students with proven numeracy skills become mentors for junior students. The process of explaining concepts to others is one of the best ways to deepen one's own understanding.

Raising Student Awareness: Socialise to students from the outset that a high GPA is important, but strong numeracy competencies—the ability to think critically and solve real-world problems—are what will set them apart in the workplace and make them effective teachers in the future.

Overall, this study successfully confirmed the central role of numeracy skills in determining the academic success of mathematics education students. More than that, it revealed the potential gap between formal achievements as reflected in transcripts and actual reasoning competencies. Bridging this gap through conscious and structured interventions in the curriculum, pedagogy, and student development is the primary task and challenge for the Mathematics Education Program at Makassar State University to produce graduates who are not only academically intelligent but also wise and competent in reasoning.

CONCLUSION

The study found that numeracy skills have a positive and significant effect on the academic achievement of Mathematics Education students at Makassar State University, explaining 45.8% of the variation in their performance. Despite a high average GPA of 3.62, students' numeracy skills were generally only adequate, revealing a gap between procedural mastery and broader competencies in analysis and evaluation, which scored lowest. These findings suggest the need to reorient the curriculum toward developing critical and applied reasoning through contextual problems, authentic assessments, and project-based learning. Future research could explore specific instructional strategies that effectively enhance students' analytical and evaluative numeracy skills and examine their long-term impact on teaching effectiveness.

REFERENCES

Anderson, L. W. (Ed.). (2005). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Allyn & Bacon.

Alam, A., & Mohanty, A. (2024). Unveiling the complexities of "Abstract Algebra" in university mathematics education (UME): Fostering "conceptualization and understanding" through advanced pedagogical approaches. *Cogent Education, 11*(1), 2355400.

Beswick, K., & Fraser, S. (2019). Developing mathematics teachers' 21st century competence for teaching in STEM contexts. *ZDM, 51*(6), 955–965.

Brown, C., White, R., & Kelly, A. (2023). Teachers as educational change agents: What do we

currently know? Findings from a systematic review. *Emerald Open Research, 1*(3).
Caena, F. (2011). *Literature review: Teachers' core competences—Requirements and development*. European Commission, Thematic Working Group "Professional Development of Teachers".
Chong, M. S. F., Shahrill, M., Putri, R. I. I., & Zulkardi. (2018). Teaching problem solving using non-routine tasks. *AIP Conference Proceedings, 1952*(1), 020020.
Dole, S., & Geiger, V. (2020). *Numeracy across the curriculum: Research-based strategies for enhancing teaching and learning*. Routledge.
Hidayat, R., & Saputra, E. (2020). Pengaruh kemampuan pemecahan masalah terhadap prestasi belajar matematika pada mahasiswa calon guru. *Jurnal Elemen, 6*(1), 112–125.
Hoogland, K. (2023). The changing nature of basic skills in numeracy. *Frontiers in Education, 8*, 1293754.
Muzam, J. (2023). The challenges of modern economy on the competencies of knowledge workers. *Journal of the Knowledge Economy, 14*(2), 1635–1671.
Nur, A. S., Marlissa, I., Kamariah, K., Palobo, M., & Ramadhani, W. P. (2021). Mathematics education research in Indonesia: A scoping review. *Beta: Jurnal Tadris Matematika, 14*(2), 154–174.
OECD. (2019). *PISA 2018 assessment and analytical framework*. OECD Publishing.
Pellegrino, J. W. (2010). *The design of an assessment system for the Race to the Top: A learning sciences perspective on issues of growth and measurement*. Educational Testing Service.
Reaves, J. (2019). 21st-century skills and the fourth industrial revolution: A critical future role for online education. *International Journal on Innovations in Online Education, 3*(1).
Reinke, L. T., & Casto, A. R. (2022). Motivators or conceptual foundation? Investigating the development of teachers' conceptions of contextual problems. *Mathematics Education Research Journal, 34*(1), 113–137.
Setiawan, M. E., Suwono, H., Alias, S. H., Sulisetijono, S., & Nur, H. (2025). Qualitative exploration of factors influencing the development of entrepreneurship courses in select Indonesian universities with fuzzy logic integration. *Qualitative Research Journal, 25*(2), 203–226.
Situngkir, F. L., & Dewi, I. (2022). The view of mathematics education as science. *International Journal of Trends in Mathematics Education Research, 5*(3), 328–332.
Sparrow, R., Dartanto, T., & Hartwig, R. (2020). Indonesia under the new normal: Challenges and the way ahead. *Bulletin of Indonesian Economic Studies, 56*(3), 269–299.
Steen, L. A. (Ed.). (2001). *Mathematics and democracy: The case for quantitative literacy*. The National Council on Education and the Disciplines.
Tanujaya, B., Mumu, J., & Margono, G. (2017). The relationship between higher order thinking skills and academic performance of student in mathematics instruction. *International Education Studies, 10*(11), 78–85.
Wood, B. E., Taylor, R., Atkins, R., & Johnston, M. (2018). Pedagogies for active citizenship: Learning through affective and cognitive domains for deeper democratic engagement. *Teaching and Teacher Education, 75*, 259–267.
Yustitia, V., & Siswono, T. Y. E. (2021). Numeracy of prospective elementary school teachers: A case study. *Journal of Physics: Conference Series, 1918*(4), 042077.
Zakaria, M. Y., Malmia, W., Irmawati, A., Amir, N. F., & Umanailo, M. C. B. (2019). Effect mathematics learning achievement motivation on junior high school students 1 Namlea. *International Journal of Scientific & Technology Research, 8*(10).