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Understanding Science-Contextualized Numeracy: A Study of Grade XI Students in the Bandung Area

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Abstract: Numeracy skills in the context of science are crucial in helping students understand and interpret scientific phenomena quantitatively. However, there has been no comprehensive review of students' numeracy skills in the context of science in secondary schools, particularly in the Bandung area. This study aims to describe the level of numeracy skills in the context of science and identify areas of student weakness. The method used is descriptive quantitative, involving 121 11th-grade students from several schools. Students who had taken science subjects (physics, chemistry, and biology) in 10th grade were assessed on numeracy skills covering five numeracy domains: arithmetic, algebra, data processing, graphing, and geometry. The data were analyzed descriptively using mean values, standard deviations, and minimum and maximum score ranges. These findings indicate that students' numeracy skills are generally in the moderate to low category, with a wide distribution of scores. Data processing is the domain with the highest success rate, while arithmetic received the lowest average score of the five numeracy domains. Strengthening in arithmetic operations is also needed to calculate decimals, ratios, fractions, and percentages. These results indicate the need to integrate numeracy content into science learning to strengthen students' numeracy skills.

Keywords: High school student; Numeracy skill; Science context

Introduction

Technological advances and the proliferation of big data have made numeracy skills a fundamental competency for individuals. Numeracy enables individuals to understand, interpret, and use quantitative information in diverse contexts, including critical decision-making (Sulak et al., 2020; Geiger et al., 2015). Furthermore, science education in the 21st century focuses on developing students' abilities in critical thinking, communication, collaboration, and innovation, which support life skills (Sahil et al., 2022). Proficiency in interpreting numerical data, diagrams, graphs, and tables is necessary for pattern recognition, data analysis, prediction, and informed decision-making (Gittens, 2015; D'Ignazio & Bhargava, 2016; Giese et al., 2020). Integrating quantitative skills into science learning familiarizes students with numerical reasoning and fosters critical thinking (Flanagan & Einarson, 2017). Numeracy in science learning combines scientific and mathematical concepts, providing interdisciplinary and contextual knowledge (Scott, 2017; Abrori et al., 2024). Enhancing students' numeracy skills is essential for understanding the context of quantitative data (Scott, 2021). Furthermore, numeracy skills can improve their ability to understand mathematical models, which can contribute to interpreting and communicating results in biology (Andrews & Aikens, 2018). Students will construct their understanding of data as they get more

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familiar with numeracy-based skills, allowing them to think critically when evaluating information, identifying misinformation, and making informed decisions (Aini et al., 2024).

Multiple international studies consistently highlight the challenges in mathematics and science literacy among Indonesian students. National assessments reveal that high school students' numeracy skills are limited to level 2 on the global scale (Arsiah et al., 2024). At this level, students are only able to recognize and interpret simple data (OECD, 2023). This performance falls short of the curriculum's intended learning outcomes (Siregar et al., 2024). The curriculum requires students to demonstrate numeracy skills such as selecting, comparing, modeling, and evaluating scientific phenomena in complex situations. Students' insufficient understanding of basic mathematical concepts can hinder students' comprehension of scientific principles (Scott, 2021). These findings underscore the need to enhance students' scientific literacy and numeracy.

Although numeracy integration into science learning has commenced in schools, its implementation remains limited (Aini et al., 2024). Most studies addressed general mathematical competencies rather than the specific application of numeracy within science disciplines such as physics, chemistry, and biology. Moreover, there is insufficient comprehensive data on actual classroom conditions, particularly in densely populated regions with diverse educational challenges such as Bandung. Addressing this gap is essential for designing effective educational interventions. Samputri et al. (2024) report that students' science literacy skills relatively low. This finding is consistent with research indicating that students' abilities to interpret data and information are also limited (Sartianis & Yuliati, 2022).

Numeracy skills have several dimensions, including arithmetic, handling data, algebra, graphs, and geometry (OCR, 2015; Arsiah et al., 2024). Student difficulties in achieving numeracy competency are influenced by external factors, such as the quality of learning, school management, facilities and infrastructure, and the learning environment (Arsiah et al., 2024). In addition, internal factors including learning motivation and self-efficacy in solving numeracy problems, also play a significant role (Rafiola et al., 2020; Siswandari et al., 2025). This study aims to provide a detailed analysis of high school students' numeracy skills within the context of science in the Bandung region. The findings aim to clarify students' understanding of each numeracy dimension, allowing teachers and education practitioners to design lesson plans and teaching materials that effectively enhance numeracy skills in science learning.

The results of this study are expected to provide a comprehensive overview and establish a foundation for integrating numeracy in science learning. The research findings may also serve as an empirical basis for designing targeted programs to improve numeracy competency, addressing students' specific needs and fostering critical and analytical thinking skills necessary for future challenges.

Method

This study uses a quantitative descriptive approach. This method is a test method to explore and describe high school students' numeracy skills in the context of science. This study was conducted on July 21-25, 2025, involving 121 11th-grade high school students from two public and two private schools. Participants were selected using a purposive sampling technique, with the criteria being students who had taken science subjects (physics, chemistry, and biology) in 10th grade. The research stages included preparation, implementation, data analysis, and reporting. The flowchart of the research stages carried out can be seen in Figure 1.

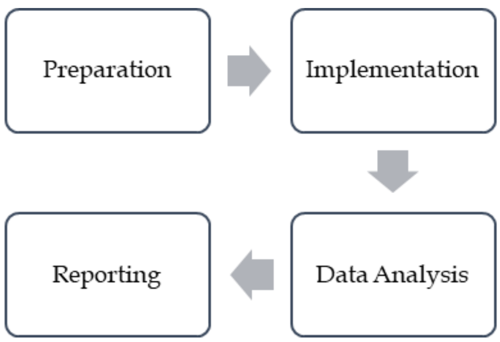

Figure 1. Flow chart for the research stages

The preparation phase began with a literature review to examine theories on numeracy, its indicators, and existing similar research. The instrument used in this study was a numeracy test with a science context, consisting of 20 questions. The test instrument was adapted from the AKM questions developed by the Center for Assessment and Learning (Pusmenjar), the PISA (Program for International Student Assessment), the OCR A Level, and the CBSE (Central Board of Secondary Education). The questions used covered five numeracy domains: arithmetic, algebra, data processing, graphics, and geometry. These five domains are divided into several indicators, as presented in Table 1.

During the implementation phase, a numeracy ability test was administered to all research subjects. Before the test, students received a detailed explanation of the research objectives and instructions. The test lasted 60 minutes. Test results were analyzed quantitatively. Assessment was based on two types of questions: a) multiple-choice/short-answer questions: scored 1 for a correct answer and 0 for an incorrect answer; b) essay questions: scored on a scale of 1–5, with scores reflecting the depth of the answer.

Table 1. Domains and Indicators of Numeracy Questions with a Science Context (OCR, 2015)

Domain	Indicator
Arithmetic (4 items)	Make use appropriate units in calculations Use expressions in decimal and standard forms Use of ratios, fractions, and percentages
Algebra (4 items)	Understand and use symbols =; <; > ; ~ Substitute numerical values in algebraic equations using appropriate units for physical quantities
Handling Data (4 items)	Understand the terms means, median, mode Construct and interpret frequency and diagrams, bar charts, and histograms
Graph (4 items)	Translate information between graphical, numerical, and algebraic forms Understand that y=mx + c represents a linear relationship
Geometry (4 items)	Calculate circumference, surface area, and volumes of regular shape

The next stage involved analyzing the collected quantitative and qualitative data. The collected scores were analyzed using descriptive statistics to provide an overview of students' numeracy skills. This analysis included calculating the average score, minimum score, maximum score, and percentage of successful answers. Furthermore, document analysis, specifically student answer sheets, was conducted to further explore domains that had been mastered and presented challenges for students. The final stage was reporting to capture the overall profile of students' numeracy skills.

Result and Discussion

The evaluation of students' numeracy skills within the science context demonstrates that their proficiency remains insufficient. As shown in Table 2, the average student score was 35.78 on a 0 to 100 scale. This result indicates the overall level of numeracy skills in the moderate to low range, with scores widely distributed. Most students were unable to apply numeracy concepts to solve problems in the science context of the assessment.

Table 2. Average Student Scores on Numeracy Questions

Mean	Standard deviation (SD)	Minimum score	Maximal score
35.78	10.98	15.52	75.86

The data analysis revealed a substantial standard deviation (10.98), indicating considerable variability in student ability. Some students achieved scores as high as 75.86, demonstrating both the feasibility of the test instrument and the presence of students with strong numeracy skills. Conversely, scores as low as 15.52 suggest that a group of students experienced serious difficulties and lacked mastery of the numeracy components assessed.

This study assessed five numeracy domains, including handling data, geometry, algebra, arithmetic, and graph. Student performance in each numeracy domain is presented in Figure 2. The highest average score, 42.09, was achieved in the handling data domain. In contrast, the arithmetic domain had the lowest average score. These results suggest that students tend to understand numeracy concepts related to data processing and interpretation, as well as visual representation through graphs, compared to basic arithmetic skills. Weak performance in arithmetic indicates insufficient mastery of basic numeracy skills, which are essential for further development. Contributing factors to low numeracy achievement include limited understanding of mathematical concepts, insufficient context-based practice, inadequate integration of numeracy in instruction, and a lack of innovative teaching methods (Ramdhani et al., 2025). Furthermore, students' difficulties with context-based problems are attributed to instructional practices that do not emphasize mathematical model construction, as science learning typically focuses on reading, comprehension, and writing skills (Hasnawati, 2016).

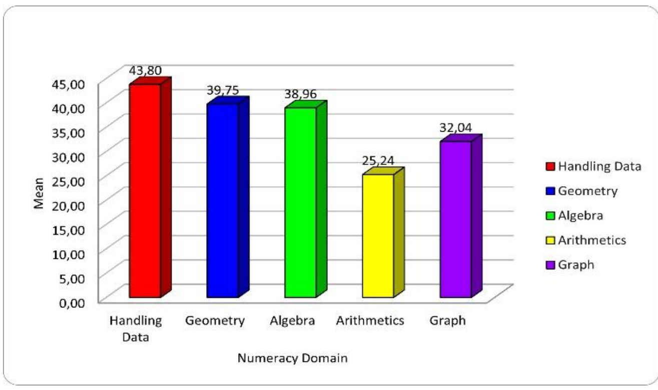

Figure 2. Mean scores on five numeracy domains

In the handling data domain, students were asked to perform basic data analysis, including calculating averages, determining the median, and identifying the mode. Students' abilities to construct and interpret frequency, bar charts, and graphs were also assessed. While this domain received the highest score among the five domains, some specific indicators did not achieve good results.

Table 3 presents the percentage of students who completed questions in the handling data domain. The indicators for calculating means, medians, and modes were notably low. This difficulty likely results from students' limited understanding of these statistical concepts and their insufficient ability to analyze data within contextual tables (Satriawan, 2018). In these questions, students were required to perform calculations based on the presented data. Many students demonstrated reluctance to engage with calculation-based problems, instead favoring questions that could be analyzed through direct observation. This trend is concerning, as proficiency in calculation is essential for science subjects such as chemistry and physics.

Table 3. Indicators in the Data Processing Domain

Indicator	Percentages
Understand the terms means, median, and mode	35.95%
Construct and interpret frequency and diagrams, bar charts, and histograms	55.57%

In contrast, students demonstrated a relatively high level of success in interpreting diagrams, indicating an understanding of variable contexts and the ability to interpret diagrammatic information. Science learning, especially practical activities, has generally integrated the handling data domain, which has contributed to students' competence in diagram interpretation (Tanti et al., 2020). Learning that involves multiple representations in the form of graphs, tables, and conceptual models has been shown to enhance students' understanding of scientific material (Damayanti & Wulanningtyas, 2025).

Table 4. Indicators in the Geometry Domain

Indicator	Percentages
Calculate circumference, surface area, and volumes of regular shape	39.75%

In the geometry domain, students are expected to be proficient in calculating the perimeter, surface area, and volume of regular plane figures. Table 4 presents the percentage of students who successfully solved geometry problems. The results indicate that students' numeracy skills in geometry are moderate to low. More than half of the students correctly solved problems involving surface area and volume comparisons. However, performance declined on more complex problems requiring advanced reasoning. For example, when asked to compare two identical objects with different geometric structures and determine the actual area from a scale, only about 7% of students answered correctly. This represents one of the lowest success rates among all indicators. These problems required students to compare objects from multiple representations and convert measurements to scale.

As shown in Figure 3, most students applied the Pythagorean theorem rather than utilizing the block scale comparison provided in the problem. This result indicates that participating students demonstrated limited spatial skills, which hindered their ability to visualize geometric shapes from different perspectives. Spatial skills are essential for solving geometric problems (Yu et al., 2022). Spatial skills help students visualize problems, understand relationships between objects, and solve geometric problems. Students with good spatial skills tend to understand geometric concepts and solve problems involving visualization and apply spatial thinking (Rangkuti et al., 2024; Madya et al., 2023).

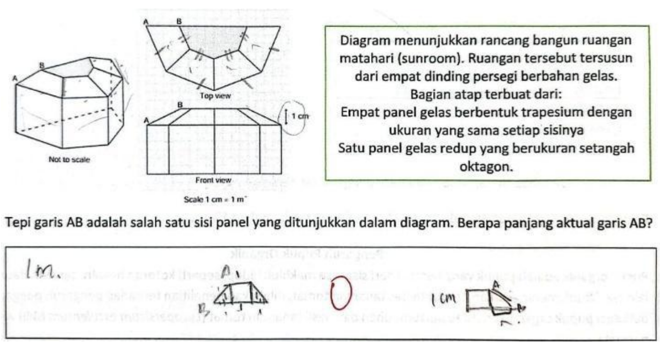

Figure 3. Example of student answers in the geometry domain.

The algebra domain in numeracy refers to the ability to understand, use, and apply algebraic concepts and operations in various contexts. Two indicators were assessed: comprehension of comparison symbols (>, <, =, ~) and the ability to substitute numerical values into algebraic equations using appropriate units for physical quantities. Table 5 presents the percentage of students' success in solving problems in the algebra domain. The findings suggest that students' abilities in this domain are moderate. Notably, students demonstrated greater proficiency in interpreting comparison symbols than in understanding verbal comparisons such as 'less than', 'more than', or 'equal to'. This is reflected in higher success rates for problems using symbolic representations. The reason for this difference may be attributed to the use of visualizations, which facilitate direct observation of size differences between objects. Visual aids have been shown to improve the accuracy and speed of data comparison (Jee et al., 2022; Jardine et al., 2020). However, students continued to struggle when comparing sizes using different units of measurement, even when images and unit descriptions were provided.

Table 5. Indicators in the Algebraic Domain

Indicator	Percentages
Understand and use symbols =; <; > ; ~	51.92%
Substitute numerical values in algebraic equations using appropriate units for physical quantities	58.47%

The use of decimal numbers also posed challenges. For example, students had difficulty comparing the size of 7 μ with 0.6 mm using the appropriate symbols. Previous studies have reported similar findings, with many students struggling to understand the relationship between units, particularly when converting units of different magnitudes or dimensions, such as from cm^3 to m^3 (Jaikla et al., 2021). These difficulties are often linked to underdeveloped proportional reasoning, which is necessary for assimilating and transforming hierarchical unit structures (Lee & Shin, 2024; Zwanch et al., 2024).

The arithmetic domain focused on three indicators as presented in Table 6. This domain had the lowest score among all domains. Assessment results indicate that students' ability to use appropriate units in calculations was moderate. Students could determine the correct units when converting certain measurements, but encountered difficulties with decimal-related problems. Although decimal concepts are introduced in elementary education, research indicates that many students continue to struggle with both conceptual and procedural aspects of decimals. Common issues include misunderstanding place value, treating digits after the decimal points as a whole number, and difficulty comparing and ordering decimals. For instance, some students incorrectly believe that decimals with more digits are larger (Pulungan & Suryadi, 2019).

Table 6. Indicators in the Arithmetic Domain

Indicator	Percentages
Make use of appropriate units in calculations	57.85%
Use expressions in decimal and standard forms	29.47%
Use of ratios, fractions, and percentages	12.26%

Students also face challenges with decimal arithmetic operations, such as placing the decimal point during multiplication or division and converting text notation to numeric expressions (González-Forte et al., 2022). The ability to calculate ratios, fractions, and percentages was particularly low at 12.26%. This may be attributed to a limited understanding of division concepts. Figure 4 illustrates examples of both incorrect and correct student answers, highlighting persistent difficulties in identifying the dividend and divisor. These results suggest that students have not yet mastered place value in serial division operations (Puspitaningtyas et al., 2023). Additionally, a lack of contextual understanding can negatively impact student motivation and performance in arithmetic tasks (Belinda et al., 2023). For example, the indicator topic involved counting dividing cells in the metaphase stage. Although the total frequency of observed cells was provided, students' motivation was reduced because they perceived the cell cycle topic as unfamiliar.

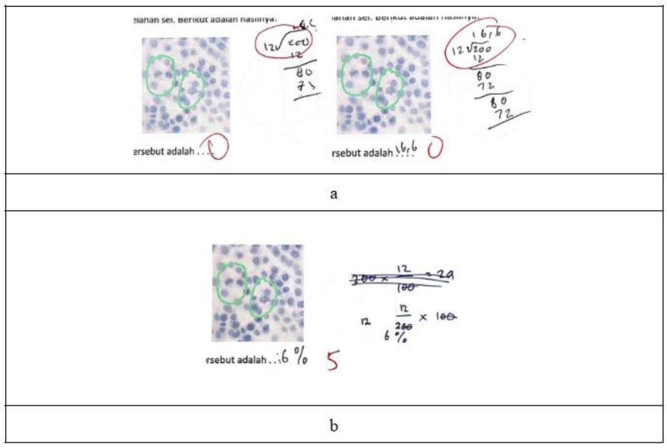

Figure 4. a. Example of a wrong answer, b. Example of a correct answer

In the geometry domain, two indicators were assessed as shown in Table 7. The success rate for these indicators was low, though higher than that in the arithmetic domain. Students demonstrated stronger abilities in interpreting discrete data in bar charts compared to continuous data in line graphs. However, they showed limited capacity to analyze the contextual meaning of variables on the X and Y axes and to draw implications from the data. These findings suggest that while students can interpret basic mathematical concepts, their skills remain at a fundamental level. This aligns with PISA results, which indicate that Indonesian students' numeracy skills are at level 2, meaning they can recognize and interpret only simple mathematical situations (OECD, 2023).

Table 7. Indicators in the Graph Domain

Indicator	Percentages
Translate information between graphical, numerical, and algebraic forms	32.57%
Understand that y=mx + c represents a linear relationship	25.61%

Students' understanding of the linear function y = mx + c was also limited. In this indicator, students are given a graph showing sugar consumption and the number of dental caries in various countries, but their ability to capture trends in the presented graph is also not optimal. These results are in line with several studies that found that students often experience difficulties in struggling to identify correlations and trends. These challenges are consistent with previous research showing that students often have difficulty transferring knowledge between mathematics and physics contexts (Angkotasan et al., 2024; Fitrieyah & Mabrouk, 2024; Becker et al., 2023). Generally, students tend to focus on surface features rather than developing a deep understanding of linear equations (Efuansyah et al., 2024). This result indicates that students' numeracy skills are still inadequate. Numeracy skills play a significant role in science learning, as they underpin the interpretation of graphs and data in physics, chemistry, and biology. Algebra, geometry, and arithmetic are also integral for solving quantitative problems, such as calculating microscope scale, object density, and stoichiometry. Therefore, integrating numeracy into science learning is necessary. This integration should include both quantitative analysis and conceptual reinforcement through arithmetic calculations, graphs, and diagrams. Teaching modules, discussion materials, and assessments should incorporate numeracy to familiarize students with quantitative analysis (Rizki & Nuranti, 2022; Soesanto & Dirgantoro, 2024). Additionally, assigning more challenging tasks during class discussions can enhance students' self-efficacy and motivation, thereby increasing their confidence in assessments (Street et al., 2022). Although this study found that students' numeracy skills are not yet optimal, the sample size was small, which restricts the generalizability of the findings. Nevertheless, the results contribute valuable insights into high school students' numeracy skills in science contexts and can inform the development of targeted teaching materials.

Conclusion

The study found that students' performance in solving numeracy problems within scientific contexts remained low, with an average score of 34.96 ± 11.15. Students demonstrated the highest proficiency in the handling data domain and the lowest in the arithmetic domain. Strengthening division operations, which underpin calculations involving decimals, ratios, fractions, and percentages, is necessary. Integrating numeracy into science curricula in a contextual manner may enhance students' numeracy skills. Future research recommendations include teacher training in the development of contextual-based numeracy biology teaching materials in order to improve students' numeracy skills.

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Conceptualization, PS; methodology, MKN; formal analysis, FR; writing—original draft preparation, PS, MKN; writing-review and editing, FR, MKN; visualization, FR; supervision, PS. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

References

Abrori, F. M., Tejera, M., & Lavicza, Z. (2024). Combining biology and mathematics in educational comics to explain evolution. *Journal of Mathematics and the Arts*. https://doi.org/10.1080/17513472.2024.2386646

Aini, V., Hidayat, T., Kusnadi, K., Williams, C., & Hadibarata, T. (2024). Analysis Numeracy Literacy Skills of High School Students in Biodiversity Material Based on Minimum Competency Assessment Questions. *Jurnal Pendidikan IPA Indonesia*, *13*(1), 128–136. https://doi.org/10.15294/jpii.v13i1.49265

Andrews, S. E., & Aikens, M. L. (2018). Life Science Majors' Math-Biology Task Values Relate to Student Characteristics and Predict the Likelihood of Taking Quantitative Biology Courses. *Journal of Microbiology & Biology Education*, *19*(2). https://doi.org/10.1128/jmbe.v19i2.1589

Angkotasan, N., Suharna, H., Abdullah, I. H., & Dahlan, S. (2024). The Difficulty of Students' Reflective Thinking in Problems Solving of Linear Program. *International Education Studies*, *17*(1), 18. https://doi.org/10.5539/ies.v17n1p18

Becker, S., Knippertz, L., Ruzika, S., & Kuhn, J. (2023). Persistence, context, and visual strategy of graph understanding: Gaze patterns reveal student difficulties in interpreting graphs. *Physical Review Physics Education Research*, *19*(2), 20142. https://doi.org/10.1103/PhysRevPhysEducRes.19.020142

Belinda, L. N., Margo Irianto, D., & Yuniarti, Y. (2023). Analisis Kesulitan Belajar Operasi Hitung Pembagian Matematika Pada Siswa Kelas 3. *Jurnal Review Pendidikan Dasar : Jurnal Kajian Pendidikan Dan Hasil Penelitian*, *9*(1), 37–42. https://doi.org/10.26740/jrpd.v9n1.p37-42

D'Ignazio, C., & Bhargava, R. (2016). DataBasic: Design Principles, Tools and Activities for Data Literacy Learners. *The Journal of Community Informatics*, *12*(3), 83–107.

https://doi.org/10.15353/joci.v12i3.3280

Efuansyah, Lukito, A., & Wijayanti, P. (2024). Utilizing task with scaffolding: growth of students' mathematical understanding from layers of image having to property noticing. *Perspektivy Nauki i Obrazovania*, *70*(4), 382–395. https://doi.org/10.32744/pse.2024.4.24

Fitrieyah, I. D., & Mabrouk, A. Ben. (2024). Analysis of Student's Difficulty in Solving Mathematical Problems in Linear Programs. *Journal of Teaching and Learning Mathematics*, *2*(1), 37–43. https://doi.org/10.22219/jtlm.v2i1.33680

Flanagan, K. M., & Einarson, J. (2017). Gender, math confidence, and grit: Relationships with quantitative skills and performance in an undergraduate biology course. *CBE Life Sciences Education*, *16*(3), 1–11. https://doi.org/10.1187/cbe.16-08-0253

Geiger, V., Goos, M., & Forgasz, H. (2015). A rich interpretation of numeracy for the 21st century: a survey of the state of the field. *ZDM - International Journal on Mathematics Education*, *47*(4), 531–548. https://doi.org/10.1007/s11858-015-0708-1

Giese, T. G., Wende, M., Bulut, S., & Anderl, R. (2020). Introduction of data literacy in the undergraduate engineering curriculum. *IEEE Global Engineering Education Conference, EDUCON*, *2020-April*, 1237–1245. https://doi.org/10.1109/EDUCON45650.2020.9125212

Gittens, C. A. (2015). Assessing Numeracy in the Upper Elementary and Middle School Years. *Numeracy*, *8*(1). https://doi.org/10.5038/1936-4660.8.1.3

González-Forte, J. M., Fernández, C., Van Hoof, J., & Van Dooren, W. (2022). Profiles in understanding operations with rational numbers. *Mathematical Thinking and Learning*, *24*(3), 230–247. https://doi.org/10.1080/10986065.2021.1882287

Hasnawati. (2016). Description of Mathematics Literacy Ability of Students First Secondary School State 15 Kendari Based on Content, Context, Materials, and Process. *International Journal of Education and Research*, *4*(11), 2016. Retrieved from www.ijern.com

Jaikla, J., Inprasitha, M., & Changsri, N. (2021). An Analysis of Students' Mathematical Competencies: The Relationship between Units. *International Educational Research*, *4*(1), 29. https://doi.org/10.30560/ier.v4n1p29

Jardine, N., Ondov, B. D., Elmqvist, N., & Franconeri, S. (2020). The Perceptual Proxies of Visual Comparison. *IEEE Transactions on Visualization and Computer Graphics*, *26*(1), 1012–1021. https://doi.org/10.1109/TVCG.2019.2934786

Jee, B. D., Matlen, B. J., Greenlaw, M., Simms, N., & Gentner, D. (2022). Spatial supports for comparison in educational science images. *Instructional Science*, *50*(6), 807–827. https://doi.org/10.1007/s11251-022-09599-0

Lee, S. J., & Shin, J. (2024). Middle School Students' Proportional Reasoning at Different Stages of Units Coordination. *International Journal of Science and Mathematics Education*, *0123456789*. https://doi.org/10.1007/s10763-024-10526-7

Madya, S., Rahman, A., & Ruslan, R. (2023). Analysis of Ability to Solve Geometry Problems in terms of Spatial Ability of Class XII Students of SMA Cokroaminoto Tamalanrea Makassar. *EduLine: Journal of Education and Learning Innovation*, *3*(2), 243–253. https://doi.org/10.35877/454ri.eduline1807

OCR. (2015). *This Mathematical Skills Handbook is designed*. Oxford Cambridge.

OECD. (2023). PISA 2022 Results Factsheets Indonesia. *OECD (Organisation for Economic Co-Operation and Development) Publication*, 1–9. Retrieved from https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/indonesia_c2e1ae0e-en.html

Pulungan, R. O. T., & Suryadi, D. (2019). From integer to real numbers: Students' obstacles in understanding the decimal numbers. *Journal of Physics: Conference Series*, *1157*(4). https://doi.org/10.1088/1742-6596/1157/4/042086

Puspitaningtyas, A. R., Fasica, N. F., & Ropida, R. (2023). Analisis Kesulitan Siswa Dalam Melakukan Operasi Pembagian Pada Kelas 3 Di Sdn 1 Talkandang Situbondo. *Jurnal IKA PGSD (Ikatan Alumni PGSD) UNARS*, *14*(2), 144. https://doi.org/10.36841/pgsdunars.v14i2.3932

Rafiola, R. H., Setyosari, P., Radjah, C. L., & Ramli, M. (2020). The effect of learning motivation, self-efficacy, and blended learning on students' achievement in the industrial revolution 4.0. *International Journal of Emerging Technologies in Learning*, *15*(8), 71–82. https://doi.org/10.3991/ijet.v15i08.12525

Ramdhani, Y., Hayati, L., Novitasari, D., & Hikmah, N. (2025). Analisis Kemampuan Numerasi Siswa Dalam Menyelesaikan Soal Asesmen Kompetensi Minimum di SMA Negeri 1 Alas. *Jurnal Ilmiah Profesi Pendidikan*, *10*(2), 1842–1849. https://doi.org/10.59672/emasains.v14i1.4553

Rangkuti, R. K., Khabibah, S., & Ekawati, R. (2024). Spatial reasoning of mathematics education students: an analysis of differences in solving hyperbola problems based on level of geometry ability. *Perspektivy Nauki i Obrazovania*, *72*(6), 248–260. https://doi.org/10.32744/pse.2024.6.16

Rizki, I. M., & Nuranti, G. (2022). Profil Kemampuan

Literasi Numerasi Peserta Didik SMA Pada Pembelajaran Biologi Kelas XII Pada Materi Evolusi. *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *08*(03), 36–42. Retrieved from https://online-journal.unja.ac.id/biodik

Sahil, J., Hasan, S., Haerullah, A., & Saibi, N. (2022). Penerapan Pembelajaran Abad 21 pada Mata Pelajaran Biologi di SMA Negeri Kota Ternate. *Biosfer : Jurnal Biologi Dan Pendidikan Biologi*, *7*(1), 13–19. https://doi.org/10.23969/biosfer.v7i1.5430

Samputri, S., & Arif, R. N. H. (2024). Description of Numeracy Literacy Skills in Science Learning. *Edumaspul: Jurnal Pendidikan*, *8*(1), 1693–1703.

Sartianis, G., & Yuliati, L. (2022). Mipa Dalam Mata Pelajaran Fisika Numerical Literacy Skills of 11th-Grade Math and Natural Science Senior High School Students in Physics Subjects. *Jurnal Inovasi Pendidikan Sains*, *13*(2), 168–176.

Satriawan, H. (2018). Problematika Pembelajaran Matematika Pada Materi Statistika Smp Kelas Ix. *Jurnal Elektronik Pembelajaran Matematika*, *5*(3), 278–285. Retrieved from http://jurnal.uns.ac.id/jpm

Scott, F. J. (2017). A Simulated peer-assessment approach to improve students' performance in numerical problem-solving questions in high school biology. *Journal of Biological Education*, *51*(2), 107–122. https://doi.org/10.1080/00219266.2016.1177571

Scott, F. J. (2021). An investigation into students' difficulties in numerical problem solving questions in high school biology using a numeracy framework. *European Journal of Science and Mathematics Education*, *4*(2), 115–128. https://doi.org/10.30935/scimath/9458

Siregar, B. H., Sihombing, T. V., Purba, F., Sulaiman, R. P., Tarigan, N. C. W., Hutapea, Y., & Dhuha, N. K. (2024). Analisis Kesalahan dalam Penyelesaian Soal SPLDV: Studi pada Literasi Numerasi Siswa Kelas X SMA. *Journal of Education Research*, *5*(4), 5940–5947. https://doi.org/10.37985/jer.v5i4.1924

Soesanto, R. H., & Dirgantoro, K. P. S. (2024). Investigation of numeracy proficiency levels among elementary students through the PEMANTIK assessment tool. *Journal of Honai Math*, *7*(1), 1–18. Retrieved from https://journalfkipunipa.org/index.php/jhm/article/view/521

Street, K. E. S., Stylianides, G. J., & Malmberg, L. E. (2022). Differential relationships between mathematics self-efficacy and national test performance according to perceived task difficulty. *Assessment in Education: Principles, Policy and Practice*, *29*(3), 288–309. https://doi.org/10.1080/0969594X.2022.2095980

Sulak, T. N., Wilson, R., Renbarger, R. L., Kaul, C. R., & O'Guinn, N. (2020). The relationships between numeracy scores and soft skills in employed and unemployed Americans. *New Horizons in Adult Education & Human Resource Development*, *32*(2), 19–39. https://doi.org/10.1002/nha3.20281

Tanti, T., Kurniawan, D. A., & Ningsi, A. P. (2020). Description of students' science process skills on density material. *Jurnal Inovasi Pendidikan IPA*, *6*(2), 156–164. https://doi.org/10.21831/jipi.v6i2.33862

Yu, M., Cui, J., Wang, L., Gao, X., Cui, Z., & Zhou, X. (2022). Spatial processing rather than logical reasoning was found to be critical for mathematical problem-solving. *Learning and Individual Differences*, *100*(September), 102230. https://doi.org/10.1016/j.lindif.2022.102230

Zwanch, K., Carter, H. C., & Davenport, J. (2024). Translating units coordination to units of length and area: a case study of undergraduate interior design students. *Research in Mathematics Education*, *26*(4), 407–424. https://doi.org/10.1080/14794802.2022.2160801