The Effectiveness of Electronic Use of Moodle-Assisted Modules in Student Numeracy Literacy Learning

Hema Widiawati*, Sujarwo, and Bambang Saptono

Faculty of Education and Psychology, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
Email: hemawidiawati.2022@student.uny.ac.id (H.W.); sujarwo@uny.ac.id (S.); b.saptono@uny.ac.id (B.S.)
*Corresponding author

Manuscript received November 24, 2024; revised January 1, 2025; accepted February 25, 2025; published August 22, 2025

***Abstract*—The integration of Moodle-assisted e-modules is essential for enhancing students' numeracy literacy, enabling them to solve real-life problems more effectively. This study examines the impact of Moodle-assisted e-modules as an interactive learning tool using a quasi-experimental design with a mixed-methods approach and longitudinal analysis. A total of 150 fifth-grade elementary school students in Cirebon City, West Java, Indonesia, participated in the experimental group using Moodle-assisted e-modules, while another 150 students in the control group relied on conventional textbooks. Quantitative data were analyzed through paired t-tests, N-gain scores, and repeated-measures Analysis of Variances (ANOVAs), while qualitative data were collected via interviews with educators and students. The findings revealed that post-test scores in the experimental group were significantly higher than in the control group. The control group achieved an N-gain score of 0.23 (low category), whereas the experimental group attained 0.62 (medium category). The longitudinal analysis further confirmed that the improvement in numeracy literacy skills was substantial and long-lasting (F = 341.724, p < 0.001). Additionally, questionnaire responses indicated that most students found the Moodle-assisted e-modules engaging and motivating, which enhanced their understanding of the subject matter. These results highlight the effectiveness of technology-assisted learning in improving numeracy skills and fostering innovation in teaching methods. By adapting to diverse learning styles, this approach can be widely implemented to increase student engagement and enhance foundational education. The study underscores the long-term benefits of integrating digital learning tools into elementary education.**

***Keywords*—Moodle, electronic module, numeracy literacy, technology**

I. Introduction

Technological advancements have profoundly influenced the educational landscape, reshaping teaching methods and learning outcomes [1]. Technology offers substantial benefits by providing students with flexible access to information and fostering greater engagement in their studies. Through the continuous development and application of Information and Communication Technology (ICT), it is possible to achieve transformative changes in education, which can lead to sustained improvements in the quality of learning [2]. Integrating multimedia into the learning process and actively integrating participation, as it blends entertainment with education participation and the active implementation of innovative learning concepts. When e-learning uses multimedia to stimulate students, create an engaging teaching environment, and enhance their academic performance [3, 4].

Numeracy literacy skills are essential for everyday life and are among the key competencies required in the 21st century [5]. All of these talents are necessary for academic success: the ability to get along with others, be responsible, control oneself, persevere, be creative, solve problems, and make good decisions [6–8]. Furthermore, the foundation of early academic and numeracy literacy skills is essential for developing subsequent abilities and predicts long-term academic achievement [9, 10]. Students' numeracy and reading levels will differ when they start school, despite the significance of these early abilities [11, 12]. Students who begin their education with insufficient numeracy literacy skills frequently encounter challenges in reading and arithmetic as they progress through their academic journey [13]. This foundational knowledge is essential, as it provides the basis for acquiring numeracy literacy skills within a school environment. Early numeracy literacy skills encompass various areas of understanding, including number recognition, quantity comparisons, basic calculations, and verbal problem-solving [14]. Therefore, numeracy literacy extends beyond merely studying symbols and numbers; it also involves analyzing information and applying reasoning skills [15]. Additionally, it plays a significant role in equipping students with the abilities needed for pursuing careers across various scientific fields in the future [16].

Many students consider mathematics challenging, primarily due to their relatively low numeracy literacy skills. Indonesia was placed 72nd out of 78 participating nations in the 2018 Programme for International Student Assessment (PISA) in Mathematics, further supporting this. While 69% of Organisation for Economic Co-operation and Development (OECD) students achieved Level 2 competency in mathematics, just 18% of Indonesian pupils did so. Students at this level are able to understand and identify, with little or no instruction, the mathematical representations of simple situations [17]. In contrast to the OECD average of 9%, a vanishingly small fraction of Indonesian students attains levels 5 or 6 on the PISA math's test, which indicates that students can mathematically model complex problems and choose, compare, and assess suitable problem-solving solutions to tackle them [17]. Looking at the outcomes of Trends in International Mathematics and Science Study (TIMSS) and PISA, Indonesia's education quality may still be considered low on both the national and international levels. Numeracy literacy stands out as a vital competence in Indonesia's school system, which is notoriously poor [18, 19].

Some of the things that cause low knowledge of elementary school students in Indonesia include the lack of students' mathematical ability to solve reasoning problems and problem-solving and student literacy reasoning in mathematical symbols, which are still low [19, 20]. In the meantime, field research (including interviews with elementary school teachers at SDN Nusantara Jaya, SDN 1

Kemakmuran, SDN 2 Kemakmuran, and SDN 3 Pulasaren in Cirebon City on February 6, 2023) suggests that one reason is that math education still mostly relies on traditional methods, which leads to student boredom and a lack of effective learning tools. The Handbook for Teachers and Students as a Resource for Education Because of this, there aren't enough tools for educators and resources for students to learn. Students' negative attitudes toward traditional teaching methods are evidence that these approaches fail to engage their critical thinking skills [21].

The usage of Moodle-assisted electronic modules is one of the educational innovations that have emerged in tandem with technology improvements to better equip pupils. Moodle is a digital learning platform that offers a variety of learning resources to students and encourages them to actively participate in their own education. In the context of numeracy literacy, the integration of Moodle with learning modules focused on numbers and geometry can provide a more enjoyable and practical approach than conventional methods.

Although previous research has highlighted the importance of numeracy literacy in academic and everyday life contexts, research that addresses the integration of Moodle-based electronic modules in primary education, particularly in Indonesia, is still limited. In contrast to conventional methods, this study investigates the potential combination of technology-based solutions with a structured numeracy literacy curriculum. With a focus on real-world application and skill development, this research fills critical literature gaps and offers insights into innovative approaches to improving basic math skills in young learners.

Recent educational research directions emphasize ICT integration to improve cognitive and practical skills [22]. For example, research shows that technology-based learning tools improve student motivation and academic performance by encouraging active participation and personalized learning experiences. However, the specific impact of Moodle-based modules on numeracy literacy has not been widely explored, so this study has become very relevant. Using a quasi-experimental design, this study evaluates the effectiveness of the module in addressing the gap in the development of existing numeracy skills.

Research has demonstrated that incorporating technology into the classroom may enhance students' intrinsic and extrinsic motivation, as well as their self-achievement levels. The students in the study showed more motivation to learn when they were taught using multimedia in the classroom, which helped create an innovative and active learning environment. Using Moodle-assisted electronic modules in numbers and geometry, this study examines fifth graders' numeracy literacy abilities. Finding the difference between students' pre- and post-test results in traditional classroom instruction and instruction using Moodle-assisted e-modules is the central research question. There is an immediate need for new, more effective ways of teaching mathematics in the modern digital age, and this research is timely because of the poor level of numeracy literacy among Indonesian students. Examining how well Moodle-assisted electronic modules help fifth graders grasp mathematical ideas, particularly those pertaining to geometry, is the primary goal of this research. The overarching goal of this study is to help educators deal with the complex problems of today's classrooms by developing a technology-based learning paradigm that boosts student performance.

II. Literature Review

A. Moodle-Assisted Module Electronics

Modules delivered digitally to facilitate student engagement and learning are known as electronic resources [23]. Teachers can save time and effort when they use e-modules to provide content to their pupils. Being in step with modern technology advances, it adds an element of intrigue to the learning process. Content in e-modules is presented in a variety of ways, not only text. Video, music, short films, and other multimedia formats are also viable options for its presentation [24]. Creating educational resources that are accessible through electronic means is comparable to creating electronic books. Typically, it is vital for electronic modules to have self-instruction, independence, flexibility, and user-friendliness. For this reason, e-modules may serve as students' primary learning resource when designed with their profile in mind and built in an interesting way to avoid boredom [25].

A web-based architecture that was designed using an object-oriented methodology, Moodle stands for a modular object-oriented dynamic learning environment. It is a living system for education [26]. The Moodle app's technology is great for generating engaging learning environments since it has several features that facilitate two-way communication between instructors and students. Among these features are conversations, discussion forums, quizzes, and assignments [27]. Online learners' motivation, self-efficacy, and learning outcomes are all positively affected by using e-modules, according to research by Fitra *et al*. [23]. Furthermore, data from Maryati *et al.* [26] demonstrates that students who have utilized Moodle learning have demonstrated an improvement in their statistical literacy abilities. Therefore, one alternative to generate engaging and motivating interactive learning in the classroom is to use e-modules supported by Moodle.

B. Numeracy Literacy of Students

The ability to reason systematically, understand abstract structures, and apply mathematical principles are all components of numeracy literacy. Number theory, geometry and measurement, algebra, and data processing are the four current domains that make up numeracy literacy [28]. Meanwhile, Lüssenhop and Kaiser [29] mentioned that there are six levels to the numeracy literacy indicator according to PISA. All necessary knowledge is at their fingertips at the first level, and pupils may answer questions in a broad context. Students at this level are able to identify and understand circumstances that call for quick judgments, as well as to solve issues using simple algorithms, formulae, processes, or agreements, and to draw suitable conclusions from their work. At the third level, students can perform procedures requiring sequential decisions and make descriptions based on their interpretations and reasoning results. At the fourth level, students can move effectively with specific and complex methods, concrete situations involving obstacles, make assumptions, and select and use different representations, including symbols. The fifth level encompasses the following skills: reasoning and thinking, developing and working with

models for statistical problems, accurately relating symbolic representations to situations, and describing and formulating work outputs. At the sixth level, students are able to apply what they've learned in study and modelling to real-world statistical scenarios, as well as to think critically about their own conclusions, interpretations, opinions, and the correctness of their work when doing so. Students who are literate in mathematics tend to think in a way that makes problem-solving a breeze [30].

C. Bloom's Taxonomy of Cognitive Domains

Educators originally created Bloom's taxonomy to aid in the development and revision of curriculum, evaluation methodologies, and educational activities; it focuses on three domains: (1) cognitive, (2) emotive, and (3) sensory [31]. The current study follows the PIAAC's (Programme for the International Assessment of Adult Competencies) example by focusing only on cognitive abilities. Developing one's ability to think at a low level is the first rung on the cognitive talent ladder, according to Bloom and colleagues. These can then be honed into Higher and Middle Level Cognitive Abilities. Anderson, who was a student of Bloom's, and Krathwohl, who was on the original Bloom team, are the main authors of the updated taxonomy that has been published [32]. The original Bloom taxonomy was revised in 2001 to change the "nouns" to "verbs." Renamed "evaluate" and "create," the two highest-level thinking skills were flipped and renamed. Unfortunately, "evaluation" was always present, as Bloom (1956) argues. Blooms taxonomy confirms that "knowledge" or "remembering" is an essential Low-Level Thinking Skill. The ability to "get it" or "get it" is another example of a memory-based low-level thinking skill. Once you've nailed memorizing and comprehending, it's time to move on to the intermediate level and learn how to apply and analyse. People should have the capacity to "evaluate" and "create" new ideas or results using their existing knowledge and skills in memorization, comprehension, application, and analysis. At its most basic level, knowledge according to the first Bloom's taxonomy can have an empirical basis. However, it can also be more topical or based on abstract ideas or theories; for instance, it could include learning specialized methods. Both the original and updated basic taxonomies only use one term per cognitive domain; however, synonyms have been added to further enhance their meaning. Examples of these synonyms have also been included in Table 1.

Table 1. Bloom's original and revised taxonomy with synonyms

Cognitive Levels	Bloom	Anderson and Krathwohl [32]	Synonyms
High Order 1	Evaluation	Create	Design, build, plan, create, make,
High Order 2	Synthesis	Evaluate	Criticize, experiment, assess, test, detect, monitor
Medium Order 1	Analysis	analyze	Comparing, organizing, deconstructing, linking, deciphering, discovering, composing, integrating
Medium Order 2	Application	Apply	Apply, implement, use,
Low Order 1	Comprehension	Understand	Interpret, summarize, conclude, paraphrase, classify, compare, explain, exemplify
Low Order 2	Knowledge	Remember	Recognize, list, describe, identify, retrieve, name, locate, find

As part of the Programme for the International Assessment of Adult Competencies (PIAAC), an expert committee on varied skills developed critical components for directly evaluating cognitive abilities (literacy and numeracy) (OECD, 2013). Multiple cognitive techniques are being evaluated using the PIAAC (Program for the International Assessment of Adult Competencies) conceptual framework, as shown in Table 1: One must be able to (1) recognize, (2) find, or (3) apply numeracy; and (3) understand and assess it. A number scale, from 1 to 6, is used to indicate the outcomes of the cognitive skills exam for literacy and numeracy. The bare minimum for reading, writing, and arithmetic skills needed to succeed in the modern world is Level 3, according to most experts [33].

Numeracy skills develop across six cognitive levels, ranging from basic understanding to complex problem-solving. Levels 1–2 involve fundamental skills such as recognizing, categorizing, and performing simple operations. Levels 3–4 focus on applying mathematical concepts in various contexts, analyzing data, and understanding patterns and proportions. Levels 5–6 require abstract thinking, critical evaluation, and the development of mathematical models. The classification of numeracy proficiency levels and their indicators is presented in Table 2.

Table 2. PIAAC literacy and numeracy descriptors based on proficiency levels adapted from [33]

Levels	Indicators
Level 1	Participants at this level are expected to complete tasks that include fundamental numeracy skills, such as counting, sorting, and working with numbers or money.
Level 2	Mathematical tasks at this level include basic operations like sorting and basic arithmetic, understanding percentages like 50%, and finding and identifying common or simple elements in visual or spatial representations. Students must apply these skills in a concrete and general context.
Level 3	Students at this level are expected to find and apply mathematical concepts and information in a range of general contexts. This encompasses a wide range of activities, from making educated guesses to analyzing basic statistics and data provided in written forms (such as tables and graphs) and using basic numerical representations (such as percentages and fractions) in calculations.
Level 4	Students at this level must be able to interpret mathematical knowledge provided in increasingly complicated ways and embedded in settings with which they may be unfamiliar. The capacity to understand and work with numerical and verbal depictions of mathematical relationships, patterns, and proportions; reading and understanding statistical data offered in a variety of formats (e.g., texts, tables, and graphs); and spatial and numerical knowledge are all necessary to solve these problems.
Level 5	Mathematical concepts at this level might be complex, abstract, or presented in strange ways, so students need to be able to decipher them. A number of phases are involved in these activities, and the right tactics and problem-solving approaches need to be chosen. At this stage, you might also have to grasp arguments and provide rational justifications for your replies or choices.
Level 6	Students at this level are expected to comprehend intricate texts that provide abstract and formal notions in mathematics and statistics, as well as to comprehend complicated representations of these concepts. Reasoning, evaluating, and critically reflecting on current solutions or alternatives, drawing conclusions, developing or working with arguments or mathematical models, and integrating various kinds of mathematical knowledge that need a suitably in-depth translation or interpretation may all be tasks that students face.

Based on some of the indicators above, we modified the ones we took based on the research [17, 32, 33], which can be seen in Table 3 below.

Table 3. Indicator of numeracy literacy

No.	Indicators	Levels
1	Identify	1 & 2
2	Using the Concept	3 & 4
3	Resolve of problem	5 & 6

D. Conceptual Framework

The diagrammatic representation of the relationships between the variables as shown in Fig. 1, reveals that students' numeracy literacy is positively impacted by the use of e-modules that are assisted by Moodle. The interactivity and flexibility of the e-modules facilitate student engagement in the learning process, and the moderating effect of student learning motivation can amplify or dampen these relationships. Conventional learning that is less interactive is the leading cause of low numeracy literacy of students. Meanwhile, the components in the Bloom Taxonomy are used as a reference in the learning process, while PISA is an indicator to measure students' numeracy literacy skills.

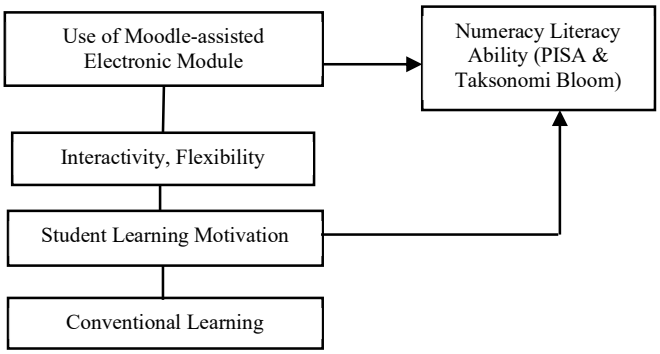


Fig. 1. Conceptual framework.

The learning experience is now more interactive thanks to innovations like e-modules helped by Moodle. Video lessons, interactive simulations, interactive quizzes, and online discussion forums allow students to do more than just absorb knowledge; they can also contribute to their own learning. Through the use of Moodle, students have the freedom to study at their own speed, whether that's alone or in small groups All these efforts aim to improve students' numeracy literacy so that they not only understand the concept of numbers but are also able to apply them in daily life. Ultimately, the combination of conventional methods, Bloom's taxonomy, and technologies like Moodle help create learning that is more engaging, effective, and future-ready.

Hwang and Chang [3] found that the use of technology creates an interactive learning environment and supports problem-based learning. Moreover, Xiao *et al.* [5] highlights that technology plays a crucial role in improving students' problem-solving skills. Moodle, as one of the Learning Management System (LMS)-based learning platforms, has interactive features that can support the development of numeracy literacy.

III. Materials and Methods

This research is a hybrid of a quasi-experimental design with a longitudinal analysis. The data was collected using a pre-test, a post-test, and a follow-up examination six months later to look at the long-term effects. This method was chosen for a more thorough comprehension as it permits the combined gathering of quantitative and qualitative data [34, 35]. Research using a quasi-experimental design was employed. There were two groups of students in this study: one that received traditional classroom instruction, and another that participated in the experiment by using online modules developed by Moodle. If we wanted to see if our intervention helped students with lower starting abilities improve their numeracy literacy skills, we choose the class with the lowest average pre-test score to be our experimental group. Gathering data was done by administering tests before the intervention, after the intervention, and again six months later. The instruments used provide consistency, which is crucial for ensuring the accuracy and reliability of the results. We compared the pre- and post-tests using an independent t-test, and we looked at the changes in all three measurement stages using Repeated Measures ANOVA, for the quantitative data analysis. We gathered qualitative data from in-depth interviews to learn about their thoughts and feelings about using e-modules with Moodle [36].

One hundred twenty-five primary schools in five different Cirebon City sub-districts made up the research target. A total of six A-accredited primary schools were chosen as study sites from this demographic. Fifty kids were divided into two groups: one for the control group and another for the experimental group. To ensure the reliability of the research, we only considered schools with an A accreditation, presuming that these institutions adhere to higher, more equitable requirements for educational excellence. Purposive sampling is employed in the sampling approach to pick respondents who are deemed to give the most relevant and useful information about the target population. So that research resources may be used more efficiently, this strategy helps researchers focus on situations that are considered essential [37].

In this study, the posttestacy literacy test consists of sixteen multiple-choice questions tailored to the learning goals of the geometry and number concepts covered in mathematics classes. As part of Bloom's Taxonomy, fill-in questions are utilized to evaluate candidates' knowledge and teaching abilities. Different sorts of queries can be evaluated using them. There was a subsequent computation of student scores following the administration of pre- and post-tests. An independent t-test was performed on the data at the 5% level to see if there was a difference between students who used electronic courses facilitated by Moodle and those who did not. In order to forecast numeracy scores using pre- and post-tests, pre-test levels, and post-test values, the standardized n-gain approach developed by Banawi *et al*. [38] was employed. Finding out how effective an intervention is requires comparing learning results before and after treatment using n-gain [39]. Three distinct degrees of efficacy are assigned to the n-gain value: high, medium, and low. The intervention was deemed very successful if the n-gain value was less than or equal to 0.7. If the N-Gain is less than 0.7 and the n-gain value is between 0.3 and 0.7, showing that there is room for improvement while the efficacy is satisfactory, the result is a category. At the same time, if the n-gain value is less than 0.3, it means that the intervention is not very successful or doesn't

have much of an influence on developing students' number literacy abilities. To determine if the intervention was effective in raising students' numeracy literacy scores, this categorization is used.

The Moodle-based electronic module will later be accessible at https://literasinumerasisd.com/login/index.php. Users (authorized students and teachers) can use the electronic module after logging into the system. The main page is shown in Fig. 2.

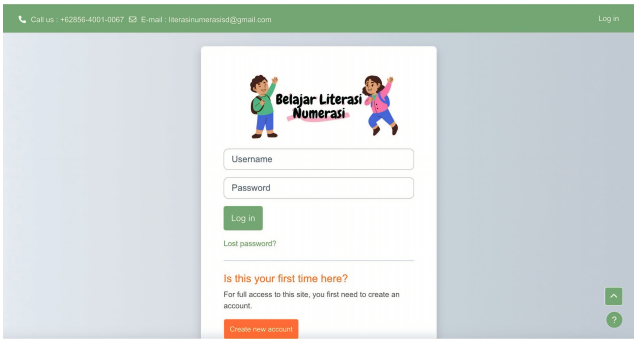


Fig. 2. The main page of e-modules on Moodle.

This study aims to determine the effectiveness of the use of Moodle-assisted module electronics in numeracy literacy learning in Grade V students in elementary school. The documentation of numeracy literacy instruction using the Moodle-assisted electronic module in a fifth-grade elementary school class is shown in Fig. 3 below.

Fig. 3. Moodle-assisted module electronics in teaching literacy numeracy.

IV. Result and Discussion

An electronic module was created to help students enhance their numeracy literacy abilities. It was evaluated using the student numeracy literacy test. It was standard practice to administer the numeracy literacy exam in both the pre- and post-test periods of each class before implementing the Moodle-assisted electronic module. Testing hypotheses using pre- and post-test scores on students' numeracy literacy abilities reveals how successful Moodle-assisted electronic programs are.

Analyses were conducted using students' responses to numeracy literacy exam questions both before and after the intervention. Topics covered include recognizing, applying, and solving issues, all of which are markers of numeracy. With the use of a mapping of the PISA (Program for International Student Assessment) content and numeracy literacy indicators, questions regarding numeracy literacy were prepared. The elements on the test were descriptions.

A. Control Class Numeracy Literacy Result Data

Numeracy literacy skills can be measured through three indicators: identifying, using numeracy concepts, and solving problems. The results of numeracy literacy scores in the control class can be seen in detail as follows.

The results in Table 4 above show an increase in each indicator of numeracy literacy in the control class. The increase in the identification indicator with a gain of 0.25 is categorized as low. The increase in the indicator of using numeracy concepts with a gain of 0.27 is low. The increase in the indicator of solving numeracy literacy problems with a gain of 0.24 is low. Thus, numeracy literacy skills in the control class increased with a total gain of 0.25 but still in the low category.

Table 4. Indicator results of numeracy literacy skills in the control class

No.	Indicators	Pre-test	Post-test	Gain	Criteria
1	Identify	47.52	56.51	0.25	Low
2	Using the Concept of Numeration	34.56	51.35	0.27	Low
3	Solving the problem	39.73	55.03	0.24	Low
	Average	40.60	54.30	0.25	Low

B. Experimental Class Numeracy Literacy Outcome Data

The results of numeracy literacy scores in the experimental class. The following is a summary of the results of numeracy literacy skills on each indicator in the experimental class.

The results presented in Table 5 indicate improvements across all numeracy literacy indicators in the experimental class. The gain score for the identification indicator (0.59) is categorized as moderate, while the gain for concept application (0.60) and problem-solving (0.62) also fall within the moderate range. The experimental class improved across the board in terms of numeracy literacy, as seen in the table above. A gain of 0.59 is considered a modest improvement in the identification indicator. With a rise of 0.60, the indicators that use numeracy concepts show a moderate increase. A gain of 0.62 indicates a moderate improvement in the indicator of solving math literacy issues. Consequently, there was a 0.60-point improvement in the experimental group's numeracy literacy abilities in the medium group.

Table 5. Indicator results of numeracy literacy skills in experimental classes

No.	Indicators	Pre-test	Post-test	Gain	Criteria
1	Identify	36.24	76.24	0.59	Medium
2	Using the Concept of Numeration	35.35	74.72	0.60	Medium
3	Solving the Problem	31.68	74.36	0.62	Medium
	Average	34.42	75.11	0.60	Medium

C. Comparative Data of Numeracy Literacy Skills

The data utilized to compare the control and experimental groups is based on how well each indicator measures progress in numeracy literacy. Table 6 below details the data summary along with the pre- and post-test values of the numeracy literacy test results for the control and experimental courses.

Table 6 shows that the control group, whose members engage in routine numeracy literacy activities utilizing course

materials (textbooks and library books), had an average pre-test score of 40.25. A score of 54.83 was found for numeracy literacy skills after the exam. The control group's numeracy literacy abilities improved somewhat (0.23) between the pre- and post-tests, but they were still below the minimum required level. During numeracy literacy hours, students in the control group made progress under the teacher's tutelage by completing both content-specific and practice problems.

Table 6. Comparison results of numeracy literacy skills

No.	Class	Average Value		Gain	Criteria
		Pre-test	Post-test		
1	Control	40,25	54,83	0,23	Low
2	Experiment	34,54	75,21	0,62	Medium

The experimental class recorded an average pre-test score of 34.54 on the numeracy literacy test. After the intervention, which involved using Moodle as a platform for numeracy literacy exercises, the experimental class achieved an average post-test score of 75.21. A moderate increase of 0.62 points in numeracy literacy skills was observed between the pre-test and post-test scores. As a result, the experimental group demonstrated a significantly higher n-gain compared to the control group. Fig. 4 below illustrates how the experimental class performed relative to the control class in terms of numeracy literacy.

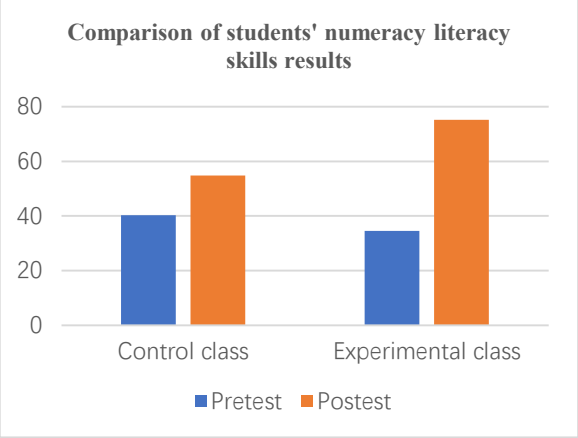


Fig. 4. Comparison of numeracy literacy results.

Research shows that students' numeracy literacy skills increased more in the experimental group than in the control group. So, the Moodle-assisted e-module test has the potential to somewhat increase students' numeracy literacy skills. The experimental group greatly outperformed the control group in terms of increase in numeracy literacy, as seen in Fig. 1. Control class students' scores increased by 14.58 with a gain of 0.23, while experimental class scores increased by 40.67 with a gain of 0.62.

D. Independent t-test

In order to find out if the experimental and control groups had different levels of numeracy literacy, we used an independent t-test.

The hypothesis tested for the numeracy literacy variable is as follows.

Ho : There is no difference in numeracy literacy skills between students who use Moodle-assisted electronic modules and students who do not use Moodle-assisted electronic modules.

Ha : There is a difference in numeracy literacy skills between students who use Moodle-assisted electronic modules and students who do not use Moodle-assisted electronic modules.

To accept or reject Ho at the 0.05 level of significance, we look at the significance value; if it's more than 0.05, we accept Ho. According to the significance level, Ho is rejected if it is less than 0.05. Data from an independent t-test on numeracy literacy are presented in Table 7.

Table 7. Independent t-test results of numeracy literacy skill

Class	Condition	Significance	Condition
Control Class	Post-test	0.000	There is a Difference
Experiment Class	Post-test	0.000	There is a Difference

In accordance with the findings of the independent t-tests shown in Table 7, the significance value for each \0.05 is 0.000. The consequence is that students' numeracy literacy abilities fluctuate depending on whether they utilize or do not use electronic courses helped by Moodle. This is because Ha is accepted and Ho is refused accordingly.

The experimental group demonstrated a higher modesty N-gain value of 76.24 at levels 1 and 2 compared to the control group. Indicators employing level 3 and 4 ideas produced higher results (74.72 vs. 0.60, indicating a medium n gain value) in the experimental group than in the control group, proving that the two sets of ideas are distinct. The experimental group outperforms the control group on level 5 and 6 problem-solving abilities with a 74.36 indicator (or a n gain value of 0.62, indicating a medium-level indication).

E. Results of the Longitudinal Study

In Table 8, the research results indicate that the use of Moodle-assisted E-Modules significantly improves students' numeracy literacy skills. The multivariate analysis revealed that there was a significant influence of time on the change in students' scores ($F = 218.629$, $p < 0.001$), which showed that along with the use of E-Modules, there was a significant increase in numeracy literacy.

Table 8. The result of the multivariate

Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.
Waktu	Pillai's Trace	0.817	218.629[c]	3.000	147.000	<0.001
	Wilks' Lambda	0.183	218.629[c]	3.000	147.000	<0.001
	Hotelling's Trace	4.462	218.629[c]	3.000	147.000	<0.001
	Roy's Largest Root	4.462	218.629[c]	3.000	147.000	<0.001

Note: c: Exact statistic

Furthermore, the results of the univariate test in Table 9 show that before the use of the Moodle E-Module, there was a variation in the initial score among students (Pre-test: $F =$ 44.404, $p < 0.001$), which reflected the uneven numeracy literacy ability. After the intervention with E-Module, students' scores improved significantly (Post-test: $F =$

315.499, $p < 0.001$), indicating that the use of Moodle contributed to better numeracy comprehension. Even in long-term measurements, the increase remained significant (Longitudinal: $F = 341.724$, $p < 0.001$), which shows that the learning effect of using the Moodle E-Module is continuous and stable.

Table 9. Result of repeat measure ANOVA

Source	Measure	Waktu	Type III Sum of Squares	df	Mean Square	F	Sig.
Waktu	Pre-test	Linear	62.563	1	62.563	44.404	<0.001
	Post-test	Linear	797.070	1	797.070	315.499	<0.001
	Longitudinal	Linear	1680.333	1	1680.333	341.724	<0.001
Error(Waktu)	Pre-test	Linear	209.937	149	1.409		
	Post-test	Linear	376.430	149	2.526		
	Longitudinal	Linear	732.667	149	4.917		

The longitudinal results showed that the effect of the Moodle-based module intervention lasted for six months after the post-test, with a significant improvement in students' numeracy skills. This indicates that technology-based learning is not only effective in the short term but also supports the development of competencies in a sustainable manner.

The results of this study show that using Moodle-based electronic modules significantly improves the numeracy literacy ability of Grade V elementary school students, especially in three leading indicators: identification, concept use, and problem-solving. This improvement can be further analyzed using Bloom's taxonomic framework, which offers six cognitive domains: remembering, understanding, applying, analyzing, evaluating, and creating.

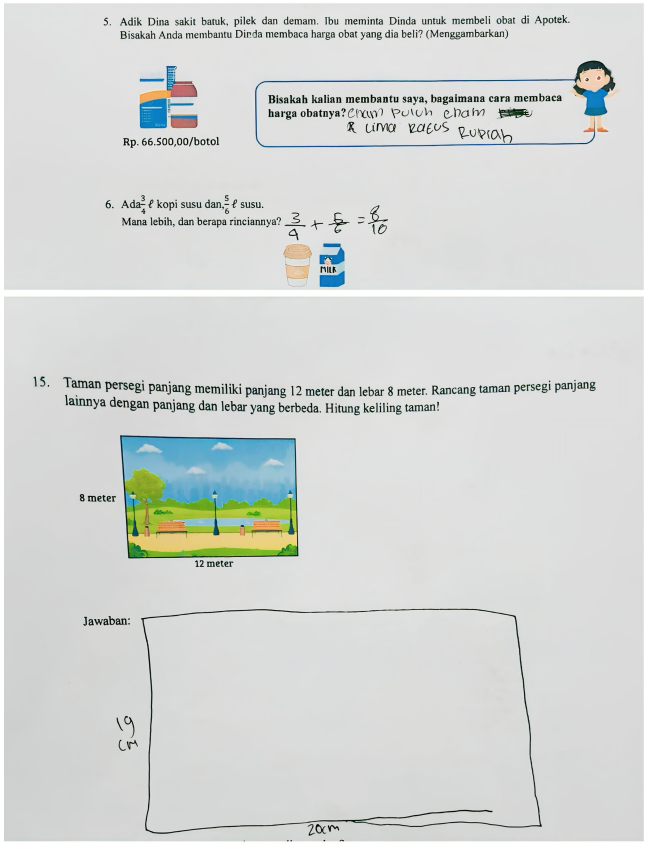


Fig. 5. Results of students in the control class.

There are several examples of student answers in the control class and experiments related to the cognitive level of Bloom's taxonomy, as shown in Fig. 5 for the control class and Fig. 6 for the experimental class.

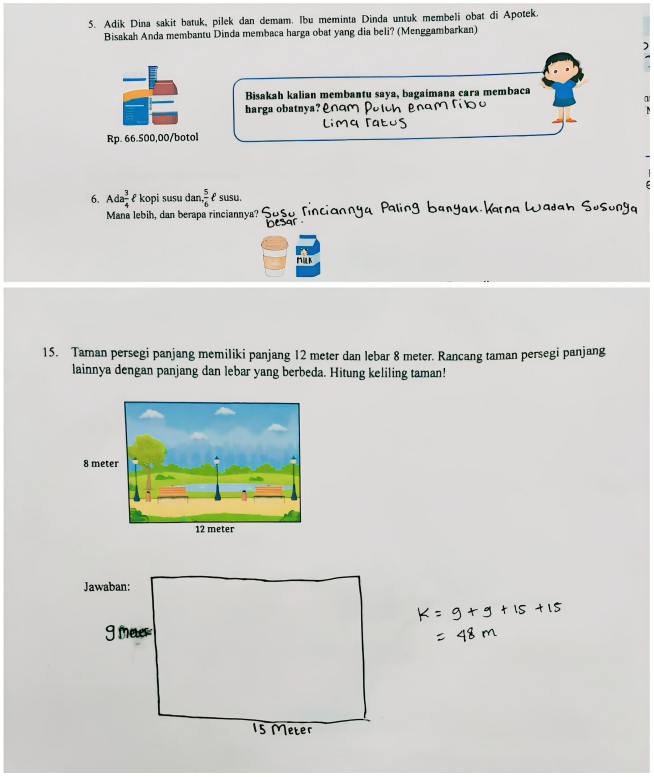


Fig. 6. Results of students of the experimental class.

1) Identification indicators

In these indicators, students are asked to recognize basic information, such as numbers and mathematical symbols. Example of a student's answer related to test question no. 5, student 1 (control class): Write "sixty-six five hundred rupiahs" (incorrect because it does not mention "thousand" correctly). Student 2 (experimental class): Write "sixty-six thousand five hundred" (more appropriate because it is in accordance with the way of reading numbers in Indonesian currency). Student 2, who was in the experimental class, showed a better ability to understand the problem and give logical answers. The questions presented can be categorized according to the level of understanding based on Bloom's Taxonomy. This is because students are asked to help Dinda read the price of the medicine she bought, which requires them to understand and interpret the information available. In this taxonomy, comprehension includes the ability to explain, describe, and analyze information. Keywords in the question, such as *"Can you help Dinda read the price?"* indicate that students need to identify and understand drug prices, not just remember information. This ability corresponds to the low-level cognitive domains in Bloom's taxonomy, namely

"remembering" and "understanding." The Moodle-assisted Electronic Module helps students access learning content designed to reinforce these foundational abilities through an interactive approach.

2) Concept usage indicators

This indicator involves the student's ability to apply mathematical concepts to real-life situations. Example of a student's answer related to test question no.6, student 1 (control class): Using fractional calculations but adding them incorrectly, even though the correct calculation is to find the KPK and compare. Student 2 (experimental class): Give a descriptive answer by mentioning that there is more milk because the container is large, but do not do numerical calculations. Both answers are not mathematically precise, but student 2 understands the concept more visually. In this case, the problems given can be categorized in the level of Analysis (Analyzing) based on Bloom's Taxonomy because students are asked to compare two fractions in litres and determine the difference. In this taxonomy, the level of analysis includes skills such as comparing, classifying, and distinguishing information based on the data provided. To solve this problem, students must understand the concept of fractions, convert them to the same form if necessary, analyze which is more extensive, and calculate the differences. If the question only asks students to mention the value of each fraction without comparing or calculating the difference, then it can enter the level of understanding or application. However, because there is an element of comparison and analysis, this problem is more appropriately categorized in Analysis (Analyzing).

3) Troubleshooting indicators

This indicator reflects the student's ability to solve complex math problems. Sample student answer related to question no.15 The first student drew a rectangular garden with a length of 20 m and a width of 19 cm, but there was an inconsistency in the unit because the length was expressed in meters while the width was in centimeters. In addition, the first student did not include the circumference calculation, so the answer was incomplete. Meanwhile, the second student gave a more precise answer by drawing a garden measuring 15 m × 9 m, using consistent units in meters, and including the correct circumference calculation using the formula $K = 2 \times (p + l) = 48$ m. Thus, the second student's answer is more accurate and in accordance with the question request, while the first student needs to improve the use of units and complete the calculation to be more precise.

The problem can be categorized in the level of Creation (Creating) based on the Bloom Taxonomy because students are asked to design a rectangular garden with different lengths and widths and calculate its circumference. In this taxonomy, the Creation level includes the skill of designing, building or creating something new based on the understanding already possessed. The significant difference in the experimental group compared to the control group showed that the Moodle module was practical in teaching basic skills and encouraging students to achieve a higher level of thinking. This is in line with Bloom's concept of taxonomy, which emphasizes progressive learning from low-level to high-level cognitive skills. From a theoretical perspective, these results reinforce the relevance of Bloom's taxonomy in technology-based learning design. Practically, this study shows that the integration of technology such as Moodle in the elementary school curriculum can be an effective tool to improve students' numeracy literacy, especially in supporting the development of higher cognitive domains. Therefore, the development of technology-based learning media must consider this framework to ensure the effectiveness and sustainability of learning.

From the results of the research, learning using Moodle-assisted electronic modules improves students' numeracy literacy. Students who underwent Moodle-assisted e-module learning scored higher than the control group in learning. This is because, according to the teacher, the e-module assisted by Moodle is appropriate and suitable for use by students. The teacher's comment on the e-module assisted by Moodle is that the book contains complete and enjoyable activities, the material is very suitable for the current learning activities, the story questions presented are according to the characteristics of the child, and the e-module has a good display. Meanwhile, students commented that the e-module assisted by Moodle was very interesting because the e-module was filled with colors and had story characters. Some of the students' comments include: 1) attractive covers; 2) many pictures and colors are beautiful; 3) there are story characters and many fun activities; 4) Easy to use; and 5) I want to read this book. The content of the module is diverse so that students do not feel bored because they can try various activities in one module. Based on the results and some of the perceptions of teachers and students above that from the study results, learning using Moodle-assisted electronic modules improved students' numeracy literacy. Students who underwent Moodle-assisted e-module learning scored higher than the control group in learning. This is because, in essence, technology can improve students' numeracy literacy skills. Previous research also revealed that technology can improve competency assessment [40]. Technology-based learning is efficacious in improving student performance [41]. Using audio-visual media can enhance the communication of ideas and concepts in numeracy literacy learning and is more effective in teaching students [2]. Effective technology-based learning media can improve communication and increase students' attention and curiosity during learning [42].

The findings of this study also show that a student-centered technology-based learning approach is suitable for learning numeracy literacy learning for elementary school students. Students were found to be more active in their education, contributing to higher numeracy literacy outcomes in post-test results. This approach has promoted a more meaningful learning experience for students in learning numeracy literacy and can transform students into proactive and independent learners. Moodle, as an online learning platform, provides various interactive features that can increase the effectiveness of the teaching and learning process. Based on student activity log data, as many as 80% of students are more active in accessing learning materials in the form of interactive videos than text modules. This shows that the use of more engaging learning media, such as videos, contributes to increased student engagement. In addition, the progress tracking feature helps teachers monitor student progress in real time, allowing for adjustments to learning methods according to individual needs. From the results of data

analysis, the average student who accesses the quiz feature in Moodle shows a 50% increase in scores ≥ compared to those who only access the text module. This indicates that interactive features, such as quizzes and online discussions, are able to improve students' understanding of the material. However, only 60% of students consistently utilize the feature.

Therefore, strategies are needed to increase participation, such as providing academic incentives or gamification in the learning system. Although Moodle has proven effective, several obstacles have been identified during its implementation. First, limited internet access is an obstacle for students in remote areas, which causes a gap in participation. Second, the adaptation of teaching staff to Moodle features still needs to be improved. Based on the survey, only 40% of teachers feel comfortable using Moodle's analytics feature to monitor student progress. This challenge shows that continuous training for teachers is essential to optimize the use of the platform. However, technology-based learning materials provide greater flexibility for students to control their learning pace as they can slow down, speed up, reverse, or pause the learning materials. By understanding these factors, future research can improve study designs to produce more prosperous and more accurate data.

V. Conclusion

This study concludes that the integration of Moodle-assisted electronic modules significantly enhances the numeracy literacy skills of fifth-grade elementary school students, based on empirical findings aligned with the research questions and objectives. The research results indicate a noticeable difference in the improvement of numeracy literacy between students taught using Moodle-assisted electronic modules and those taught through a direct instruction model in schools situated in urban areas. This difference in improvement can be attributed solely to the use of distinct learning media.

Using multimedia elements in learning materials has dramatically enhanced students' learning experience. Multimedia learning materials allow students to learn independently and address their different senses. Through learning with the integration of e-module content applied on Moodle, students' numeracy literacy improved and helped them better understand mathematical concepts and ideas. For teachers, these findings offer a new, more interactive, and enjoyable way to teach numeracy literacy. This module not only helps students understand the material more efficiently but also makes the learning process more enjoyable. For policymakers, these findings highlight the need for comprehensive support, including teacher training and the development of technology infrastructure, to facilitate the seamless integration of digital learning tools in schools. Curriculum developers are also expected to continue to refine modules like these by adding richer interactive features and adapting them to the diverse needs of students. In addition, further research can be conducted to see the impact in more depth, including how this technology can help students develop critical and creative thinking skills. With the support and collaboration of all parties, this approach can be a fundamental step in improving the quality of education, helping students be better prepared to face real-world challenges, and making learning a more meaningful experience. In addition, the longitudinal approach in this study shows the potential of technology-based learning to improve students' numeracy skills in the long term. Further research can explore the application of this model to different educational contexts to reinforce the generalization of outcomes.

Appendix

A. *Pre-test and Post-test Questions Numeracy Literacy*

A concern the numeracy literacy ability test instrument for Grade V students in elementary school. The test contains 16 descriptive questions, each with a different level of cognitive aspect.

Answer the questions below correctly!

1. Luna bought Taliwang chicken, a typical Sasak food, Lombok at a food stall. Taliwang chicken tastes more delicious when eaten with spicy water spinach salad.

Taliwang Chicken Price = Rp. 32,500

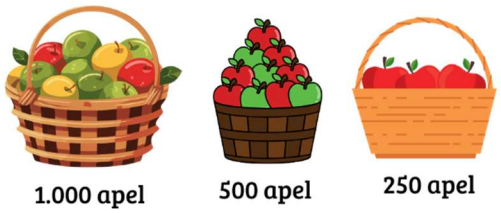
Price of kale Plencing = Rp. 13,250

If Luna has Rp. 47,500.00 and buys a portion of taliwang chicken and spicy water spinach salad. Write down the amount of money Luna has to pay in short stacks. (Identify)

	Tens of Thousands	Thousands	Hundreds	Tens	Unit
Chicken Taliwang					
spicy water spinach salad					
Total					

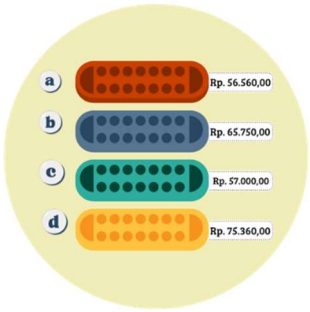
2. Pak Budi has six cake boxes with a total of 72 cakes. If each box contains the same number of cakes, how many are in each box? (Classifying)

3.



Determine the following two numbers if this pattern continues! (Describe)

4. Lukas is a Grade V student of Pancasila Elementary School. His teacher asked him to help him buy a dakon toy board at Komang's minimarket. There are four types of dakon boards with the following prices: (Deduce)



Let's compare:

Cards	Place Value				
	Tens of Thousands	Thousands	Hundreds	Tens	Unit
Card 1					
Card 2					
Card 3					
Card 4					

5. Dinda's sister was sick with a cough, cold, and fever. Mother asked Dinda to buy medicine at the Pharmacy. Can you help Dinda read the price of the medicine she purchased? (Describes)

Rp. 66.500,00/botol

Can you guys help me, how to read the price of the medicine?

6. Exist $\frac{3}{4}\ell$ milk coffee and, $\frac{5}{6}\ell$ milk.

Which is more, and how much is the breakdown? (Compare)

7. The mother has 2 liters of milk that will be given to her three children. How many liters of milk does each child get? (Organize)

8. My mother shopped at the market for Rp59,000.00. If there are two bills of Rp20,000.00 in my mother's wallet, three bills of Rp10,000.00, two bills of Rp5,000.00, and five bills of Rp2,000.00, What is the composition of the possible ways to pay? (Compose)
9. Budi went fishing. It has been running 4 $\frac{1}{2}$ km from his home, and he still has to travel a distance, $\frac{5}{8}$ km to get to the river. How many km does Budi travel from home to the river? (Find)
10. Suppose you make two cassava steamed sponges with two different colors, as shown in the picture below

Cut the first steamed sponge into eight equally large pieces while the second steamed sponge you cut into four similarly large pieces. (Implement)

11. Take a look at the following table!

Zafran and Ula are choosing food for lunch. The following packages are available at the food stall.

Package A 1 Fried Chicken 1 Rice 1 Sweet Tea	Package B 2 Fried Chicken 2 Rice 2 Sweet Tea
Rp27.500,00	Rp53.000,00

If Zafran and Ula each buy one portion of package A, how much money will be paid? (Associate)

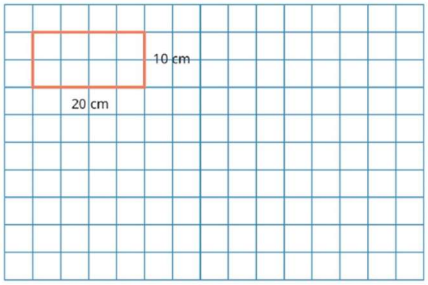
12. A child takes a slice of pizza on the plate, then the fraction to describe the size of the pizza the child takes is... (Assess)

13. Rara buys biscuits and donuts at the pastry shop. The biscuit box has a height of 6 cm, and the donut box has a height of 8 cm, each stacked as follows.

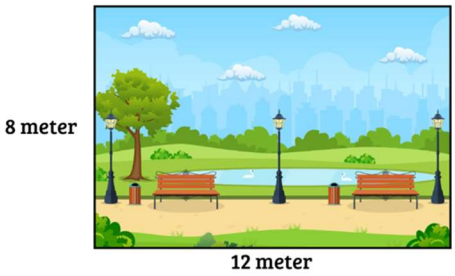
At what height is the total height of a biscuit box and a doughnut box the same? How many squares are there in each stack? (Create)

14. After learning about the circumference of various flat buildings and the area of the area, pay attention to the following questions.

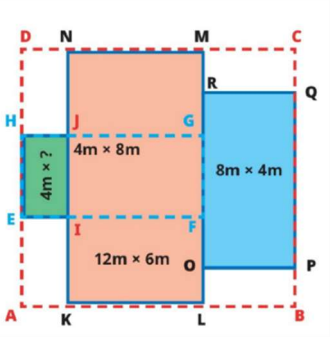
The father has a wire 60 cm long. Using the wire, he wanted to make a rectangular frame. Help him make a picture of the skeleton. How many ways can you make it? Which produces the widest skeleton? Draw on the following squares! (Designing)



15. A rectangular garden is 12 meters long and 8 meters wide. Design another rectangular garden with different lengths and widths. Count the circumnavigation of the park! (Create)



16. What is the circumference of a combined build on the side? (Create)



Notice the EFGH, KLMN, and OPQR rectangles along with the ABCD square. First, find the exact line length between the sides of the rectangle and the outermost square, and get the following similarities!

B. Assessment Guidelines

Table B1. Guidelines for assessment of numeracy literacy ability

Aspects	Assessed indicators (PISA & Bloom Taxonomy)	Learning Objectives	Question Number	Scores
1. Identify	- Identify (C1)	5.1 Students can identify numbers from 10,000–100,000	1	1
	- Classify (C2)	5.2 Students can read and write numbers from 10,000–100,000 that are presented correctly	5	1
	- Describe (C2)	5.3 Students can compare the number of numbers from 10,000–100,000 using the <, >, or = sign	4	1
	- Concluding (C2)	5.4 Students can fill in unknown values in a mathematical sentence related to addition, subtraction, multiplication, and division in the numeral number from 100–1000.	3	1
	- Explaining (C2)	5.5 Students can identify, imitate, and develop patterns of enlarged and decreasing numbers that involve multiplication and division	2	1
2. Using the Concept	- Compare (C3)	5.6 Students can compare various fractions (ordinary fractions and mixed fractions) with real numbers by observing contextual problems	6	1
	- Sort (C3)	5.7 Students can compare and sort various fractions (ordinary fractions and mixed fractions) using number lines	7	1
	- Set (C4)	5.8 Students can compose and decompose (decompose) the number of numbers from 10,000 – 100,000	8	1
	- Stack (C4)	5.9 Students can add and subtract numbers from 10,000 to 100,000 by stacking down	9	1
	- Implement (C3)	5.10 Students can multiply numbers from 10,000–100,000 using multiplication of the length and the division of the number from 10,000–100,000 by dividing the parentheses	10	1
	- Hook (C4)	5.11 Students can solve problems related to money using tens of thousands	11	1
3. Troubleshoot	- Assess (C5)	5.12 Students can add and subtract various fractions (ordinary fractions and mixed fractions) with natural numbers by observing contextual problems.	12	1
	- Make (C6)	5.13 Students can determine the circumference of various flat shapes, such as triangles, quadrilaterals, and polygons, including their combinations	13	1
	- Troubleshooting (C5)		14	1
	- Planning (C6)		15	1
	- Make (C6)		16	1
NUMBER OF SCORES				16

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Hema W. drafted the initial manuscript and conducted all the experiments. Sujarwo and Bambang S. supervised

research and provided insights into designing the experiment. All authors had approved the final version.

FUNDING

This research was funded by PPAPT (Pusat Pembiayaan dan Asesmen Pendidikan Tinggi) and LPDP (Lembaga Pengelola Dana Pendidikan) Indonesia.

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