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Development of Problem-Based E-Worksheet Assisted by GeoGebra to Improve Numeracy Literacy and Student Learning Activeness in Junior High School

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Abstract

This research aims to develop a problem-based electronic worksheet (E-Worksheet) assisted by GeoGebra to enhance students' numeracy literacy and learning activeness in junior high school. This research employs a quantitative method to collect and analyze data. The development procedure follows the ADDIE model, including analysis, design, development, implementation, and evaluation stages. Validation by experts shows the E-Worksheet is very feasible to use, with an average validation score of 4.46 out of 5. Practicality is confirmed through positive responses from teachers and students, scoring above 4.5. Within the Research and Development (R&D) framework, the effectiveness testing indicated a significant enhancement in students' numeracy literacy and learning activeness through the use of the developed E-Worksheet. These findings suggest that the developed E-Worksheet can be a valuable learning resource to improve mathematical literacy and student engagement in learning.

Keywords: problem-based learning, E-Worksheet, GeoGebra, numeracy literacy, learning activeness

1. Introduction

In the rapidly advancing era of digitalization and globalization, numeracy literacy has become one of the fundamental skills essential for every individual. Numeracy literacy is not only important in academic contexts but is also crucial for daily life activities, such as making financial decisions, understanding health information, interpreting statistical graphs, and responding to economic and political issues. According to the Ministry of Education and Culture (Kemendikbud, 2017), making

appropriate decisions in various aspects of life requires the ability to understand and use numerical information, which is often presented in the form of numbers, graphs, or tables. Furthermore, Rachmansyah (2022) asserts that numeracy literacy positively influences character development, talent cultivation, and the improvement of numerical and writing skills.

Unfortunately, field conditions reveal that numeracy literacy skills in many educational institutions remain relatively low (Kemendikbud, 2021). Based on the 2022 and 2023 Education Report, SMPN Satu Atap 1 Rawajitu Timur experienced a significant decline in numeracy literacy performance, particularly in the geometry domain. The researcher's observations support this data, showing that many students struggle with understanding basic geometric concepts, such as distinguishing volume formulas of 3D shapes, calculating surface area, and visualizing three-dimensional objects. These difficulties also contribute to low student engagement in the classroom; they tend to be passive, rarely ask questions, are reluctant to take notes, and respond minimally during lessons. According to Sareong and Supartini (2020), passive students are characterized by their lack of response to teachers' questions, failure to record important information, and disinterest during demonstrations. This is consistent with the findings of Febianti et al. (2022), who stated that student disengagement is often triggered by monotonous teaching methods, such as lectures without engaging media. The results of interviews conducted by the researcher also indicate that students feel bored and unmotivated due to the uniform nature of mathematics instruction, which lacks diverse learning experiences. Inappropriate learning tools can hinder teachers' effectiveness in achieving learning objectives (Yumiati et al., 2023). Therefore, the learning process should employ effective and varied methods to help students achieve optimal understanding (Sudirman, 2020). This effort aims to eliminate gaps in the learning process, as highlighted by Mery et al. (2025), who noted significant disparities in teacher readiness and curriculum design, particularly regarding the integration of technology to support geometry instruction.

Consequently, with the advancement of technology, interactive digital learning media have become a promising alternative. One such medium is the use of electronic student worksheets (E-LKPD), which allow students to engage in self-directed learning supported by visualizations, interactive exercises, and multimedia features. According to Okviani et al. (2024), the use of E-LKPD can facilitate students' understanding of materials by providing contextual learning resources that align with their characteristics. This is further supported by Puspita and Dewi (2021), who argue that interactive E-LKPDs offer not only practice opportunities but also enhance students' learning motivation.

In supporting geometry learning, GeoGebra serves as a highly effective digital tool, capable of dynamically presenting mathematical concepts in both 2D and 3D visual formats. As stated by Weinhandl et al. (2020), GeoGebra is specifically designed to meet the needs of mathematics education in schools, with features that allow direct visualization of geometric concepts and relationships between elements. Additionally, the integration of a problem-based approach is highly relevant for fostering meaningful learning. Hendriani et al. (2023) mention that problem-

based approaches encourage students to become active learners who engage directly in solving real-world problems while developing critical and analytical thinking skills. In line with this, Yumiati et al. (2015) emphasize that mathematical problem-solving skills cannot be acquired instantly but must be developed through continuous practice and habituation. Therefore, it is essential to select instructional models that can motivate students to solve mathematical problems. Based on these conditions, the researcher developed a problem-based E-LKPD assisted by GeoGebra as a solution to enhance numeracy literacy and student engagement, particularly in the topic of three-dimensional shapes for Grade IX students at SMPN Satu Atap 1 Rawajitu Timur. This study focuses on producing a learning medium that is valid, practical, and effective in addressing the challenges of low numeracy achievement and student participation in the learning process

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2. Methods

This research is a type of Research and Development (R&D) aimed at producing an instructional product in the form of a problem-based electronic student worksheet (E-Worksheet) assisted by GeoGebra that is valid, practical, and effective in improving students' numeracy literacy and learning activeness. The development model used in this study is the ADDIE model, which stands for Analysis, Design, Development, Implementation, and Evaluation. According to Sugiyono (2015), the ADDIE model is a systematic and flexible instructional development model that allows for revisions at each stage based on needs.

The **analysis stage** was conducted to identify instructional needs through observation, interviews, and documentation. The purpose was to gain an in-depth understanding of students' learning problems, curriculum conditions, learner characteristics, and the learning environment. This stage is crucial to ensure that the instructional media developed is truly relevant to the needs of end users—students and teachers.

In the **design stage**, the researcher organized the structure of the E-Worksheet, determined the problem-based learning strategy, designed evaluation instruments, and selected appropriate visual media and activities based on student characteristics. According to Branch (2009), the design phase in ADDIE emphasizes the importance of thorough planning to ensure that the media developed is capable of achieving the intended learning objectives.

The **development stage** involved compiling learning content integrated with GeoGebra, creating an interactive interface, and conducting validations by three experts: a content expert, a media expert, and a language expert. The validation process was conducted to ensure product quality based on content, language, and visual appearance. As stated by Akbar (2013), expert validation is a crucial step in media development as it determines the appropriateness of the content and presentation of instructional products.

The **implementation stage** was carried out through a limited trial involving 22 ninth-grade students at SMPN Satu Atap 1 Rawajitu Timur. This trial included the administration of pre-tests and post-tests, the distribution of practicality questionnaires, and observations of student engagement during learning. Practicality was assessed based on criteria such as ease of use,

attractiveness, and perceived benefits by students in the learning process. Widoyoko (2014) emphasized that the practicality of instructional media can be observed from positive user responses and its smooth implementation in the classroom.

The final stage, evaluation, was conducted both formatively and summatively. Formative evaluation was carried out at each stage to revise product deficiencies, while summative evaluation was performed to assess the overall effectiveness of the product.

Effectiveness was analyzed by comparing pre-test and post-test results using the N-Gain test to measure the improvement in learning outcomes. In addition, the percentage of students achieving the Minimum Mastery Criteria (KKM) was also analyzed. The N-Gain test was chosen in this study to measure the effectiveness of the developed instructional material, as it provides a reliable metric for assessing students' improvement in understanding. Data collection techniques in this study included observation, interviews, questionnaires, and tests. Qualitative data were analyzed descriptively, while quantitative data were analyzed using descriptive statistics. Validity was measured by calculating the percentage of expert assessments, practicality was analyzed from student response questionnaires, and effectiveness was determined based on N-Gain results and learning mastery. Through this approach, the developed E-Worksheet is expected to become an innovative, contextually relevant, easy-to-use instructional medium that has a positive impact on numeracy literacy and student learning activeness, particularly in areas with limited learning resources such as SMPN Satu Atap 1 Rawajitu Timur.

3. Result and Discussion

3.1 Validation Results

To ensure the quality of the developed E-Worksheet, a validation process was carried out by three experts: a content expert, a language expert, and a media expert. The validation was conducted using an assessment instrument that covered content, language, and media appearance aspects. Each validator provided scores based on predetermined indicators, and the results were converted into percentages to determine the product's level of validity.

a. Validation by Content Expert

This validation aimed to evaluate the feasibility of the content in the E-Worksheet, including its alignment with learning objectives, integration with numeracy literacy, and the relevance of the problem-based approach and the use of GeoGebra. Based on the assessment results, a total score of 79 out of a maximum of 92 was obtained, which corresponds to a validity percentage of 85.86%, falling into the "Valid" category. Although most aspects received high scores, particular attention was given to improving student activeness and the organization of content.

Table 1.

Recapitulation of Content Expert Validation

No	Assessment Aspect	Score
1	Alignment of Content with Learning Objectives (CP)	11
2	Clarity and Comprehensibility of Content	10
3	Integration with Numeracy Literacy	10
4	Use of GeoGebra as a Supporting Tool	10
5	Problem-Based Learning Approach	10
6	Student Activeness in Learning	7
7	Suitability to Students' Cognitive Levels	7
8	Organization of Content	6
9	Evaluation and Feedback within the Content	8
	Total Score	**79**
	Maximum Possible Score	**92**
	Validity Percentage	**85.86%**

The content expert stated that the E-Worksheet is sufficiently well-developed and suitable for use, with minor revisions recommended, particularly in presenting the content in a more structured manner and encouraging more active student involvement.

b. Validation by Language Expert

The language aspect validation assessed clarity, readability, the appropriateness of terminology for students' age, and grammar in the E-Worksheet. The evaluation resulted in a score of 48 out of a maximum of 56, yielding a validity percentage of 85.72%, which falls under the "Highly Valid" category. Improvement efforts focused on simplifying several technical terms to better suit the comprehension level of junior high school students.

Table 2.

Recapitulation of Language Expert Validation

No	Assessment Aspect	Score
1	Clarity of Language	10
2	Language Appropriateness for Students' Age	5
3	Readability and Text Coherence	12
4	Language Alignment with Learning Objectives	6
5	Accuracy and Appropriateness of Grammar	8
6	Simplicity of Language and Clarity in Concept Delivery	7
	Total Score	**48**
	Maximum Score	**56**
	Validity Percentage	**85.72%**

The validator suggested refining mathematical terms and GeoGebra instructions to avoid ambiguity, especially for students who are not yet familiar with the software.

Validation by Media Expert

The media expert's assessment focused on aspects of visual design, interactivity, media integration, and the suitability of the media with student characteristics. The validation resulted in a score of 26 out of a maximum of 28, with a validity percentage of 92.85%, categorized as "Highly Valid." Almost all aspects received the maximum score, except for visual design and readability, which still scored high but were noted as areas for improvement.

Table 3. Recapitulation of Media Expert Validation

No	Assessment Aspect	Score
1	Media Alignment with Learning Objectives	4
2	Visual Design and Aesthetics	3
3	Media Interactivity	4
4	Quality of GeoGebra Integration	4
5	Readability and Ease of Use	3
6	Suitability of Media for Student Characteristics	4
7	Diversity and Flexibility in Media Use	4
	Total Score	**26**
	Maximum Score	**28**
	Validity Percentage	**92.85%**

The media expert provided detailed input on the wording of questions, visualization of geometric objects, and clarity of instructions for using GeoGebra. These suggestions were addressed and incorporated during the revision phase.

3.2 Practicality of the E-LKPD

The practicality test aimed to assess the extent to which the E-LKPD can be used easily, attractively, and effectively to support student learning in real-world contexts. The assessment was conducted in two stages: individual trials and small group trials involving Grade VIII students at SMPN Satu Atap 1 Rawajitu Timur. Data were collected through student response questionnaires and open-ended interviews.

a. Individual Trials

In this stage, the E-LKPD was tested on three students. Interview results indicated that students found it easier to understand the material with the help of visualizations and GeoGebra features. However, there were some technical challenges such as unstable internet connectivity and the need to simplify certain terms or sentence structures in the questions. The questionnaire responses were analyzed based on five response categories: Very Feasible (VF), Feasible (F), Less Feasible (LF), Not Feasible (NF), and Completely Inappropriate (CI). The results showed that the majority of students gave positive feedback, with "Very Feasible" as the dominant category.

Table 4.
Recapitulation of Student Responses (Individual Trial)

Assessment Aspect	VF	F	LF	NF	CI
Readability and Clarity of Language	30	16	5	13	0
Layout and Visual Design	19	17	3	3	0
Integration with GeoGebra	28	22	13	3	0
Attractiveness and Learning Motivation	24	16	3	1	0
Ease of E-LKPD Use	11	26	3	3	0
Development of Numeracy Literacy	6	14	1	1	0
Interactivity in Learning	15	5	1	1	0
Impact on Learning Activeness	15	5	2	0	0
Total Score	148	121	31	25	0
Percentage (%)	45.5	37.2	9.5	7.7	0

The results show that 45.5% of students rated the E-LKPD as "Very Feasible" and 37.2% as "Feasible." Although 9.5% of responses were categorized as "Less Feasible," no students selected the "Completely Inappropriate" category, indicating that the product is generally practical. Student feedback regarding practicality has been addressed through actions such as simplifying question sentences, improving layout, and revising GeoGebra usage instructions.

b. Small Group Trial

The small group trial was conducted with 10 randomly selected Grade VIII students. The activity took place in the school computer laboratory, utilizing the available WiFi and digital devices. Based on the questionnaire results, the average practicality score was 86%, categorized as "Very Practical." The highest percentage reached 93.3%, and the lowest was 75%, all falling within the "Practical" category.

Table 5. Practicality Recapitulation of the E-LKPD (Small Group Trial)

Description	Value
Number of Students	10 students
Highest Percentage	93.3%
Lowest Percentage	75%
Average Practicality	86%

Student responses were also highly positive. Comments included that the E-LKPD was engaging due to its use of images and videos, the questions were easier to understand with guidance, and GeoGebra greatly helped in understanding three-dimensional shapes. Although some students still required initial guidance, the results indicated that the E-LKPD is easy to use both independently and in groups. Based on the results from individual and small group trials, the E-LKPD is deemed practical and highly suitable for classroom use. Students felt supported, interested, and motivated while using the E-LKPD, especially due to its visually appealing design and the interactive support of GeoGebra.

3.3 Effectiveness of the E-LKPD

Hypothesis testing was not applied in this study because it is a Research and Development (R&D) study, not experimental research. The effectiveness analysis focused on measuring the learning outcomes descriptively to determine whether the developed product meets the intended objectives. The effectiveness of the E-LKPD was assessed by measuring the improvement in student learning outcomes through a comparison of pre-test and post-test scores, as well as the percentage of students achieving mastery based on the Minimum Completeness Criteria (KKM) set at 60. The trial was conducted with 22 Grade IX students at SMPN Satu Atap 1 Rawajitu Timur.

a. Comparison of Pre-Test and Post-Test Scores

Before using the E-LKPD, students were given a pre-test to measure their initial understanding of the topic on three-dimensional shapes. After learning through the E-LKPD, students completed a post-test with equivalent difficulty.

Table 6. Comparison of Pre-Test and Post-Test Results

Description	Average Score
Pre-test	55.23
Post-test	81.14
Score Increase	+25.91

The increase of 25.91 points reflects a meaningful improvement in students' conceptual understanding after using the E-LKPD. The post-test average score also exceeded the minimum mastery criteria (KKM), indicating that the product supports learning success (Sugiono, 2017).

b. N-Gain Test Results

To more objectively assess learning gains, the N-Gain test was used with the formula: **N-Gain = (Post-Test Score − Pre-Test Score) / (Maximum Score − Pre-Test Score)** (Hake, 1999).

Table 7.

N-Gain Analysis Results

Effectiveness Criteria	N-Gain Range	Number of Students	Percentage
High	> 0.70	10 students	45.45%
Medium	0.30–0.70	11 students	50.00%
Low	< 0.30	1 student	4.55%
Total	—	22 students	100%

This finding is consistent with Hake's (1998) interpretation of normalized gain categories, which considers medium to high gain as indicators of learning effectiveness. Moreover, the use of problem-based E-LKPD supported by GeoGebra aligns with findings from Arisetyawan et al. (2014) and Hasanah & Fitriyani (2021), who reported similar improvements in student learning outcomes.

Perlu saya bantu buatkan daftar pustaka lengkapnya dalam gaya **APA atau**

c. Mastery Learning Percentage

As a complementary measure, effectiveness was also evaluated based on the number of students achieving or surpassing the KKM.

Table 8.

Learning Mastery Results

Description	Number of Students	Percentage
Mastered (≥ 60)	20 students	90.91%
Not Mastered (< 60)	2 students	9.09%
Total	22 students	100%

A total of 90.91% of students achieved mastery, demonstrating that the E-LKPD is highly effective in supporting competency achievement. Based on the comparison of pre-test and post-test scores, N-Gain results, and learning mastery, the problem-based E-LKPD supported by GeoGebra has been proven effective in enhancing students' conceptual understanding of geometry and numeracy literacy. Furthermore, this learning media successfully encouraged students to become more active

and enthusiastic during the learning process. These findings are in line with previous studies which reported that problem-based learning combined with interactive tools such as GeoGebra significantly improves students' mathematical understanding and numeracy skills (Pratiwi & Riyadi, 2021; Widodo & Kartini, 2018; Mutakin, Suparman, & Mulyanto, 2020). However, successful implementation also depends on students' and teachers' digital readiness, as noted by Putra and Yuliati (2019).

4. Conclusion

Conclusion

This study aimed to develop a problem-based E-LKPD supported by GeoGebra to enhance students' numeracy literacy and learning engagement in the topic of three-dimensional shapes. Based on the results of validation, practicality, and effectiveness tests, it can be concluded that the developed product meets the three essential criteria for instructional media development: valid, practical, and effective.

The validation results from content, language, and media experts indicated that the E-LKPD possesses high content quality, appropriate language for students' comprehension levels, and visual design and interactivity that support technology-based learning. The practicality tests revealed that students responded positively to the E-LKPD, found it engaging, easier to understand, and encouraged more active participation in the learning process. Meanwhile, the effectiveness tests demonstrated that the use of GeoGebra-supported E-LKPD significantly improved student learning outcomes, with most students showing moderate to high learning gains and a mastery rate of over 90%.

Therefore, the problem-based E-LKPD supported by GeoGebra is deemed suitable for use as an alternative learning resource in contextual mathematics instruction, particularly in teaching three-dimensional geometry at the junior high school level.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **For teachers**, it is recommended to begin incorporating digital media such as GeoGebra into mathematics instruction to increase student engagement, interactivity, and conceptual understanding through visual representation.
2. **For schools and policymakers**, it is expected that they provide training or technical assistance for teachers in using technology-based learning applications so that these tools can be effectively integrated into teaching and learning activities.
3. **For future researchers**, it is advisable to conduct broader-scale trials across different topics to evaluate the consistency of the E-LKPD's effectiveness and to further develop the product with additional features that support differentiated and collaborative learning.

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