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## RESEARCH ARTICLE

# The Effectiveness of Digital Interactive Media Worksheets in Improving Elementary School Students' Mathematical Literacy

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## Abstract

This study aims to develop interactive digital worksheet media to enhance the mathematical literacy skills of elementary school students. The Research and Development method, based on Sugiyono's model, was employed, encompassing potential and problem identification, data collection, product design, design validation, product revision, product testing, and final product revision. The study involved teachers and fourth-grade students at SDN Mangunjiwan 1 Demak. The results indicate that the interactive digital worksheets are highly valid, with an average validation score of 89.31%. Effectiveness testing showed a significant improvement in mathematical literacy skills, with the experimental class achieving an average N-Gain score of 83.33%, categorized as very effective. Thus, interactive digital worksheets are highly effective in improving the mathematical literacy skills of fourth-grade students.

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# INTRODUCTION

Digital technology, when integrated into learning, serves as a crucial communication link between teachers and students. The use of digital media in education is considered to have a positive impact by facilitating active, effective, efficient, and enjoyable learning experiences (Sunaryo et al., 2022; Wijaya, 2021; Sarah & Rani, 2020). According to Narvaez Rojas et al. (2021), interactive learning media can enhance student engagement during the learning process. Furthermore, digital media supports distance learning, making education more accessible.

A significant challenge for Indonesia in achieving quality education is the relatively low mathematical literacy of its students (National Commission on Human Rights, 2020). Mathematical literacy is defined as the ability to interpret, formulate, and apply mathematics in various contexts, including reasoning with mathematical concepts, procedures, facts, and tools to describe, predict, and solve real-world problems effectively and efficiently (Tasekeb et al., 2019). The 2018 PISA study involved 12,098 students from 399 educational units, representing 3,768,508 students aged 15 years, or 85% of the total. The results showed that Indonesian students scored 379 out of an OECD average of 489 in mathematics (OECD, 2019). According to the OECD, about 71% of Indonesian students did not reach the minimum competency level in mathematics, indicating difficulties in solving mathematical problems, especially those involving non-whole numbers or less detailed instructions.

A comparative study by TIMSS in 2015 categorized students' mathematical literacy skills into four levels: advanced benchmark, high benchmark, intermediate benchmark, and low benchmark (Munaji & Setiawahyu, 2020). Indonesia ranked 44th out of 49 participants, with fourth-grade students scoring 397 compared to the international average of 500 (Mullis et al., 2015). These results place Indonesian students in the low benchmark category, highlighting the urgent need for improved mathematical literacy.

The numeracy ability of Indonesian students is below the minimum competency level, as indicated by the 2022 public education report card (Kemendikbudrisek, 2022). The assessment revealed that less than 50% of students meet the minimum competency standard in numeracy. At SDN Mangunjiwan 1, the education report card analysis showed a score of 1.63 in numeracy skills, which is below the minimum competency. The proportion of students' numeracy skills is as follows: 0% with proficient numeracy skills, 25% with basic proficiency, 75% with basic numeracy ability, and 0% requiring special intervention.

Observations at SDN Bintoro 16 Demak during the 2022/2023 school year highlighted several issues in fourth-grade mathematics learning. The primary findings were: 1) Mathematics lessons were predominantly teacher-centered, with minimal student engagement, limiting direct learning experiences. This was exacerbated by the teacher's limited use of learning media; 2) The average student score in mathematics for the first semester was 68.53, with only 33.33% of students scoring above the class average, while 66.67% scored below it. Students performed best in tasks related to reading, writing, place values, and whole numbers, while struggling with fractions, particularly in comparing, sorting, and recognizing equivalent fractions; 3) Learning resources included student books from the Indonesian Curriculum and Books Center and Student Worksheets (LKS), which did not facilitate an orientation towards discovering and proving mathematical concepts; 4) There was minimal use of digital technology, despite the availability of Chromebooks and other facilities.

These observations underscore the need to improve the quality of mathematics education by actively involving students through engaging learning media to enhance the effectiveness of mathematics learning. Further observations at SDN Bintoro 1 Demak

provided a different perspective. Here, the school had adequate facilities, including a computer lab and an LCD projector in each classroom. Teachers utilized digital learning media, such as instructional videos, to engage students. This approach resulted in enthusiastic student participation, with active classroom discussions and questions related to the video content.

In assessing learning outcomes, it was found that students' performance was inversely proportional to the conditions observed during the learning process. The average mathematics score for the first semester of the 2022/2023 academic year was 63.95, with 47.83% of students scoring above the class average and 52.17% scoring below it. According to the teacher's analysis, the discrepancy between the learning process and outcomes is due to students' low ability to understand certain mathematical problems and difficulties in solving problem-solving questions. This issue arises because students are often limited to observing without engaging directly. The inadequate development of mathematical concepts during the learning process results in subpar learning outcomes. Therefore, there is a need for learning media that actively involve students in constructing their learning experiences while utilizing digital media (Purwanto et al., 2022).

Research by Yesika et al. (2020) examined the mathematical literacy skills of fifth-grade students at SDN Sintang 6 in solving word problems. The data showed that 6% of students received a C rating (sufficient), while 94% were rated D (insufficient), with an average score of 12. This indicates that students' mathematical literacy skills are still low, particularly in solving word problems (Purwanti et al., 2021; Yesika et al., 2020).

Tristanti et al. (2021)and Prestoza, M. J. (2024) explored the use of digital technology in elementary schools and found it significantly supports classroom learning activities. Student outcomes improved dramatically after using digital media, with 96% of students fulfilling all five indicators for adding integers, compared to 0% before the implementation of video learning media. This demonstrates the benefits of digital technology in achieving comprehensive learning. Puspita and Dewi (2021) and Prestoza and Banatao (2024) studied the effect of critical thinking skills using E-LKPD based on a mathematical investigative approach in fifth-grade students. Their findings showed that students taught with E-LKPD had higher mathematical critical thinking skills than those taught by conventional methods. Further research by Putra and Agustiana (2021) and Pentang et al. (2023) on E-LKPD for mathematics lessons in online-based fractional operations found the developed media valid, reliable, and highly suitable for classroom use.

Furthermore, this study aims to develop interactive digital worksheets to reinforce mathematical literacy. These worksheets aim to enhance students' logical thinking and ability to analyze and apply mathematical concepts through systematic activities. The focus will be on fractions, aligned with the learning achievements for phase B (grade IV) mathematics. The outcome of this research will be a learning media product designed to optimize the learning process for fourth-grade students.

## METHODOLOGY

The researchers employed a Research and Development (R&D) approach using Sugiyono's (2019) development model, which includes seven steps: identifying potential and problems, data collection, product design, design validation, design revision, product testing, and product revision. The study's subjects comprised 30 fourth-grade students from SDN Mangunjiwan Demak.

# RESULTS AND DISCUSSION

## Product Concept

The developed media consists of interactive digital worksheets (LKPD) designed to support fourth-grade students in learning mathematics, specifically on fraction material. These worksheets have an unlimited time duration for use and incorporate images in .png and .jpg formats. Each worksheet includes explanations of the material and step-by-step examples of problem-solving.

The interactive digital worksheets cover seven subtopics: 1) the concept of fractions; 2) equivalent fractions; 3) comparing fractions; 4) sorting fractions; 5) simplifying fractions; 6) adding fractions; and 7) subtracting fractions. The development of these materials is tailored to the cognitive development stages of children in mathematics learning, as described by Bruner (2017), which include the enactive stage, the iconic stage, and the symbolic stage.

## Product Design

The initial media design development included several worksheet components: the main page (cover), table of contents, materials, practice questions, and competency tests. The purpose of developing these interactive digital worksheets is to facilitate learning for both students and teachers by leveraging digital technology, while also enhancing the mathematical literacy skills of fourth-grade students. The detailed initial design of the media is outlined in Table 1.

**Table (1) Initial Design for Media Interactive Digital Worksheets Development**

| Media Component | Content |
|---|---|
| Cover | It consists of product identity, subject identity, media information barcodes containing instructions for use, learning objectives, teaching modules, and summative assessment grids |
| List of contents | Contains interactive digital worksheets and media content developed |
| Material | Contains fractional learning material which is arranged systematically based on learning outcomes |
| Exercises | Contains practice questions for each learning material and is developed based on indicators to train students' mathematical literacy abilities |
| Summative assessment | Developed according to learning objectives and integrated with students' mathematical literacy abilities |

## Media Development

**Table (2) product revisions after product validation by experts**

| Item | Description |
|---|---|
| <br>Cover | The cover of the learning media contains the title, author's name, and barcode links to worksheet information which contains steps for using learning media, analysis of learning outcomes and learning objectives, teaching modules, and assessment grids. |

| Item | Description |
|---|---|
|  List of content | The table of contents in learning media makes it easier for students to find the page to be read. This table of contents includes links so students can go directly to the page they want. |
|  Learning materials from interactive digital worksheets media | There are 7 learning materials related to fractions presented in this learning media. |
|  Exercises in interactive digital worksheets media | At the end of each material, there are practice questions which are presented interactively via a barcode link connected to the Quizizz website page. Exercise questions were developed to train students' mathematical literacy skills. |
|  Summative assessment in interactive digital worksheets media | Competency test at the end of learning as a summative assessment to determine the achievement of learning objectives in fraction material. The questions in the competency test were developed to train students' skills in formulating problems, applying concepts, and interpreting the results of solving problems effectively and efficiently in everyday life. The competency test is presented interactively via a barcode link connected to the Quizizz website page. |

### Media Validation

The quality assessment of the interactive digital worksheets was conducted by a panel of experts, including lecturers, teachers, and graduates with a Master's in Education who have experience in research and development. Feedback and suggestions from these assessments were used to refine the product before trial implementation. The detailed results of the validation are presented in Table 3. Based on the validation results, the interactive digital worksheets were found to be valid and suitable for use in teaching mathematics, specifically on fractional material.

**Table (3) Results of interactive digital worksheets learning media validation**

| Validators | Average (%) | Category |
|---|---|---|
| Media Expert | 88,45 | Very valid |
| Material Expert | 93,15 | Very valid |
| Linguist | 86,34 | Very valid |

*Media Eligibility*

The learning media is considered feasible based on the results of teacher and student response questionnaires administered after using the media in mathematics lessons. The detailed results of these responses are presented in Table 4.

**Table (4) The results of the teacher and student response questionnaire**

| Indicator | Average (%) | Category |
|---|---|---|
| Teacher Questionnaire | 87,5 | Very good |
| Student Questionnaire | 90 | Very good |

*Media Effectiveness*

Based on Table 5, the significance (2-tailed) values for the control class were 0.200 for both the pretest and posttest, while the significance (2-tailed) values for the experimental class were 0.115 for the pretest and 0.092 for the posttest. Since the significance values for both the control and experimental classes' pretest and posttest data are greater than 0.05, the null hypothesis (H0) is accepted, indicating that the data is normally distributed.

**Table (5) Normality test results**

| Learning Outcome | N | Test Statistic | Sig. (2-tailed) | Category |
|---|---|---|---|---|
| Pretest control | 30 | 0.109 | 0.200 | Normal |
| Pretest experiment | 30 | 0.102 | 0.200 | Normal |
| Posttest control | 30 | 0.144 | 0.115 | Normal |
| Posttest experiment | 30 | 0.148 | 0.092 | Normal |

Based on Table 6, the significance value for the mathematical literacy ability pretest data is 0.334, which is greater than 0.05. Therefore, the null hypothesis (H0) is accepted, indicating that the data variance is homogeneous.

**Table (6) Results of homogeneity test data pretest class control and experiment**

| Data | Levene Statistic | df1 | df2 | Sig. |
|---|---|---|---|---|
| Score | 0.951 | 1 | 58 | 0.334 |

Based on Table 7, the significance value for the posttest data on mathematical literacy ability is 0.239, which is greater than 0.05. Therefore, the null hypothesis (H0) is accepted, indicating that the data variance is homogeneous. Consequently, the research data from both the pretest and posttest groups exhibit the same, or homogeneous, variance.

**Table (7) Posttest data homogeneity test results for control and experiment classes**

| Data | Levene Statistic | df1 | df2 | Sig. |
|------|------------------|-----|-----|------|
| Score | 1.416 | 1 | 58 | 0.239 |

Based on Figure 1, the N-Gain results for the control class show that 46.67% of students are in the low category, 53.33% are in the medium category, and 0% are in the high category. In the experimental class, 6.67% of students fall into the low category, 83.33% are in the medium category, and 10% are in the high category. The average N-Gain in mathematical literacy skills was 0.31 for the control class and 0.50 for the experimental class. These results indicate that the use of interactive digital worksheet media in the experimental class is more effective in improving students' mathematical literacy skills compared to the use of conventional media in the control class.
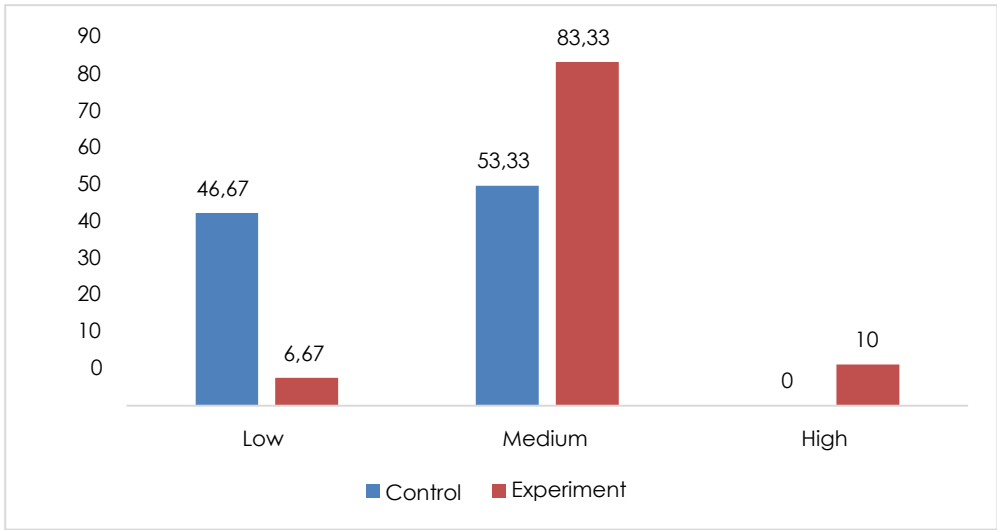


**Figure (1) Graph of N-Gain frequency distribution of mathematical literacy ability**

## CONCLUSION

Based on the results, it can be demonstrated a significant improvement in mathematical literacy skills, confirming the superior effectiveness of interactive digital worksheets compared to conventional media. Therefore, it can be concluded that interactive digital worksheets are an effective tool for enhancing mathematical literacy skills in fraction material for fourth-grade students at SDN Mangunjiwan 1 Demak.

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