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Development of Interactive Learning Multimedia Based on Problem-Based Learning Oriented Toward Students' Self-Efficacy

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Abstract

This study aims to: (1) produce interactive learning multimedia characterized by problem-based learning and oriented toward students' self-efficacy, and (2) describe the feasibility of the developed multimedia in terms of validity, practicality, and effectiveness. The study employed a research and development approach using the ADDIE model, encompassing the stages of analysis, design, development, implementation, and evaluation. The research subjects consisted of 21 junior high school students selected through purposive sampling. Data were collected using validation sheets, teacher and student practicality assessments, classroom observation sheets, and a self-efficacy questionnaire. Validity and practicality were analyzed using qualitative value standards. The product was considered effective if there was an increase in the mean score from pre-test to post-test on self-efficacy. Effectiveness was analyzed using paired sample t-tests. The developed product, called ProSmart, is interactive learning multimedia designed to support students' self-efficacy in learning. This multimedia includes quizzes, instructional videos, and problem-based activities. Features consist of an introduction page, structured learning steps, interactive videos, and interactive quizzes. The results indicate that: (1) the multimedia supports self-efficacy by embedding motivational statements to strengthen students' confidence and providing interactive displays of objectives, materials, and engaging quizzes; (2) the multimedia was considered valid in terms of content and highly valid in terms of media; (3) it was rated highly practical by teachers, practical by students, and the classroom implementation was also rated highly practical; (4) there was a significant improvement in students' self-efficacy. Therefore, the multimedia developed meets the criteria of being valid, practical, and effective.

Keywords: *Interactive Learning Multimedia; Problem-Based Learning; Self-Efficacy*

Introduction

Self-efficacy plays a crucial role in mathematics. Low self-efficacy can negatively affect students' motivation and performance in solving mathematical problems. Several studies indicate that most Indonesian students' self-efficacy remains at moderate to low levels (Alvianti et al., 2023; Asri et al., 2023). Hence, to enhance self-efficacy, innovation in instructional media is necessary. Integrating learning media with digital technology is a relevant approach in 21st-century education.

According to BPS (2024), junior high school students ranked second among internet users in 2023. However, 80.26% of internet use was for entertainment, while only 10.12% was for learning. Teachers therefore need to optimize internet use through learning multimedia to make it more productive for education. Learning multimedia presents materials using words and images to support instruction (Mayer, 2009). Multimedia-based instruction has been shown to enhance students' self-efficacy. Chen et al. (2019) found that multimedia-based learning produced higher self-efficacy than conventional instruction and positively influenced learning outcomes. Similar findings were reported by several research (Fajri, Johar, & Ikhsan, 2017; Manurung, Siagian, & Minarni, 2020; Taufiq et al., 2024; Vega & Ramos, 2023).

Nevertheless, the quality of interactive learning multimedia in schools remains suboptimal. Research shows that teachers often rely on textbooks, modules, and printed worksheets, which are conventional and not tailored to students' characteristics (Setiyani et al., 2022). Moreover, such media are less engaging for students(Angraini et al., 2023; Putri & Siregar, 2023). This underlines the urgent need for more effective learning media in schools.

Interesting interactive learning multimedia needs to be supported by good material delivery, so that it can make learning more effective Problem-Based Learning (PBL) is a suitable model to integrate learning content with students' thinking processes in solving real-life problems (Delisle, 1937; Suprihatiningrum, 2017). PBL engages students directly, helping them build confidence to overcome challenges (Aprilita & Handican, 2023). Working in groups further allows students to learn from peers and receive social support, thereby improving their self-confidence in learning mathematics. Studies have shown that PBL can enhance students' self-efficacy (Aprilita & Handican, 2023; Yunitasari & Zaenuri, 2020; Yusritawati et al., 2023). Thus, developing interactive multimedia based on PBL is a strategic solution to foster students' self-efficacy, particularly in learning mathematics.

Methodology

This research employed Research and Development (R&D) with the ADDIE model by Dick and Carey, comprising five stages: Analysis, Design, Development, Implementation, and Evaluation. The study involved 21 seventh-grade junior high school students in Sleman Regency. Data collection was carried out using non-test instruments, including validation questionnaires (completed by expert validators), media assessments (completed by validators, teachers, and students), classroom observation sheets, and self-efficacy questionnaires. The following are the techniques and instruments of data collection

The product validity assessment scores provided by media and content experts were calculated using the mean score and categorized according to the following table.

Table 1. Categories Based on Product Assessment Score Range

No	Percentage Score	Criteria
1	$85\% < p \leq 100\%$	Highly Valid
2	$70\% < p \leq 85\%$	Valid
3	$50\% < p \leq 70\%$	Less Valid
4	$0\% \leq p \leq 50\%$	Invalid

Source:Akbar (2016, p.82)

The data on product practicality were obtained from the learning implementation observation sheet, the teacher assessment sheet, and the student assessment sheet of the product. The percentage range and its categories are as follows:

Table 1. Practicality Assessment Criteria

No	Percentage Score	Criteria
1	$K \geq 85\%$	Very Practical
2	$70\% \leq K < 85\%$	Practical
3	$50\% \leq K < 70\%$	Fairy Practical
4	$0\% \leq K < 50\%$	Impractical

Modified from:Akbar (2016, p.82)

The developed interactive learning multimedia is considered practical if the assessments from teachers and students meet at least the "Practical" category. The practicality of the product, based on the percentage of learning activity implementation, refers to the following criteria.

Table 2. Learning Implementation Criteria

Rentang Nilai	Kriteria
$90\% \leq p \leq 100\%$	Very Good
$80\% \leq p < 90\%$	Good
$70\% \leq p < 80\%$	Enough
$0\% \leq p \leq 60\%$	Less

Sumber: Sudjana (2010)

The interactive learning multimedia is considered to meet practicality if the implementation of teacher and student activities achieves at least ≥70% in the "enough" category.

Data analysis to determine the quality of the effectiveness of the interactive learning multimedia was conducted by analyzing self-efficacy scores in mathematics learning. The use of interactive learning multimedia to facilitate students' self-efficacy is considered effective if the average score of students' self-efficacy questionnaire results falls within the high category (minimum score of 72) with a percentage of 75%. The categories of students' self-efficacy are as follows:

Table 3. Student Self-Efficacy Categories

Score Interval	Score	Category
$\boldsymbol{x \geq \overline{xi} + sbi}$	$\boldsymbol{x \geq 88}$	Very High
$\boldsymbol{\overline{xi} \leq \overline{x} < \overline{xi} + sbi}$	$\boldsymbol{72 \leq x < 88}$	High
$\boldsymbol{sbi \leq x > \overline{xi}}$	$\boldsymbol{16 \leq x < 72}$	Low
$\boldsymbol{x < sbi}$	$\boldsymbol{x < 16}$	Very Low

source: Sungkono, Trilisiana, & Prabowo (2022).

Description:

$x = empirical\ score$

$\overline{xi} = \frac{1}{2}$(ideal maximum score+ideal minimum score)

$sbi = \frac{1}{6}$(ideal maximum score-ideal minimum score)

The analysis was conducted using the paired sample t-test if the data were normally distributed and the Wilcoxon signed-rank test if the normality assumption was not met.

Results and Discussion

Result

The developed product is oriented toward students' self-efficacy. The problem-based learning e-learning product was developed in accordance with the stages of the ADDIE development model (Analyze, Design, Development, Implementation, and Evaluation). The research findings in detail are as follows.

Analysis stage

Teachers used applications such as Quizizz and Kahoot but had not employed interactive multimedia like Nearpod. Students showed difficulties distinguishing ratio concepts and displayed low self-efficacy (lack of confidence, frequent dependence on teachers, and tendency to give up on difficult problems.

Design stage

The multimedia was designed in line with curriculum goals and structured based on PBL syntax: problem orientation, organizing students, investigation, presentation, and evaluation

Tahap Pengembangan (Development)

The development stage was carried out by designing interactive learning multimedia based on the initial design and expert input. This process included the creation of texts, videos, and learning materials, as well as expert validation, utilizing Nearpod features. The multimedia design was guided by the problem-based learning model and oriented toward students' self-efficacy. Experts validated the product, yielding 82% (valid) for content and 88% (highly valid) for media. Based on these results, it can be concluded that the feasibility of the developed interactive learning multimedia, in terms of both content and media aspects, demonstrates validity that meets the criteria for use in the learning process. The interactive learning multimedia was revised in accordance with expert feedback before being used in the implementation stage.

Implementation Stage

The implementation was carried out through small-scale and then large-scale trials. The small-scale trial involved a teacher and six students, who completed a practicality assessment sheet to measure the practicality of the interactive learning multimedia. Small-scale and large-scale trials showed high practicality. Teachers rated ProSmart as highly practical (89%), students rated it practical (80%), and classroom implementation achieved 96% (very good). In the large-scale trial, six meetings were conducted: the first meeting was a pretest, the second to fourth meetings involved the learning process using the multimedia, and the final meeting was a posttest.

Evaluation Stage

The evaluation stage was carried out to assess the feasibility of the developed product. The feasibility of the problem-based learning interactive multimedia, oriented toward students' self-efficacy, was examined in terms of validity, practicality, and effectiveness. The validity test has been discussed in the development stage; therefore, this stage presents the practicality and effectiveness tests.

The practicality of the developed interactive learning multimedia was determined by analyzing the collected data, which included teacher and student assessments of the interactive learning multimedia as well as observation sheets of the learning implementation. The following are the results of the analysis of the learning implementation.

Table 6. Learning Implementation Results

Meeting	Teacher Activities			Student Activities		
	Score	Percentage	Criteria	Score	Percentage	Criteria
1	54	93%	Very good	50	86%	Good
2	58	100%	Very good	54	93%	Very good
3	57	98%	Very good	55	95%	Very good
4	58	100%	Very good	58	100%	Very good
Total	227	98%	Very good	217	94%	Very good

Table 7. Total Penilaian Keterlaksanaan Pembelajaran

Total Teacher Activities	Total Student Activities	Total	Percentage	Criteria
227	217	444	96%	Very good

Based on the results of the learning implementation analysis in Table 6 and Table 7, a total implementation score of 444 was obtained with a percentage of 96%. This percentage meets the "Very Good" criteria; therefore, the quality of the interactive learning multimedia, based on the observation results of learning implementation, is considered practical.

The effectiveness of the problem-based learning interactive multimedia oriented toward students' self-efficacy was determined by analyzing the data from the students' self-efficacy questionnaire results. Prior to conducting the hypothesis test, a normality test was first performed. The results of the univariate normality test are presented in the following table.

Table 8. Normality Test Results

No.	Data	Sig.	Decision
1.	*Pre-test self-efficacy*	0,637	H_0 Accepted
2.	*Post-test self-efficacy*	0,406	H_0 Accepted

Berdasarkan uji normalitas, data *self-efficacy* siswa dianalisis menggunakan *paired sample t-test*. Berikut adalah hasil dari *paired sample t-test.*

Tabel 4. Paired Sample T-Test Results

Data	t_{count}	$t_{0,05(20)}$	Decition
Self-efficacy	2,617	1.724	H_0 rejected

Table 12 shows that the calculated t-value for self-efficacy is 2.617. The calculated t-value for self-efficacy is greater than t0.05(20)=1.724t_{0.05(20)} = 1.724t0.05(20)=1.724, indicating that there was an increase in students' self-efficacy before and after the learning process.

Discussion

The developed Interactive Learning Multimedia is oriented toward students' self-efficacy. Based on expert validation and the trials conducted, it can be concluded that the Interactive Learning Multimedia developed in this study meets the criteria of being valid, practical, and effective.

The interactive multimedia product was developed using Nearpod, which can be accessed via the link https://nearpod.com/. Teachers are required to log in to their accounts, while students can access it using an access code provided by the teacher. In addition to the web link, Nearpod can also be accessed through the application, which can be downloaded from the Play Store. The application developed with Nearpod is designed based on the problem-based learning (PBL) syntax to facilitate students' self-efficacy.

The problem-based learning syntax includes: orienting students to the problem, organizing students for learning, conducting investigations, presenting learning outcomes, and evaluating the problem-solving process. Self-efficacy is assessed through: students' confidence in their ability to learn mathematics and solve tasks/problems of varying difficulty levels (magnitude aspect), confidence in their mathematical abilities to persist in completing assigned tasks (strength aspect), and confidence in learning various topics and solving different types of problems (generality aspect). The developed interactive learning multimedia utilizes Nearpod's features to support the PBL syntax while simultaneously facilitating students' self-efficacy.

The first step in the PBL syntax, orienting students to the problem, is implemented using the memory test feature or images that guide students toward the material to be learned. Once the problem is presented, students are instructed to identify and record the information provided as well as the questions asked. Authentic problems train the magnitude and generality dimensions of self-efficacy, as students evaluate difficulty levels and build confidence in tackling various types of problems. The following is an example of students' responses in noting what is known and what is asked in the problem.

Figure 1. Student Orientation Activities on the Problem

During the activity of organizing students for learning, students are directed to sit in groups and engage in discussions. At this stage, the textfield and whiteboard features are used, allowing students to discuss and collaboratively record their investigation plans. Students work in groups to design problem-solving strategies. This collaborative activity strengthens the strength and magnitude dimensions of students' self-efficacy, as they build confidence in their ability to develop a step-by-step problem-solving plan.

Figure 2. Student Organization for Learning Activities

Figure 3. Investigation Activities

The third step is conducting the investigation. Students are asked to observe the instructional videos and learning materials.

After gathering sufficient information, students are directed to solve the problem using the fill-in-the-blank feature. Persistence in facing challenges at this stage further develops the strength and generality dimensions of students' self-efficacy. Figure 4 presents an example of students' responses using the fill-in-the-blank feature.

Figure 4. Example of Student Responses in the Fill-in-the-Blank Feature

Based on Figure 4, it can be seen that students were able to place the available answer choices into the provided blanks. This task requires students to select the more affordable travel option by

calculating the one-day bus rental cost. In addition to the fill-in-the-blank feature, students can also solve problems using LiveWorksheet. LiveWorksheet was utilized during the second to fourth meetings..

Figure 5. Investigation Activities Using the Electronic Worksheet

The following is an example of students' responses on the electronic worksheet.

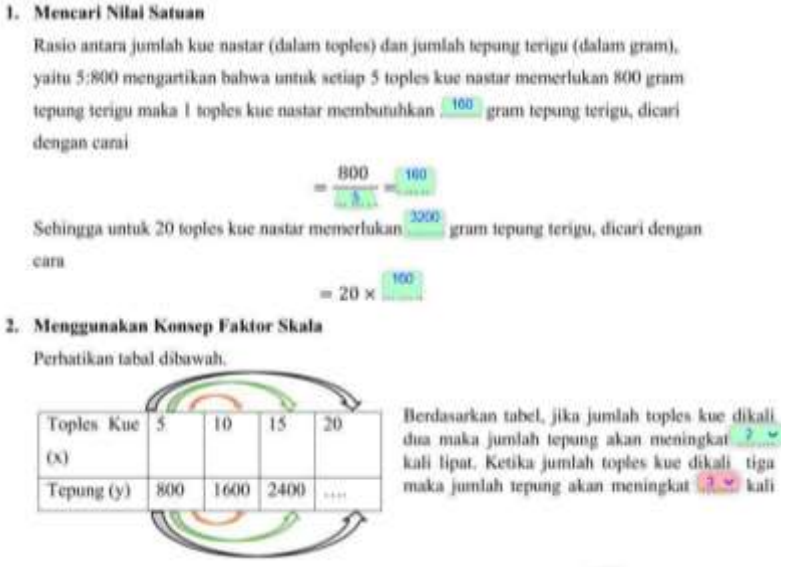

Figure 6. Example of Student Responses on LiveWorksheet

In Figure 6, it can be observed that students understood how to determine unit values but still made errors in applying the concept of the scale factor. For example, in the problem "when the number of cakes is tripled, the amount of flour will double," students answered incorrectly.

The fourth step is the presentation of learning outcomes. In the multimedia, students are facilitated to present their results through a collaborative board. Additionally, students are instructed to present their work directly in front of the class. They present their problem-solving results to other groups. Engaging in discussion with classmates or the teacher, while defending their arguments, fosters self-efficacy strength and enhances confidence in facing complex problems (magnitude). Figure 7 illustrates an example of the learning outcomes presentation activity on the collaborative board.

Figure 7. Learning Outcomes Presentation Activities

Figure 8. Example of Student Responses on the Collaborative Board

Based on Figure 8, all students were able to write the correct answers on the collaborative board. It is also evident that some students included the steps taken to reach the selected conclusion.

The final step is the evaluation of the problem-solving process, which involves a comprehensive assessment of each stage of problem resolution. Students evaluate their conceptual understanding, the development of practical competencies, and the effectiveness of the methods applied. They are asked to summarize what they have learned, facilitated through the fill-in-the-blank and open-ended question features. This stage reinforces all three dimensions of self-efficacy: magnitude (through reflection on the complexity of problems solved), strength (through awareness of personal resilience), and generality (through the ability to relate prior learning to new situations).

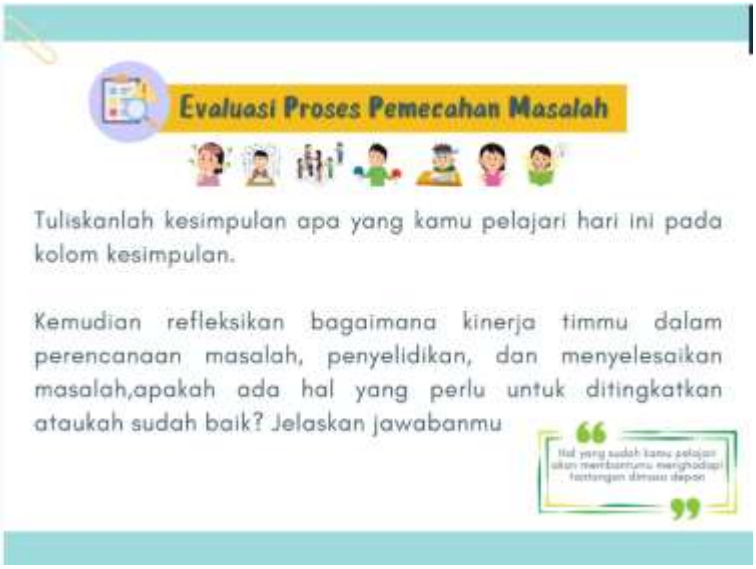

Figure 9. Problem-Solving Process Evaluation Activities

The following is an example of students' problem-solving process evaluation results.

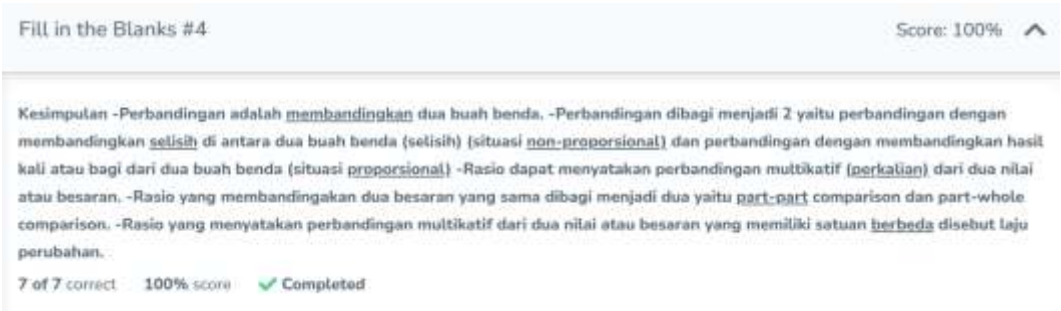

Figure 10. Example of Student Responses in the Problem-Solving Process Evaluation Step

As shown in Figure 10, students were able to summarize the lesson material on ratios. The core of the lesson involved learning about additive and multiplicative comparisons, ratios, and rates of change of units.

Students' self-efficacy is divided into four categories: very high, high, low, and very low. The following presents the data on students' achievement for each self-efficacy indicator.

Table 5. Post-Scale Student Self-Efficacy Results by Indicator

No	Indicator	Average Score	Category
1	Confidence in the ability to learn mathematics and solve tasks/problems of varying difficulty levels.	76,00	High
2	Confidence in one's mathematical abilities to engage in learning and persist in completing assigned tasks.	81,75	High
3	Students' confidence in learning various topics and solving different types of problems.	76,25	High

The results indicate that students' self-efficacy falls within the high category, although it still needs to be improved to reach the very high category. Overall, learning using the ProSmart multimedia was well implemented and has been shown to have a positive impact on students' self-efficacy in mathematics. Chen et al. (2019) stated that multimedia-based learning results in higher self-efficacy compared to conventional learning and has a positive impact on learning outcomes. Other studies also support that multimedia can enhance students' self-efficacy (Fajri et al., 2017; Manurung et al., 2020; Taufiq et al., 2024; Vega & Ramos, 2023). Furthermore, the problem-based learning (PBL) model also contributes to improving self-efficacy by providing students with opportunities to solve real-world problems and engage in group discussions (Anggalia et al., 2020; Handayani & Louise, 2019; Masitoh & Fitriyani, 2018; Nst et al., 2023). Social interaction and experience during group discussions further strengthen students' self-efficacy (Risnawati et al., 2018).

Research Implications

The developed product, an interactive learning multimedia based on problem-based learning, can serve as a catalyst for the continuous development of technology-based learning media in mathematics instruction. This initiative should be further encouraged to support the implementation of the Kurikulum Merdeka education program.

Conflict of Interest

There is no conflict of interest.

Limitations

The main limitation arose from unstable internet connectivity at the research school. This condition required the researcher to provide alternative mobile hotspots during the implementation process, which may not represent ideal learning conditions. Additionally, the fully online design of the "ProSmart" product created access challenges for students with limited internet data, potentially resulting in differences in learning experiences between students with adequate access and those with restricted access. Lastly, the current product development only covers comparison material for Grade VII, so the research findings cannot yet be generalized to all mathematics domains or other grade levels.

Conclusion

Based on the results of the research and development using the ADDIE model, it can be concluded that the developed ProSmart interactive learning multimedia aims to enhance students' self-efficacy by integrating the problem-based learning model. Each stage is designed to actively engage students in knowledge construction and improve self-efficacy through motivational prompts. From the media perspective, ProSmart is presented in an interactive structure comprising an introductory page, pre-learning activities, PBL-based learning activities, interactive instructional videos, and engaging, challenging quizzes.

This interactive learning multimedia is feasible for use based on validity, practicality, and effectiveness tests. Expert validation showed that the content scored 82% (valid category) and the media 88% (highly valid category). In terms of practicality, teacher assessments showed 89% (highly practical), student assessments 80% (practical), and learning implementation 96% (very good). Regarding effectiveness, the paired sample t-test indicated a significant increase in students' self-efficacy before and after using ProSmart. Therefore, the ProSmart interactive learning multimedia is effective for use in mathematics learning.

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