

DEVELOPMENT OF ADOBE FLASH LEARNING MEDIA FOR PRACTICALITY AND EFFECTIVENESS IN MATHEMATICAL REASONING

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ABSTRACT

This study aims to develop mathematics learning media using Adobe Flash that are practical and effective in improving students' mathematical reasoning abilities on trigonometry material. The research employed a Research and Development (R&D) approach using the ADDIE instructional design model, which consists of the stages of Analysis, Design, Development, Implementation, and Evaluation. The subjects of this study were eleventh-grade students of MAN 2 Model Medan. The research instruments included teacher and student response questionnaires to measure the practicality of the learning media, as well as tests of students' mathematical reasoning abilities to determine its effectiveness. The results showed that the practicality of the Adobe Flash-based learning media, based on teacher and student responses after implementation, obtained an average score of 91%, which falls into the "very practical" category. Furthermore, the effectiveness of the media was indicated by the improvement in students' mathematical reasoning test results, with an achievement percentage of 71%. A t-test analysis demonstrated that the calculated t-value ($t_{\text{count}} = 12.96$) was greater than the t-table value ($t_{\text{table}} = 2.14$), indicating a significant difference between pretest and posttest scores. These findings suggest that the Adobe Flash-based mathematics learning media are practical and effective for enhancing students' mathematical reasoning abilities.

Keywords: Adobe Flash; Mathematics Learning Media; Practicality; Effectiveness; Mathematical Reasoning.

INTRODUCTION

Education is a deliberate and well-planned effort to create a learning environment and instructional process that enable students to actively develop their full potential. This potential includes spiritual strength, self-control, personality, intelligence, moral values, and skills that are beneficial not only for personal development but also for society, the nation, and the state (Depdiknas, 2003).

In the learning process, students tend to engage predominantly in theoretical learning, focusing mainly on understanding subject matter conceptually. However, the lack of opportunities to apply theory in daily activities often results in limited comprehension. Therefore, teachers are expected to help explore and develop students' potential and creativity so that they not only understand concepts theoretically but are also able to apply them in real-life situations to face future challenges (Nurfadillah et al., 2021).

One important factor that supports effective learning is the use of instructional media. According to Magdalena et al. (2021), instructional media serve as essential non-verbal communication tools and should be integrated into every learning session as part of the instructional system. Learning outcomes will not be optimal if one of the instructional components is absent. Similarly, the National Education Association (NEA) states that media refer to all forms of tools that facilitate message delivery to learners with the aim of stimulating students' thoughts, emotions, attention, and interest, thereby supporting an effective learning process (Junaidi, 2019). In line with this view, Nurrita (2018) explains that instructional media are tools that assist the teaching and learning process by conveying messages more clearly and facilitating the efficient and effective achievement of educational objectives. Thus, instructional media function as non-verbal communication tools that help deliver messages clearly, effectively, and efficiently to learners.

In developing learning activities, teachers are required to have the ability to select and utilize available media optimally. One commonly used instructional medium is textbooks, which play an important role in encouraging students to access and read quality learning materials. Reading activities have been shown to have a significant correlation with the development of critical thinking skills, which in turn foster students' creativity and innovation (Trilaksono et al., 2018). In addition to textbooks, other instructional media that are considered highly effective include technology-based media such as Adobe Flash. Research conducted by Ramadani and Amini (2021) revealed that learning media developed using Adobe Flash were appropriate and feasible for use, with an average validation score of 94.41%, categorized as very valid. Furthermore, Suryaningsih and Jahrotunisa (2022) reported that interactive learning media utilizing Adobe Flash technology successfully increased students' learning interest, as indicated by an average assessment score of 91%, which also fell into the very valid category. These findings indicate that, besides textbooks, Adobe Flash-based instructional media represent a valuable and beneficial alternative for enhancing students' learning interest and mathematical reasoning abilities.

Based on the results of evaluation tests administered to tenth-grade students at MAN 2 Model Medan using Higher Order Thinking Skills (HOTS) questions, students' mathematical reasoning abilities were found to be relatively low. The test results showed that the average score obtained was below 60%. This finding was supported by interviews with a mathematics teacher, who stated that the average score of 30 students was below the minimum mastery criterion (KKM) of approximately 60%. Therefore, students' mathematical reasoning abilities were considered to be below the expected standard.

To address this issue, teachers need to improve the quality of instruction by implementing more effective learning strategies. One important approach to enhancing students' logical and mathematical thinking skills is the use of instructional media that are effective, interactive, and capable of attracting students' interest. In addition, comprehensive and clear explanations of learning materials are essential to support the improvement of students' mathematical reasoning skills.

RESEARCH METHODS

Research and Development (R&D) is a research method aimed at producing specific products and testing their performance. Needs analysis is an essential stage in the development process to ensure that the resulting product meets particular requirements and to evaluate how effective the product is in practical use (Sugiyono, 2016). Unconsciously, the Research and Development approach has been applied throughout human history. Many products inherited from previous generations have demonstrated practical benefits over time. Subsequent studies conducted by experts have

shown that these products are scientifically advantageous for human use. However, traditional products were not always formally recognized for their quality and benefits because their testing processes were undocumented and lacked scientific justification, as they were not based on adequate literature references (Winaryati, 2021).

One of the instructional design models widely used in educational development research is the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which was introduced by Reiser and Mollenda in the 1990s. The ADDIE model serves as a systematic guideline for developing efficient, dynamic, and effective learning media and instructional systems that support the achievement of learning objectives (Danuri & Maisaroh, 2019).

In this development research, data analysis was divided into two main components: the analysis of the practicality and the effectiveness of Adobe Flash-based mathematics learning media. The practicality of the learning media was evaluated based on the results of response questionnaires completed by teachers and students.

The practicality data were analyzed using the Guttman scale measurement technique (Sugiyono, 2016). This measurement approach produces definitive responses, such as “agree–disagree,” “true–false,” “yes–no,” and “positive–negative.” Each measured variable consists of two response categories, where an “agree” response is assigned a score of 1 and a “disagree” response is assigned a score of 0. This analysis method enables clear and objective interpretation of the practicality of the developed learning media.

Table 1. Guttman Scale Assessment Categories

| No | Score | Explanation |
|----|---------|-------------|
| 1 | Score 1 | Agree/Yes |
| 2 | Score 0 | Disagree/No |

According to Sugandi and Rasyid (2019), the practicality percentage is calculated using the following formula:

$$P = \frac{\sum X}{\sum X_1} \times 100\%$$

Explanation:

- P = Practicality score percentage
- $\sum X$ = Total expert responses in one aspect
- $\sum X_1$ = Maximum possible responses in one aspect
- 100% = Constant

The following table presents the practicality standards used in the development of this learning media:

Table 2. Criteria of Learning Media Practicality

| No | Level of Achievement | Qualification | Explanation |
|----|----------------------|---------------|----------------------|
| 1 | 81 – 100% | Very Strong | Very Practical |
| 2 | 61 – 80% | Strong | Practical |
| 3 | 41 – 60% | Moderate | Moderately Practical |
| 4 | 21 – 40% | Weak | Less Practical |
| 5 | 0 – 20% | Very Weak | Not Practical |

If the Adobe Flash-based mathematics learning media achieve a minimum practicality percentage of 61% or meet high qualification standards, the product can be considered practical and suitable for use as a mathematics learning medium in classroom instruction.

The effectiveness of the learning media was evaluated through tests assessing students’ mathematical reasoning abilities after they used the Adobe Flash-based learning media. Furthermore, according to Jaya (2019), a paired t-test was employed to determine the significance of the difference between pretest and posttest scores using the following formula:

$$t \text{ count} = \frac{Md}{\sqrt{\frac{\sum x^2 d}{N(N-1)}}}$$

Explanation:

- Md : the mean of the posttest-pretest scores
- d : posttest score minus pretest score
- $\sum x^2d$: the sum of $Xd (d - Md)$
- N : the number of students

The formula used to determine the t-table value is as follows:

$$t \text{ table} = df = n - 1$$

Where:

- df : degrees of freedom
- n : the number of students

If the calculated t-value (*t* count) is greater than the t-table value (*t* table), there is a significant difference between the pretest and posttest scores, indicating that the learning media used are effective in improving students' mathematical reasoning abilities. Conversely, if the calculated t-value (*t* count) is less than the t-table value (*t* table), there is no significant difference, which means that the learning media are not effective.

RESULTS AND DISCUSSION

After the Adobe Flash-based mathematics learning media were reviewed by media experts and subject matter experts and subsequently revised, the media were declared ready for field testing. The field trial was conducted through direct classroom implementation at MAN 2 Model Medan on August 7 and 9, 2024.

The implementation of the product trial involved the mathematics teacher conducting instruction using the developed learning media, while students utilized the media as instructional materials in place of textbooks. Prior to the learning activities, the researcher provided explanations to both teachers and students regarding the proper use of the media. During the learning process, the researcher guided and assisted students in operating the media. In addition, this trial provided students with opportunities to enhance their technological skills, particularly in using devices such as laptops, which can support the learning process.

After using the Adobe Flash-based mathematics learning media, students were asked to complete a questionnaire provided by the researcher. The students' responses to the questionnaire were used as quantitative data, which were then analyzed to determine the level of practicality of the Adobe Flash-based mathematics learning media for use in schools. The assessment results for each statement item were based on the accumulation of students' responses.

In addition to collecting students' responses, the practicality of the Adobe Flash-based mathematics learning media was also evaluated from the teacher's perspective. After teaching using the developed learning media, the teacher was asked to provide an evaluation through a questionnaire prepared by the researcher. The teacher's responses were used as quantitative data, which were subsequently analyzed to determine the level of practicality of the mathematics learning media. The following table presents the teacher's responses to the developed mathematics learning media.

Based on the analysis of responses from students and teachers after using the Adobe Flash-based learning media, the average overall student response was 88.5%, which falls into the "Very Practical" category. Meanwhile, the average teacher response reached 93.8%, also classified as "Very Practical." The responses from both students and teachers were then analyzed cumulatively. Based on the cumulative analysis, an overall average score of 91% was obtained. This percentage reflects the overall responses of students and teachers after using the developed learning media, indicating a very high level of practicality.

Following the practicality evaluation, the effectiveness of the learning media was assessed through a mathematical reasoning test administered to students after they used the Adobe Flash-based learning media. The test was designed to measure students' ability to solve problems related to trigonometry.

The results showed that the average score of students' mathematical reasoning before using the learning media was 51, while the average score after using the media increased to 71. Furthermore, a paired t-test analysis was conducted, yielding a calculated t-value of 12.96 and a t-table value of 2.14. Since the calculated t-value was greater than the t-table value, this result indicates a significant difference between the pretest and posttest scores. Therefore, the use of Adobe Flash-based learning media can be considered effective in improving students' mathematical reasoning abilities.

The practicality of the Adobe Flash-based mathematics learning media was evaluated based on respondents' assessments during the implementation stage, namely the product trial conducted in the school setting. The respondents consisted of 15 students and one mathematics teacher. The evaluation covered several aspects, including visual appearance, ease of use, material presentation, and the benefits obtained from the learning media.

Based on students' responses after using the learning media, the following results were obtained: (1) the visual appearance aspect of the learning media achieved an average percentage score of 95%, which falls into the very practical category; (2) the ease of use aspect obtained an average percentage score of 91.1%, also classified as very practical; (3) the material presentation aspect reached an average percentage score of 83.3%, categorized as very practical; and (4) the benefit aspect achieved an average percentage score of 84.4%, which also falls into the very practical category. The average percentage across these four aspects was 88.4%, indicating that the learning media are very practical from the students' perspective.

Based on the teacher's responses after conducting instruction using the learning media, the following results were obtained: (1) the visual appearance aspect achieved an average percentage score of 100%, which is categorized as very practical; (2) the ease of use aspect also achieved an average percentage score of 100%, classified as very practical; (3) the material presentation aspect obtained an average percentage score of 75%, which falls into the practical category; and (4) the benefit aspect achieved an average percentage score of 100%, categorized as very practical. The average percentage across these four aspects was 93.8%, indicating that the learning media are very practical from the teacher's perspective.

The responses from both students and the teacher were then analyzed cumulatively. Based on the cumulative analysis, an overall average percentage of 91% was obtained. This percentage reflects the overall responses of students and teachers after using the developed mathematics learning media. These findings are consistent with the study conducted by Vela et al. (2021), which reported teacher assessment results of 87.82% and student assessment results of 91.77%, indicating that the learning media are suitable for use in the learning process.

Following the cumulative practicality analysis, the effectiveness of the learning media was evaluated based on the results of the mathematical reasoning test. The analysis revealed that the average score of students' mathematical reasoning after using the learning media reached 71. Furthermore, a paired t-test was conducted, yielding a calculated t-value of 12.96 and a t-table value of 2.14. Since the calculated t-value was greater than the t-table value, this result indicates a significant difference between the pretest and posttest scores. Therefore, the use of Adobe Flash-based learning media can be classified as effective.

These findings demonstrate that Adobe Flash-based learning media are capable of improving students' mathematical reasoning abilities. Consequently, this study is consistent with the research conducted by Milala et al. (2021), which reported an average media effectiveness score of 86.77, categorized as very effective.

CONCLUSIONS

Based on the findings of this study, the practicality of Adobe Flash-based mathematics learning media was evaluated through students' and teachers' responses after using the media. The cumulative analysis of these responses yielded an average practicality percentage of 91%, indicating that the developed learning media fall into the very practical category. Furthermore, the effectiveness of the learning media was assessed through students' mathematical reasoning test results. The average pretest score was 51, while the average posttest score increased to 71. A paired t-test analysis revealed a calculated t-value of 12.96, which exceeded the t-table value of 2.14, indicating a significant difference between pretest and posttest scores. Therefore, it can be concluded that the Adobe Flash-based mathematics learning media are both very practical and effective for use in mathematics instruction at MAN 2 Model Medan.

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