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Development of TPACK Based-Learning Media Oriented Towards Students' Motivation and Mathematics Outcomes

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Abstract: This study aims to develop Technological Pedagogical Content Knowledge (TPACK)-based learning media oriented towards motivation and mathematics learning outcomes that are valid, practical and effective. The subjects in this study are class VIII students at one of the junior high school in Mataram. This type of this study is Research and Development with the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model. Data analysis in this study was carried out using descriptive quantitative and qualitative regarding the advisibility of learning media obtained from assessment or validation sheets, analysis of the practicality of learning media obtained from student response questionnaires and teacher responses to learning media, and analysis of the effectiveness of learning media obtained from posttest results. The study results obtained that: TPACK-based learning media has been developed is suitable for use as learning media with high validity; TPACK-based learning media is practically used as learning media with a practicality score of 79.67%; The N-gain value for increasing students matemathics learning motivation is 43.34% in the medium category, while for increasing students matemathics learning outcomes it is 56.74% in the medium category. Based on the results, TPACK-based learning media is suitable for use, practically applied for learning, less effective for increasing learning motivation, and quite effective in improving learning outcomes.

Keywords: Learning Media, TPACK, Matemathics Learning Motivation, Matemathics Learning Outcomes

Introduction

Mathematics learning in schools plays a crucial role in developing students' mathematical thinking. The problems that arise in the process of learning are usually caused by a lack of communication between teachers and students, passive student interactions with their peers, and a monotonous learning process.The passivity of students in the process of learning mathematics contributes to a diminished motivational drive for study. Consequently, it will impact their learning outcomes.

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For students, learning motivation can grow enthusiasm for studying, thereby propelling students to engage in learning activities (Lestari, 2020:2). However, in reality, many students in schools face some difficulties in comprehending mathematical concepts, leading them to dislike the subject. They perceive mathematics as challenging to grasp and unenjoyable. The difficulty in mastering mathematical concepts can be influenced by several factors, one of which is the teacher's method of delivering course materials. Sukma et. al (2022) Stated that a study reveals that 70% of learners do not enjoy mathematics lessons, this is attributed to the use of media, materials, and learning methods that fail to capture the interest of students in the learning process. This leads to students losing enthusiasm and motivation to learn mathematics, consequently resulting in low academic achievement.

Based on the interview results conducted in September 2022 with mathematics teachers at SMP Negeri 16 Mataram, it was found that the conducted learning is still teacher-centered and the instructional media used primarily consists of students' mathematics textbooks provided by the Ministry of Education and Culture, with a structured learning system. Jumiati et al. (2020) stated that teachers are obligated to create instructional media or visual aids to be used in delivering course material, enabling students to grasp the concepts more quickly.

Based on interviews with several 7th-grade students at SMP Negeri 16 Mataram in October 2022, it was stated that the majority of students are not interested in learning mathematics due to feeling bored when presented with lecture-based teaching methods without varied instructional media and teaching models. As a result, some of them choose to leave the classroom learning activities.

The development of science and technology urges teachers to make efforts to update the use of instructional media in schools. Teachers must be capable of creatively innovating and creating new approaches that can support the success of learning. The limited use of instructional media in the classroom is identified as one of the factors contributing to the insufficient academic performance of students (Sari et al., 2022). A means to enhance the quality of education is leveraging technological advancements, particularly through the careful selection of suitable instructional media. A key strategy entails the creation and utilization of technology-based instructional media to elucidate subjects for students, aiming to facilitate better comprehension. The aspiration is that the incorporation of such instructional media will not only simplify understanding but also boost student motivation and improve overall learning outcomes. The study by Nurrita (2018) concludes that instructional media can enhance students' learning motivation, learning experiences, and academic outcomes. Furthermore, students can easily comprehend the lessons with the aid of instructional media.

In order to align the use of technology and information in education, a teacher needs to understand and possess TPACK (Technological Pedagogical Content Knowledge) skills. Koehler et al. (2013) explained that TPACK is a complex and interrelated framework involving Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK) that develops situational and active learning activities. The study by Wijaya et al. (2020) concludes that the implementation of instructional media based on the TPACK concept has been proven to make students more active in classroom learning activities.

One technology-based instructional media is educational videos. According to Azmi et al. (2021), students are more interested in viewing graphics and images presented in educational videos compared to reading extensive written materials. Additionally, Ariyanti and Sulisworo (2019) stated in their research that educational videos are highly engaging when used as instructional media in the classroom. Through learning via educational videos, students can enhance their listening and visualization skills. Moreover, they can use these videos individually and watch them anywhere and anytime, allowing them to review the video content until they thoroughly understand the material. Based on the related studies above, it can be concluded that instructional media needs to be utilized as a means of presenting engaging content to foster the activeness and learning enthusiasm of students in the classroom. Therefore, this research aims to develop TPACK-based learning media

based on the motivation and learning outcomes of students in mathematics that are valid, practical, and effective.

Method

The type of research employed is Research and Development with the ADDIE model, consisting of five stages: analysis, design, development, implementation, and evaluation.

Analysis

There are three activities conducted within this stage, namely curriculum analysis, which involves selecting the required curriculum for the matching of the content in the media. This is done by choosing the middle school mathematics material, specifically Number Patterns, along with its indicators based on the defined core competencies and basic competencies. Student analysis is also performed to understand the characteristics of the students through interviews with both students and mathematics teachers, as well as direct observations at the school. Situation analysis is conducted to assess the school's conditions and facilities.

Design

The design of instructional media provided the content or components within educational videos, created to be as engaging as possible to capture students' interest in learning. This includes the material title, learning objectives, initial concepts, material definitions, illustrations, and sample problems.

Development

The development stage involves testing or validating the instructional media, in this case, the instructional video, with experts to ensure its suitability for use as a learning tool. This stage aims to verify that the content within the instructional video aligns with the specific basic competencies outlined in the sub-topic of the material.

Implementation

The implementation stage involves the product's trial with students from class VIII-C at SMP Negeri 16 Mataram, presenting the instructional video during the teaching and learning activities. The results obtained after the teaching and learning activities include the students' responses and the teacher's feedback on the instructional media, which are then analyzed simply.

Evaluation

The evaluation stage is conducted after the teaching and learning activities, involving the assessment results of the learning activities (posttest). These results will be analyzed simply to understand and assess the effectiveness of the instructional media.

The subjects of this research are students from class VIII-C at SMP Negeri 16 Mataram in the academic year 2023/2024. The data collection techniques utilized include questionnaires and a posttest. The research instruments consist of assessment or validation sheets, a questionnaire on mathematics learning motivation before and after the use of TPACK-based learning media, a questionnaire on student and teacher responses to TPACK-based learning media, and student posttest questions.

The data obtained is then analyzed using the following analysis techniques:

Analysis of the Validity of TPACK-Based learning Media.

The Validity of TPACK-based instructional media is assessed through a validity test using Aiken's V Validity Theory. The validation criteria guidelines are as follows:The Validity of TPACK-based learning media is assessed through a validity test using Aiken's V Validity Theory. The validation criteria guidelines are as follows:

Table 1. Guidelines for Validation Criteria

Value	Category
$0.80 < V \leq 1.00$	Very High
$0.60 < V \leq 0.80$	High
$0.40 < V \leq 0.60$	Moderate
$0.20 < V \leq 0.40$	Low
$0.00 < V \leq 0.20$	Very Low

TPACK-based learning media that has been developed is considered suitable for use if it falls within the high and very high categories.

Analysis of the Practicality of Instructional Media

Practicality can be measured using a Likert scale with answer alternatives, namely 1 = not good, 2 = less good, 3 = sufficient, 4 = good, and 5 = very good. After obtaining the practicality values, grouping is done according to the practicality categories in the following table.

Table 2. Practicality Category

Value	Category
$80\% < P \leq 100\%$	Very Practical
$60\% < P \leq 80\%$	Practical
$40\% < P \leq 60\%$	Moderately Practcal
$20\% < P \leq 40\%$	Not Practical
$0\% < P \leq 20\%$	Not at All Practical

Based on Table, the developed instructional media is considered practical if it falls within the practical and very practical categories.

Analysis of the Effectiveness of Instructional Media

a. *Normalized gain* Test

The analysis of the effectiveness of instructional media is calculated using the Normalized Gain test (N-gain score) as follows.

$$N\text{-}gain = \frac{S_{after} - S_{before}}{S_{max} - S_{before}} \times 100\%$$

Keterangan:

S_{after} = Score of the motivation questionnaire and students' learning outcomes after using media.

S_{before} = Score of the motivation questionnaire and students' learning outcomes before using instructional media.

S_{max} = Maximum Score

The obtained scores are then categorized based on the following table.

Tabel 3. Categories of N-gain Score Division

Interval	Category
$N\text{-}gain > 70$	High
$30 \leq N\text{-}gain \leq 70$	Moderate
$N\text{-}gain < 30$	Low

b. Paired t-test

Paired t-test is used to determine the improvement in students' learning outcomes before and after the use of TPACK-based learning media overall through hypothesis testing. The paired t-test is conducted using the following formula.

$$t = \frac{\bar{B}}{S_B/\sqrt{n}}$$

Keterangan:

t = t value

$\bar{B}$ = Mean of the difference in learning outcomes before and after the use of media

S_B = Standard Deviation

n = Sample Size

The significance level (α) used is 0.05 with a confidence level of 95%. The decision criterion is if $t_{Value} > t_{table}$ indicates a significant result, so it is said that H_1 is accepted and H_0 is rejected. In contrast, if $t_{value} < t_{table}$ shows insignificant result, then H_1 is rejected and H_0 is accepted.

Result and Discussion

Stage of *Analysis*

The initial stage of this research is the analysis stage, which involves analyzing the curriculum, student analysis, and situation analysis. Based on the observation activities conducted with the mathematics teachers at SMP Negeri 16 Mataram, it was found that the school adopts the 2013 curriculum with a learning time allocation of 40 minutes per class hour. Mathematics is scheduled for 5 hours of learning per week. The instructional media used by teachers consists only of student textbooks and teacher guides provided by the Ministry of Education and Culture. The teaching model employed by teachers still revolves around a teacher-centered approach with lecture methods. In other word, students are still less active in the learning process because there is no interaction between the teacher and the students. The instructional media used is not optimal because students only find the answers without understanding the concepts from various pieces of information.

The conducted student analysis revealed that students are having difficulty understanding the material and lack enthusiasm in participating in classroom learning. Some even leave the class during lessons due to boredom caused by the lack of variation in the teaching methods provided by the teacher. Consequently, the situation analysis indicates that the school has facilities that support the use of instructional media. However, the utilization of these facilities has not been maximized by the teachers.

Stage of *Design*

In this stage, there are two instructional videos designed according to the predetermined number of sessions for the Number Patterns material, which is two sessions. The content of the designed videos includes the video titles, namely "Number Patterns First Session" for the first video and "Number Patterns Second Session" for the second video. The learning objectives for the first session are to recognize various number patterns and to generalize the patterns of number sequences into an equation. Meanwhile, in the second session, the objectives include determining the next term in a number sequence pattern and solving contextual problems related to number patterns. In each session, the initial concept provided is daily basis examples related to patterns so that students can grasp the concept of number patterns. The video mentions examples of patterns using daily basis scenarios. After that, students are asked to determine the solution to a problem presented in the video.

Stage of *Development*

In this stage, the instructional media is validated and then revised according to the validation results to obtain valid instructional media. Salsabila & Setyaningrum (2019) stated that one of the criteria that must be met by the developed instructional media is the validity criterion, and it is considered valid if it can measure what should be measured according to its intended purposes. The instructional media was validated by two expert validators from the Mathematics Education Department, Faculty of Teacher Training and Education, Universitas Mataram. Based on the Validity test results, the validation score from the first validator is 0.80, and the validation score from the second validator is 0.71. From these results, the overall validation score is 0.755 with a high category. This means that the developed instructional media meets the basic criteria for instructional media development, making it suitable for use as a learning tool.

After the validity test was conducted, the instructional media was then revised according to the improvement suggestions provided by both validators. The results of the instructional media revision are as follows.

Figure 1. TPACK-Based learning Media Before Revision

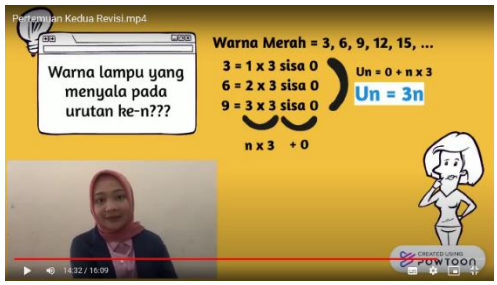

Figure 2. TPACK-Based learning Media After Revision

Stage of *Implementation*

The implementation stage is a limited trial conducted with students from class VIII-C at SMP Negeri 16 Mataram, by showing instructional videos during teaching and learning activities. The instruments used to collect data from the trial at this stage are questionnaires on student responses and teacher responses to the developed instructional media. These questionnaires are provided after the trial. From the results of the student and teacher response questionnaires, it was found that the practicality score of TPACK-based learning media is 79.67%. These results indicate that the developed TPACK-based learning media is a practical instructional media for use in teaching.

Stage of *Evaluation*

The evaluation of the developed instructional media aims to measure the level of effectiveness of the instructional media. The data on the effectiveness of the instructional media

is obtained from the improvement of students' motivation for learning mathematics, as indicated by the results of a questionnaire on students' motivation for learning mathematics. Additionally, the student's learning outcomes data comes from the posttest results, which are then compared with the students' mathematics learning outcomes in the previous topic without using TPACK-based learning media. In the improvement of students' motivation for learning, the total score for students' motivation for learning mathematics before the use of TPACK-based learning media is 1.191 with an average score of 44.1. Meanwhile, the total score for students' motivation for learning mathematics after the use of TPACK-based learning media is 1.585 with an average score of 58.70. From these results, it is obtained that the effectiveness of TPACK-based learning media based on the N-gain score regarding students' motivation for learning mathematics is 43.34%, and it falls into the category of less effective with a classification of N-gain scores in the moderate criteria. Furthermore, the effectiveness of TPACK-based learning media based on students' mathematics learning outcomes yields an N-gain score of 56.74%, falling into the moderate category and classified as quite effective. The students' mathematics learning outcomes before the use of TPACK-based learning media were obtained from the results of learning in the previous topic with a total score of 1.544 and an average score of 57.18. Meanwhile, in the mathematics learning outcomes after the use of TPACK-based learning media, the total score obtained is 2.200 with an average score of 81.48.

In addition to the research subject, TPACK-based instructional media is also used by the mathematics teacher in other classes at SMP Negeri 16 Mataram, namely classes VIII-A, VIII-B, and VIII-D. Based on the N-gain analysis results, in class VIII-A, it was found that TPACK-based learning media has an effectiveness score of 55.15%, falling into the moderate category and classified as quite effective. Meanwhile, in classes VIII-B and VIII-D, the effectiveness scores obtained are 52.65% for class VIII-B and 52.09% for class VIII-D, both falling into the moderate category and considered less effective. From these results, the overall average N-gain score is 54.12%, falling into the moderate category. This average result indicates that TPACK-based learning media is less effective in improving students' mathematics learning outcomes. To observe the improvement in learning outcomes before and after the use of TPACK-based learning media. Overall, a paired t-test was conducted to determine the improvement in students' mathematics learning outcomes with the following hypothesis.

$H_0 : \mu_B = 0$
$H_1 : \mu_B > 0$

H_0 : There is no significant increase in the average learning outcomes before and after implementing learning using TPACK-based learning media

H_1 : There is a significant increase in the average learning outcomes before and after implementing learning using TPACK-based learning media.

Given that the total number of eighth-grade students is 114, the average improvement in learning outcomes before and after the use of TPACK-based learning media is 22.54. The standard deviation obtained from the scores of students' learning outcome improvement before and after the use of TPACK-based learning media is 7.72. From the analysis results, with a significance level of 5% and degrees of freedom (df) 113, the t-table value is 1.658. The calculated t-value is 31.153. This result indicates that the calculated t-value is greater than the t-table value. Therefore, it is concluded that there is a significant improvement in students' learning outcomes before and after the use of TPACK-based learning media.

In spite of the fact that TPACK-based learning media is less effective in improving students' motivation to learn mathematics, students are enthusiastic and eager to learn using TPACK-based learning media. This is because learning using TPACK-based learning media is a new experience for students, which is rarely encountered in the teaching and learning process. The use of TPACK-based learning media in the learning process makes students actively engage in discussions with their peers. When students feel uncertain, they immediately ask questions

about the challenging aspects. Additionally, students actively respond to questions and solve problems presented in the instructional videos. Furthermore, learning with TPACK-based learning media meets the curriculum standards set by the school. The school's curriculum encourages teachers to use innovative instructional media in teaching. Moreover, the curriculum emphasizes active student participation, student-centered learning with the teacher as a facilitator, and students' ability to independently grasp the concepts taught and find solutions.

Conclusion

According to the findings and discussions, it can be concluded that TPACK-based learning media is suitable for use as a learning tool, practical to implement in teaching activities, less effective in improving motivation for learning mathematics, and moderately effective in enhancing students' mathematics learning outcomes. Therefore, it can be considered as an alternative instructional media. A suggestion to improve students' learning experiences is to continue using TPACK-based learning media in future teaching and learning activities.

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