



**MATERIALS DEVELOPMENT TEACHING MATHEMATICS
PHET VIDEO BASED ON THE CONCEPT OF FRACTIONAL
NUMBERS FOR CLASS IV STUDENTS**

Ardiansyah Latif, FN H, 1 Eni Titikusumawati, 2

¹UIN Salatiga, ²UIN Salatiga

ardihanafi69@gmail.com

ABSTRACT:

This research answers the low student learning outcomes due to less interesting learning. This research aims to develop mathematics teaching materials based on PhET Interactive Simulation videos and obtain PhET videos that are valid, practical, and effective. The research method used is the Research and Development (R&D) method with the ADDIE model which includes analysis, design, development, implementation, and evaluation stages. The subjects of this research were 28 class IV students at MI Tegalwaton, Tenganan District. Data collection techniques used were interviews, FGD, questionnaires, and documentation. The validation stage of teaching materials is carried out by asking for assessments from material experts and media experts. The average result of the material expert assessment was 91.5% which was in the very valid category and the result of the media expert assessment was 83.4% which was in the very valid category. The results of student responses in the limited trial were 89.5% in the very effective category and in the extensive trial, it was 88.63% in the very effective category. The students' pretest results got an average score of 69.2 and the students' posttest results got an average score of 79.6. There was an increase in the learning outcome scores between the students' pretest and posttest so the learning videos developed were considered effective. So it can be stated that this PhET video is valid, practical, and effective.

Keywords: Teaching materials, Mathematics, PhET, Fractional Numbers.

INTRODUCTION

Open materials are an important part of education. Teaching materials or materials are basically the content of the curriculum (Putra et al., 2022: 122). Teaching materials that are well-prepared and interesting will make it easier for teachers to convey learning, and students will be more helped in the learning process. According to Fitria (2017:99), teaching materials are a collection of materials arranged systematically that can be used to support the learning process. Meanwhile, according to Magdalena et al. (2020:312), teaching materials can also be interpreted as all forms of learning materials that are systematically arranged which enable students to learn independently and are designed in accordance with the applicable curriculum.

The principles of making teaching materials must consider breadth, depth, adequacy of materials, and also relevance to developments in science and technology (Jippes et al., 2010: 967). The preparation of teaching materials will be better if they are developed through technology. Technology-based teaching materials are teaching materials that are prepared and developed using technological tools to process data, including processing, obtaining, compiling, storing, and manipulating data, in various ways to produce quality information (Sholeh & Sutanta, 2019: 5).

PhET Interactive Simulations an open form of material based on modern technology. PhET Interactive Simulation is an interactive simulation of physical research phenomena (Prima et al., 2018: 61). PhET simulation is a discovery-based interactive learning media (Arinda et al., 2019: 225). The main goal of developing PhET is to increase student involvement in the discovery of science concepts (Adams et al., 2006: 231). This application is capable to facilitate educators to carry out virtual practicums (Chotimah & Festiyed, 2020: 2). Through PhET, various student difficulties can be avoided because students can explore to discover concepts from the learning material themselves (Arisandy et al., 2021: 3040).

Mathematics is a subject that trains children to think rationally, logically, carefully and systematically (Kusniati, 2020: 52). One of the main reasons given to mathematics students at school are for provide each individual with knowledge that can help them to overcome various things in life, such as education or work, personal life, social life, and as citizens (Khaesarani & Hasibuan, 2021: 39). One of the materials in mathematics subjects is fractions. A fraction is a number whose symbol can be written in the form a/b where a and b are integers and the value of $b \neq 0$. In the fraction a/b , a is called the numerator and b is the denominator of the integer (Kania, 2018:7). Fractions are a material that is quite difficult and prone to misconceptions among students (Pajarwati et al., 2019: 92). This could be because students had previously encountered introductory material about natural numbers and whole numbers and then had to understand numbers which had to be understood into several various parts.

Based on the results of interviews conducted on August 22 2023 with teachers class IV named Mrs. Eny Latifah, S.Pd at Madrasah Ibtidaiyah (MI) Tegalwaton, Semarang District, Semarang Regency, the author found that starting from 2023, MI has used the independent learning curriculum, but its implementation is still not optimal. This can be seen from the low learning outcomes and lack of innovation in the mathematics learning process. Apart from that, the teaching materials used are still in learning books. Limitations in the use of innovative teaching materials have an impact on students' low understanding. The low level of student learning outcomes can be seen from the Criteria for Achieving Learning Goals (KKTP) which have not been maximized, namely that there are 39% of students who have only achieved the KKTP out of a total of 28 students. The lack of innovation in the teaching materials used makes students feel bored in understanding the teaching materials. . Therefore, the use of innovative PhET application video-based teaching materials can be applied in learning. Previous research that developed mathematics teaching materials used PhET Interactive Simulation, namely (Rawa et al., 2018) in its research to improve students' mathematical communication with an inquiry learning model assisted by the PhET application. In previous research that increased understanding of learning material using PhET Interactive Simulation videos, namely (Hollil et al., 2022) in their research to increase students' understanding of learning material on the concept of particle dynamics. The latest in this research is a product in the form of a PhET video which contains an explanation of the concept of fractions for class IV SD/MI. The use of PhET videos in learning is still rarely used in the SD/MI realm. Therefore, the aim of this research is to determine the validity and effectiveness of the PhET Interactive Simulation video on fractional number concept material for class IV SD/MI.

Method

The research method used in this research is research and development (R&D). Research and Development Methods are research methods producing a product in a certain field of expertise, which is followed by certain by-products and has the effectiveness of that product (Saputro, 2017: 8). so that it is able to produce certain products, research is used that is needs analysis and to test the effectiveness of the product so that it can function in the wider community, so research is needed to test the effectiveness of the product (Sugiyono, 2020: 12). The research model used in this development research is the ADDIE research model. ADDIE is an abbreviation for Analysis, Design, Development, Implementation and Evaluation (Nababan, 2020: 40).

The research subjects in this study are educators and students of class IV MI Tegalwaton, Tengaran subdistrict. The material that will be developed in PhET video-based mathematics teaching materials is the concept of fractional numbers. The research subjects in this study were educators and students of class IV MI Tegalwaton, Tengaran subdistrict, academic year 2023/2024. The material that will be developed in PhET video-based mathematics teaching materials is the concept of fractional numbers. There were 10 students taken to take part in limited product trials and 18 students taken to take part in extensive product trials. The instruments used to collect data were questionnaires consisting of material expert and media expert questionnaires which were used to determine the validity of PhET videos as development products and student questionnaires to determine the practicality of the video-based teaching materials being developed.

The initial data analysis in this research is in the form of qualitative data analysis obtained from results of interviews with teachers class IV MI Tegalwaton and quantitative data analysis from the results of material expert assessments, media expert assessment results, and student response questionnaire results. The qualitative data that has been collected will then be calculated for its validity using the formula:

$$P = \frac{f}{n} \times 100$$

Information:

P = presentation number

F = score obtained

N = overall score

The results of the percentage of feasibility data will then be converted using criteria below this.

Table 1. Feasibility Presentation

NO	Score in percent	Eligibility category
1	< 20%	Verynot feasible
2	21% - 40%	Not feasible
3	41% - 60%	Decent enough
4	61% - 80%	worthy
5	81% - 100%	Very worthy

Primary data source
(Arikunto, 2009:35)

The final data analysis is an analysis of effectiveness in product development. This analysis can be carried out through a "one-group pretest-posttest design" research design with the following formula:





O₁XO₂

O₁ is the result of the pretest (learning process before using open material development). Meanwhile O₂ is the result of the posttest (learning process after using open material development). After getting these results, the next step will be the t test. If the data is normally distributed then a parametric test (paired t test) is carried out, whereas if the data is not normally distributed then a non-parametric test (Wilcoxon test) is carried out. Control one-group pretest-posttest research design using history. Event history is a specific event between the first and second measurements, Saputro, (2017: 97-98).

Results

This research has a product in the form of a PhET Interactive simulation-based video that discusses the concept of fractional numbers for class IV SD/MI. This research uses the RnD method with ADDIE as the research model. According to Branch (2009: 2) The steps in developing the ADDIE model are as follows. First, the analysis stage is carried out to collect data in the form of information on needs, curriculum, student characteristics and real conditions of the learning process. The second is the design stage, which is the stage of designing and compiling the research instruments and product videos being developed. The third is Development, this stage is the production stage of teaching materials in the form of PhET-based videos and video validation by material experts and media experts. Here's part of the video based *PhET* which has been revised by material experts and media experts.

Table 2.Revision Notes from Learning Media Validators

NO	Revision notes	Before revision	Afterrevision
1.	Learning objectives in learning planning should be explained correctly.		
2.	Fix selectionsay in theillustrate fractional numbers		


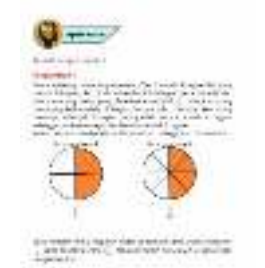
3.	In the let's reason section, the concept of fractional numbers for more emphasized.		
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Table 3.Material Expert Assessment Results

NO	Aspects Evaluation	Score Observation	Score Hope	Appropriateness
1	Process goals learning	19	20	95%
2	Material learning	18	20	90%
3	Presentation data	18	20	90%
	Amount	55	60	91%

Table 4.Media Expert Assessment Results

NO	Aspects Evaluation	Observation Score	Expectation Score	Appropriateness
1	Coloring View	6	8	75%
2	Grammar View	7	8	87.5 %
3	Screen Display	14	16	87.5 %
4	Presentation View	10	12	83%
	Amount	37	44	84%

After getting suggestions from material experts and media experts, the video was then revised and then received valid assessments from both experts through a questionnaire. The results of the assessment from material experts can be obtained seen in Table 3 while the results of the assessment from media experts can be seen in table 4. The fourth stage of ADDIE is Implementation. The implementation stage is the stage of using and implementing PhET-based videos. In addition, in the implementation phase there are limited and extensive product trials. At the limited product trial stage, the following data was obtained.

Table 5.Test Results Limited Products

Respondent	Total score
10 4th grade students at MI Tegalwaton	533
Demonstrate eligibility Criteria	89.05
	Very worthy

After conducting limited product trials and obtained very feasible criteria, the research continued to the extensive product trial stage with respondents totaling 18 class IV students at MI Tegalwaton. Following are the results of extensive product testing.

Table 6. Test Results Products Widely

Respondent	Total score
18 grade 4 students at MI Tegalwaton	970
Demonstrate eligibility Criteria	88.63
	Very worthy

The final stage of ADDIE is Evaluation. Evaluation stage, to determine the level of effectiveness of the PhET-based video product, it can be seen from the pretest and posttest results. The respondents' test results can be seen in Table 5 below.

Table. 7 Pretest and Posttest Results

	Pretest Score	Posttest Value
Amount	1939	2231
Average	69.2	79.6

Discussion

The results of this research show that the development of PhET video-based mathematics teaching materials is declared valid and effective in learning. Based on Table 2 above, the material expert has provided an assessment which has obtained an average percentage of material validation of 91.5%. The validation percentage of the material shows that the PhET video-based mathematics teaching material on the concept of fractions is within the criteria of being very feasible and valid. Based on Table 3, material experts have given a score of 91% for the material content in PhET video products, while in Table 4 media experts have given an assessment which results in an average media validation percentage of 83.4%. The percentage results show that the PhET video-based mathematics teaching material on the concept of fractions is within the criteria of being very feasible and valid so that it can be used in student learning.

After material experts and media experts stated the validity of the video product, the research continued by distributing questionnaires to students. The questionnaire is used for knowing students' responses to use PhET videos in learning. Based on Table 5 above, the results of the student limited trial questionnaire which was filled in by 10 respondents obtained a score of 533 and a percentage of 89.5% with very feasible and valid criteria and based on Table 6 regarding extensive product trials which was followed by 20 respondents obtained a score of 970 and a percentage of 88.63% with very feasible and valid criteria.

Videos that have been declared appropriate and valid are then seen for their level of effectiveness through pretest and posttest. Based on Table 7, the pretest results for grade 4 students at MI Tegalwaton got a score of 1939 with an average of 69.2. then the posttest results were obtained with a score of 2231 with an average of 79.6. Based on the results of the pretest and posttest scores, it can be stated that bringing the PhET video with a discussion of the concept of fractions is declared effective for use in learning.

Conclusion

Based on research conducted in class IV MI Tegalwaton, it can be concluded that the PhET video-based mathematics teaching material on the concept of fractions has met the criteria for validity and effectiveness. The validity value of the PhET video is at a very valid level. The effectiveness value of the PhET video increased at the pretest and posttest stages.

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ACCEPT THE WORDSLOVE

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