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Development of Interactive Learning Media Assisted by Desmos To Improve Mathematical Representation Abilities at SMP

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ABSTRACT

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This study aims to describe: 1) the validity, practicality and effectiveness of the interactive learning media assisted by Desmos which was developed to increase students' mathematical representation abilities at SMP; 2) increasing students' mathematical representation abilities through interactive learning media assisted by Desmos. This study is development research using the Tessmer development model, formative evaluation type. This development model consists of two development stages, namely preliminary (determination) and prototyping (design and evaluation). From the outcomes of trial I and trial II it was gotten: 1) Interactive learning media assisted by Desmos to improve students' mathematical representation abilities which was developed met the criteria of being valid, practical and effective; 2) Increasing mathematical representation abilities using interactive learning media assisted by Desmos which has been developed as seen from the N-gain value in trial I of 0,41, increasing to 0,47 in trial II, meaning it is in the "medium" category. Based on the study results, it is suggested that teachers utilize interactive learning media assisted by Desmos in learning straight line equations to progress students' mathematical representation abilities.

A. INTRODUCTION

The use of media in learning activities is very important. Interesting and learning media interactive can influence the learning activities to be more efficient and effective, besides that learning media able to make it more easily for teachers to deliver lessons to students. Using learning media as a tool can facilitate the delivery of information from teachers to students with interesting stimuli, so that students will easily process the information received (Kusumaningtyas et al., 2018).

In contrast to the phenomenon that occurs at SMPN 1 Idi, it turns out that teachers rarely use technology-based media as a learning tool. This is seen from the outcomes of researchers' observations of teachers who teach mathematics at the school regarding the learning media that are often used during the mathematics learning activities.

Figure 1 Results of Teacher Answers via Mentimeter

Based on Figure 1, several teachers' answers to the media used in mathematics learning can be seen, including: whiteboards, textbooks, teaching aids, puzzles, games, learning videos, pictures, student worksheets, internet, ppt, and audio. Of these media, the most dominant media used by teachers are blackboards and textbooks. This shows that teachers are less creative in choosing learning media, especially technological learning media. Of course, this is not a mistake, but if the teacher explains the material using the blackboard continuously, it will tend to make students bored and less motivated (Ishartono et al., 2018).

From the outcomes of the researcher's observations of mathematics teachers at SMPN 1 Idi, it can be seen that some teachers use computer technology (Powerpoint) when making teaching presentations in class. Of course, as a presentation medium, PowerPoint is the right medium. However, as a mathematics teacher in the current era you need more than just presentation skills, but the ability to teach using technology applications. Moreover, the school is equipped to assist the creation of technology learning resources. As an illustration, a computer laboratory with good internet connection facilities. Based on data from the manager of the computer laboratory, Mr. Abdul Rahmi, S. Pd, mathematics teachers rarely take students to the computer laboratory during lessons. The reason is because teachers lack application/software resources related to learning material and teachers do not have time to prepare learning media. This was also conveyed by Azni & Ananda (2022), that many teachers are less able to realize learning through technology-based learning media. Most teachers are limited to technical issues in creating e-learning media programs, either in mastering programming techniques or visual appearance or design.

Interactive learning media with the digital Desmos application is one of the technological developments that teachers can use. According to Hafni et al (2021), The integration of digital media, like digital text, images, animated movies, and sound, into a well-structured digital space that allows users to communicate with data for the intended objectives is known as interactive media.

Desmos graphing calculator is an interactive mathematical media in the form of a graphing calculator (Solihah, 2018). By means of the web or iOS and Android applications, Desmos is a website or service that offers a variety of mathematical resources, interactive math problems, and curricula to encourage students' advanced learning. The mathematical tools provided by Desmos include graphing calculators, scientific calculators, four-function calculators, matrix calculators, and geometric tools. Desmos also provides many digital math activities that teachers can search, use, or edit through its website. In addition, teachers can develop their own interactive learning activities through the website and share them easily with other teachers or students (Kristanto, 2021).

The field's facts show that students' proficiency with mathematical representation is still weak. Based on giving mathematical representation questions to 29 students in class VIII-1 SMPN 1 Idi on March 14 2023, the results showed that 34.5% of students who met the indicators presented data or representational information in the form of tables and graphs (10 people). Furthermore, the indicator to create mathematical equations or mathematical models from representation to another representation was 51.7% (15 people). Meanwhile, the indicator of writing down answers to problems through textual text in sentences was 41.4% (12 people).

Another fact regarding the low ability of mathematical representation is also shown by Rizki and Haerudin (2021), that schools have not been able to improve students' representation abilities. This is because teachers only deliver learning through textbooks and examples of less diverse questions as a result of which students are not prepared to put in work on independent practice questions, resulting in a lack of development of representational abilities.

Because of its low levels of mathematical representation, students are less likely to be able to create concepts on their own, which means that learning is primarily focused on the teacher. Teachers also find it difficult to employ a variety of teaching strategies, and most students are accustomed to memorizing material as part of their learning activities rather than developing their mathematical representation skills. Aside from that, students who are learning mathematics in class are not resilient till they figure out a solution since they are terrified of the difficulties they may encounter.

The aim of this development is to produce by Desmos-assisted interactive learning media that satisfies the requirements for validity, practicality and effective. Additionally, this also seeks to determine the amount of students capacity for mathematical representation has increased through interactive learning media assisted by Desmos.

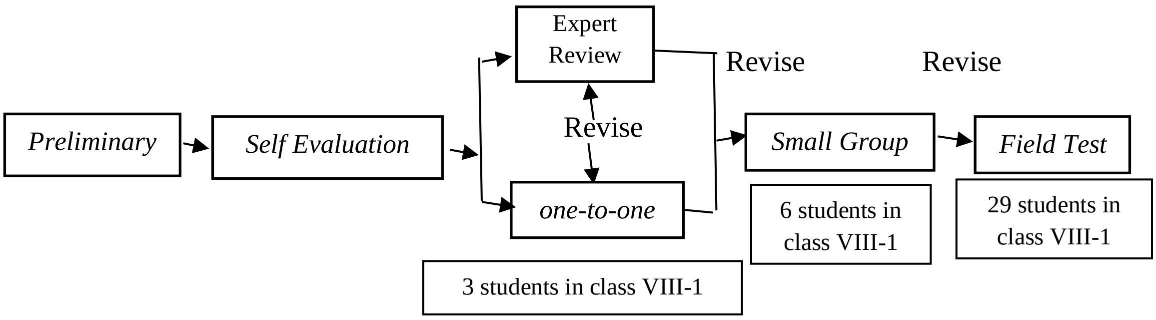
B. RESEARCH METHODS

Improvement inquire about may be a frame of think about that this is often (Research and Development). This research employments the Tessmer development model, developmental assessment sort. This development demonstrate comprises of two advancement stages, to be specific preliminary (determination) and prototyping (plan and assessment). In this Preliminary Stage, analysts will conduct an examination of the educational modules, understudies, materials and media. At this stage, a detailing of learning destinations and the shortcomings of the media utilized by the teacher will be created. The prototyping arrange has 5 (five) stages (self assessment, expert review, one to one, small group and field test). From the self evaluation stage to the small group, a learning media design will be created which is able be assessed at the field test arrange. Within the field test, practicality, effectiveness, change of mathematical representation capacities will be seen.

This study was carried out at SMP Negeri 1 Idi, Kabupaten Aceh Timur in 2023/2024. The subjects in this study were students in class VIII-1 of SMP Negeri 1 Idi. In the field test, there were 29 students in all and 3 students were selected for the *one to one* stage and six students for the *small group* stage. The object of this study is interactive learning media assisted by Desmos on straight line equations.

The image that follows provides a schematic representation of the development model used in this study.

Figure 2. Tessmer 1998 Research Flow (Jurnaidi & Zulkardi, 2013, p. 45)



This preliminary stage is the stage of determining the place and research subject. At the Self Evaluation stage, a preliminary analysis is carried out including student analysis, curriculum analysis and analysis of the materials to be developed. The design results of the first prototype were developed on the basis of student resilience which was given to experts (expert review) and students (one-to-one) in parallel. The results of both are used as revision material. The results of the revisions to the first prototype are called the second prototype. At the one-to-one stage, a trial of the design that had been developed was carried out on 3 students who were testers and divided into 3 groups, namely 1 student with low ability, 1 student with medium ability, and 1 student with high ability. The results of the revision from the expert review and the difficulties experienced during testing on the first prototype were used as a basis for revising the prototype and it was called the second prototype. The results were then tested on small groups consisting of 6 students, namely 2 students with low abilities, 2 students with high abilities. medium, and 2 students with high abilities. The results of this trial are then used for revision before testing is carried out at the field trial stage. After revisions were made based on student comments in small groups, a prototype result was obtained which was called the third prototype. From the third prototype stage, comments from students are used to revise the learning media that have been developed.

A study instrument was constructed and developed in order to assess the validity, usefulness, and efficacy of the interactive learning medium that Desmos helped to build. The trial's tools comprised an assessment of students' proficiency in mathematical representation, and interactive learning materials made possible by Desmos.

The validity of Desmos-assisted interactive learning media employments expressive measurable examination based on the normal score of each Desmos-assisted intelligently learning media which has been affirmed by the validator and reexamined based on the validator's suggestions. The equation for deciding the Va Esteem or add up to normal esteem from the normal values for all angles is as takes after.

$$V_a = \frac{\sum_{i=1}^{n} A_i}{n} \quad (1)$$

Information:
V_a = total average value for all aspects
A_i = average for the ith aspect
n = number of aspects.

The Va value or total average value obtained can be referred to in the interval for determining the level of validity of RME-based Desmos-assisted interactive learning media on table 1.

Table 1 Validity Level Criteria

No	V_a or total average value	Validity criteria
1	1≤ Va < 2	Not valid
2	2≤ Va < 3	Less Valid
3	3≤ Va < 4	Fairly Valid
4	4≤ Va < 5	Valid
5	Va = 5	More Valid

Susanto (2012, p. 75)

The criteria state that RME-based Desmos-assisted interactive learning media has a great degree of validity, if the minimum level of validity achieved is the valid level .

The practicality of interactive learning media helped by Desmos incorporates perception pointers for learning usage which are analyzed by choosing the normal score for watching learning utilization utilizing the condition:

$$O_k = \frac{\sum_{j=1}^{m} P_i}{m} \quad (2)$$

Information:
O_k = average score of learning usage perceptions
P_i = average score of learning usage perceptions at each assembly
m = number of assembly

The O_k value obtained is referred to concurring to the category on table 2.

Table 2 Criteria for Level of Learning Implementation

No.	Level of Learning Implementation	Implementation Criteria
1.	$1 \leq O_k < 2$	Not implemented
2.	$2 \leq O_k < 3$	Poorly implemented

3.	$3 \leq O_k < 4$	Well implemented
4.	$O_k = 4$	Very well implemented

(Sinaga, 2007)

The interactive learning media assisted by Desmos that was developed is called to be practical if the average learning implementation is at least in the 'well implemented' category ($3 \leq O_k < 4$).

The effectiveness of interactive learning media helped by Desmos is seen from (1) the completeness of students' classical learning, particularly a slightest of 85% of understudies who take parcel inside the learning are able to achieve a score of; (2) 80% of understudies responded empjatically to intuitively learning media helped by Desmos that was made.

The following shows how students' abilities to represent mathematical concepts have improved as a result of using the normalized gain index data:

$$N - Gain = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Table 3 below displays the normalized gain index criteria.

Table 3 *N-Gain* Score Groups

N-Gain Score	*N-Gain* Criteria
$0{,}00 < N - Gain \leq 0{,}30$	Minimal
$0{,}30 < N - Gain \leq 0{,}70$	In between
$N - Gain > 0{,}70$	Elevated

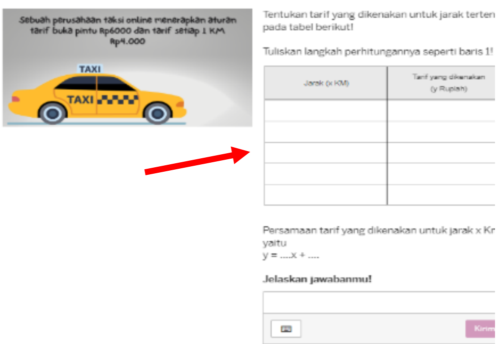
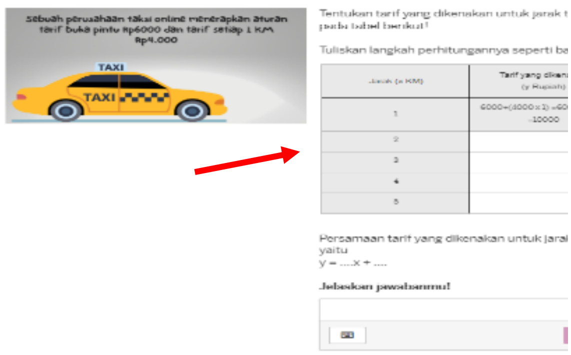
C. RESULT AND DISCUSSION

1. Validity of Interactive Learning Media assisted by Desmos

The total average value of learning media validation is 4,39. So referring to these criteria, it means that the learning media developed meets the validity criteria in the "valid" category and can be used with minor revisions.

Improvements to learning media carried out according to validator suggestions is displayed on the table 4.

Table 4. Revision of Learning Media

Before Revision	**After Revision**
Lack of clarity in the table description	It has entered data and/or numbers in the table
	

2. Practically of Interactive Learning Media assisted by Desmos

The outcomes of the analysis of the average value of observations of learning implementation in trial I were 2,90 namely in the poorly implemented category ($2 \leq O_k < 3$). This score does not get the criteria for achieving the practicality of learning media in terms of learning implementation. so it needs to be revised and tested again.

The outcomes of the analysis of the average value of observations of learning implementation in trial II were 3,78 namely in the well implemented category ($3 \leq O_k < 4$). In terms of learning implementation, this score satisfies the requirements for attaining the practicality of learning media.

3. The Effectiveness Of Interactive Learning Media assisted by Desmos

The score for the classical completeness of students' numerical representation abilities in trial I was 68,97% and in trial II it was 90,62%. The posttest comes about of trial II's scientific representation capacity have fulfilled the prerequisites for accomplishing classical completeness, which is 90,62%, indicated that least 85% of the understudies who taken an interest within the learning were able to realize a score of ≥75. Hence, it specifically that in trial II, the advancement of intuitively learning materials with Desmos fulfilled the prerequisites for achieving classical completeness.

The outcomes of questionnaire data analysis of student responses to Desmos-assisted interactive learning media component developed in trial I visibled a positive response, it was 85,13% and 86,23% in trial II. It means the learning carried out was interesting, not boring and made it more easily for students to understand the material presented.

4. Improved Representation Ability

The results of the examination of students' scientific representation capacity in trial I visibled that the normal numerical representation expertise of understudies within the pretest comes about of trial I was 57,76, increasing to 74,43 within the posttest. The normal N-Gain value obtained in trial I was 0,41 or within the "medium" category ($0.3 < g \leq 0.7$). At that point, the results of the examination of students' numerical representation capacity in trial II visibled that the normal scientific representation ability of understudies within the pretest comes about of trial II was 62,24, expanding to 80,47 within the posttest. The normal N-Gain esteem gotten in trial II was 0,47 or within the "medium" category ($0.3 < g \leq 0.7$). It implies that students' numerical representation capacity increment by utilizing intuitively learning media helped by Desmos.

From the outcomes of the N-Gain test in trials I and II, it showed that students ability to improve their mathematical representation skills remains unchanged, namely it is still in the medium category. This matter that there were errors made by students when working on mathematical representation ability questions. The following are several examples of errors made by students in completing mathematical representation ability tests.

Figure 2 Error Analysis of Student Answer Results

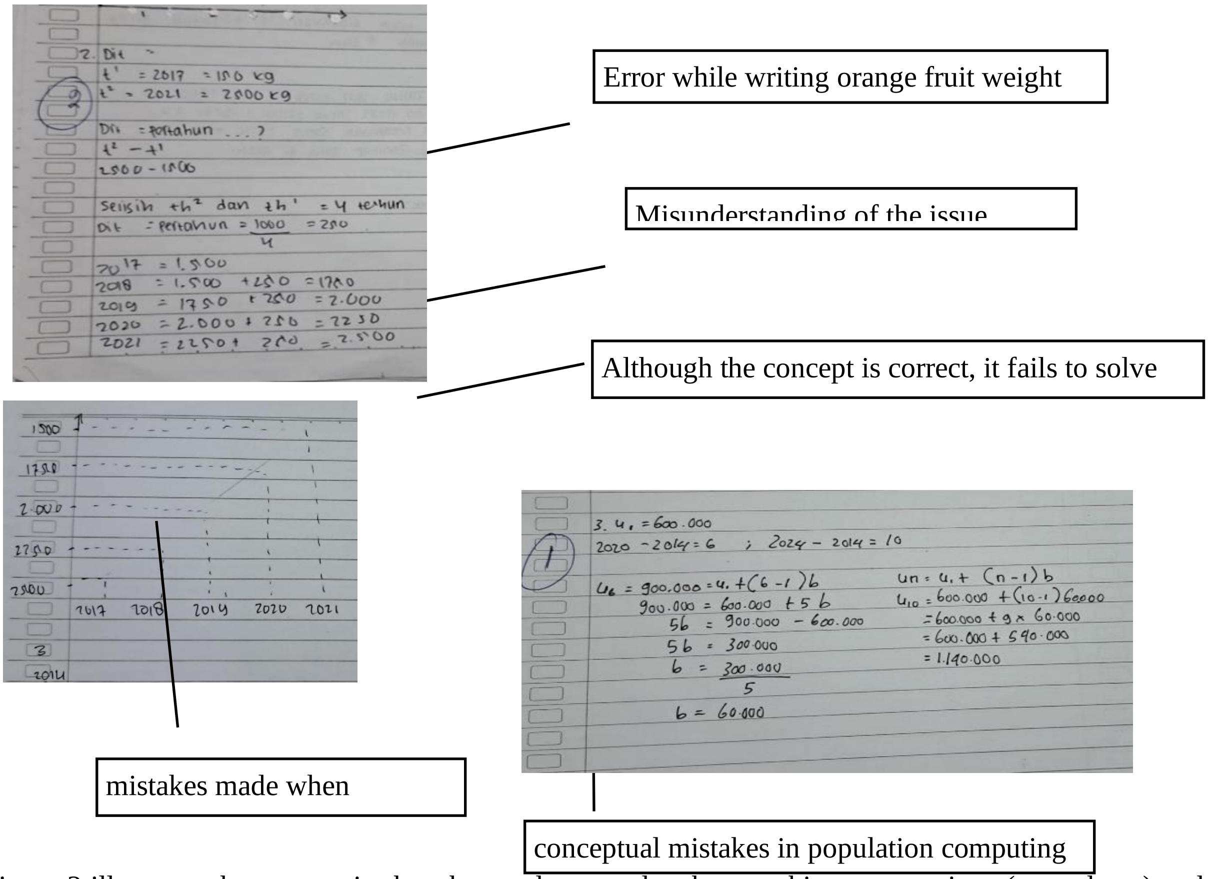


Figure 2 illustrates the many mistakes that students made when working on questions (procedures) and when applying ideas. However, if studied as a whole based on the average scores obtained by students, it means that the use of interactive learning media assisted by Desmos developed can improve students' mathematical representation skills.

The previous research that supports this research is research by Hindarto, et al (2023) where in this research it was found that the Desmos technology has the potential to provide higher level thinking support for students in studying linear function graph material in a context that is closer to their daily lives. Desmos technology media also has the potential to give chances for students to express mathematical ideas, ideas and understanding that they already have. Mathematical representation skill is one of the higher thinking skills that students must have so that the use of Desmos-assisted learning media is able to encourage students to understand straight line equation material critically and creatively with teacher guidance. Teachers cannot be separated from the learning process. Students must be guided to prevent misinterpretation in learning. Their researchs were stated that Desmos technology can facilitate students to learn with good visual representations of linear function graphs based on the animations provided. Providing continuous problems in Desmos technology with various representational solutions makes students accustomed to conveying their ideas in the form of mathematical ideas and graphics.

D. CONCLUSION AND SUGGESTIONS

Based on the outcomes of the analysis and discussion in this research, several conclusions are put forward that the validity of the Desmos-assisted interactive learning media developed is in the valid category, increasing students' mathematical representation abilities can be showed in each aspect of mathematical representation abilities. Based on the normalized gain index, it was cloncluded that in trials I and II there was an increase in the mathematical representation ability score. So it means that the interactive learning media assisted by Desmos that was developed can improve students' mathematical representation abilities. The interactive learning media assisted by Desmos that has been developed has met the criteria for the practicality of learning media in terms of analysis of the outcomes of observations of learning implementation. The developed interactive learning media assisted by Desmos meets the effectiveness criteria based on: (1) Mastery of learning students' mathematical representation abilities, and (2) students' responses to Desmos-assisted interactive learning media.

In order assist students develop their resilience and mathematical representation skills at both the same and different learning lesson levels, the interactive learning media that has been developed with aid from Desmos can be used as a model for developing an interactive learning media component with support from Desmos and other materials.

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