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Development of Linear Equations e-Learning Media by Integrating Geogebra in Google Sites

Muhammad Ainur Rizqi[1,2,*], Cholis Sa'dijah[1], & Susiswo[1]

[1]Department of Mathematics, Universitas Negeri Malang, Indonesia

[2]MTsN 1 Kota Malang, Indonesia

Abstract: The purpose of this research is develop online linear equation learning media using Geogebra through Google sites. This is a research and development research that uses the Alessi and Trollip (2001) models. The development steps are: planning, design, and development. The instrument used in this study was student worksheets found on Google sites. This research was tested on 56 students of grade 8 MTsN 1 Malang City. The validation results show that this media is valid with a score of 85.6%. When the experiment was conducted on students, it showed that this media was practical with a score of 83.0% and effective with a score of 81.3%. This study also shows that through the steps of guided discovery learning: providing stimulation, problem statement, data collection, data processing, verification, and drawing conclusions students are able to construct concepts about straight-line equations independently.

Keywords: learning media, linear equation, geogebra, google site.

Abstrak: *Penelitian ini bertujuan untuk mengembangkan media pembelajaran persamaan garis lurus menggunakan geogebra melalui google sites. Penelitian ini adalah penelitian pengembangan yang berlandasan pada model menurut Alessi & Trollip (2001). Langkah-langkah pengembangan yang dimaksud yaitu: perencanaan, desain, dan pengembangan. Instrumen yang digunakan pada penelitian ini adalah lembar kerja siswa yang terdapat pada google sites. Penelitian ini diujicobakan kepada siswa 56 siswa kelas 8 MTsN 1 Kota Malang. Hasil validasi menunjukkan bahwa media ini valid dengan skor 85,6%. Saat dilakukan percobaan kepada peserta didik menunjukkan media ini praktis dengan skor 83,0% dan efektif dengan skor 81,3%. Penelitian ini juga menunjukkan bahwa melalui tahap-tahap pembelajaran penemuan terbimbing, yaitu: memberikan rangsangan, menyatakan masalah, mengumpulkan data, mengolah data, memverifikasi, dan menarik kesimpulan, peserta didik mampu membangun konsep tentang persamaan garis lurus secara mandiri.*

Kata kunci: *media pembelajaran, persamaan garis lurus, geogebra, google cites.*

▪ INTRODUCTION

Learning is a change in behavior that involves representations and mental relationships that originate from a person's experiences (Ormrod, 2016). Listening, reading, seeing, experimenting and discussing activities can be experiences that can change a person's behavior. Learning is also a series of activities that are arranged and designed to help a person's learning process (Gagne, 2013).

Teaching and learning activities in Indonesia are planned to be held in an interactive, inspiring, fun way, able to provide challenges and motivate students to participate actively and provide opportunities for students to develop independent and creative personalities that suit their interests, talents, physical and psychological development. (Kemendikbud, 2016). As a result, every educator is required to plan, process and assess the learning process in order to achieve efficient and effective

Muhammad Ainur Rizqi
*Email:
muhammad.ainur.1903117@student.um.ac.id

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graduation competencies by creating active and innovative online learning in synergy with technology.(Jamil et al., 2022). Furthermore, learning activities must also be interesting and easy to access so that students behave actively during the learning process.

The learning carried out by educators will determine students' behavior when carrying out learning activities. During learning activities, students are expected to get results in accordance with the learning objectives. In fact, the results obtained by students were not in line with expectations. This happens to students because they still consider the learning they are doing to be difficult and boring. As many as 45% of students think that mathematics is difficult (Siregwith, 2017). One of the learning topics that students often consider difficult is straight-line equations.

Straight-line equations are one of many mathematical materials related to geometric and algebra concepts. Many students have difficulty combining geometric and algebraic concepts in straight-line equations. Wati et al. (2018) stated that factual errors, concepts, operations and principles, are difficulties that students often experience in learning straight-line equations. Apart from that, difficulty imagining is also the cause that makes students have difficulty learning geometry (Yohanes et al., 2016). So learning media is needed that will help students increase their motivation and interest (Sa'dijah et al., 2021) and reduce students' mistakes and difficulties when learning material related to geometry.

Learning media are instruments designed to facilitate and improve students' skills in learning geometry (Nurani et al., 2016). There are several types of learning media. Some are in the form of writing (text), sound (audio), images (visual), moving image media, manipulative media, and some are in the form of people (Mayangsari & Mahardhika, 2019). Each learning media has its own advantages and disadvantages which depend on the materials, work steps and learning materials. Among various learning media that have been developed, there is one media that can be used as an alternative, namely Geogebra. Geogebra is a complete software with a wide scope, one of which is for learning mathematics. Research on geogebra Arienda et al. (2016); Listiawan et al. (2018); Shadaan & Leong (2013); and Zulnaidi & Zamri (2017).

According to Murni et al. (2017), Geogebra media can help students learn geometry and algebra at the same time. Geogebra can be a medium that can help increase student interest and achievement (Wassie & Zergaw, 2019). Based on the research results of Purwanti et al. (2016) geogebra can increase students' motivation and interest in studying mathematics, as well as improve students' learning outcomes. Apart from that, Geogebra also helps students understand mathematical concepts effectively (Listiawan et al., 2018).

During the Covid-19 pandemic, learning activities in Indonesia were carried out remotely (Kemendikbud, 2020). The teaching and learning process which was originally carried out directly at school was changed and carried out from home. Educators and students also take part in the teaching and learning process from their respective homes. Educators use all kinds of methods, models and approaches so that the teaching and learning process is carried out even though it is not carried out face to face. Educators who do not have internet access carry out learning by visiting each student's house in turn. Educators who have access to the internet carry out the teaching and learning process using applications tailored to the students' abilities and conditions.

There are various media choices that educators can use in the teaching and learning process. Many people use websites, blogs, Google Sites as researched by Maskar et al. (2021) and the WhatsApp application studied by Hasanah et al. (2021). There is also

media in the form of videos or images for one-way learning that are uploaded on social media. There are also those who use long-distance video conferencing, Zoom, or Google Meet. Apart from that, there are also those who use more complex and complete media such as e-learning which is developed by each educational institution and is already available.

Each educator determines media and applications based on the characteristics of the material, learning, and the abilities of each educator and student. Learning carried out using GeoGebra media must be prepared well because educators must create applets and media platforms that can contain the GeoGebra applets that have been created. Not all media can display Geogebra applets directly. Google sites, schoology and the Geogebra website itself are several platforms that can load Geogebra applets.

Google sites is a website creation site developed by Google. Google has been developing Google Sites since 2008 with an intuitive user interface and using a drag and drop display system(drag-and-drop) to add various elements to a website, such as text, images, videos, links, forms, and more. Google Sites also allows users to create websites for various purposes, such as personal portfolios, event sites, educational sites, and collaborative sites. Apart from that, Google Sites is also integrated with other Google services such as Google Drive, Google Docs, and Google Sheets. This integration can make it easier for users to insert documents or other media into their website (Google Sites, n.d.).

There are several advantages obtained when using Google sites (Educators Technology, 2013), including: free Google sites, ease of use and access, and having simple and complete features for a free site and a friendly and easy to operate interface. A Google website can be created in just a few minutes using existing templates without the need for advanced knowledge and skills. Google learning sites can be filled with images, videos, writing, sounds, files, or Google forms as feedback material from students. Apart from that, there is also a facility in the form of an embed code that can display media without changing pages, including Geogebra applets. Based on this description, the researcher considers it necessary to develop a medium for learning straight-line equations with the help of Geogebra media via Google Sites.

▪ METHOD

Research Design and Procedures

This research into the development of learning straight-line equations assisted by Geogebra via Google Sites uses the media development research method according to Alessi & Trollip (2001). This research method has three stages, namely: planning, design and development. At the planning stage, needs identification activities and collection of ideas and sources are carried out. Based on the identification results, students need interactive digital learning media that can help students build understanding of straight-line equation material. At the design stage, the researcher created a learning plan, prepared teaching materials, created the required Geogebra applets, student worksheets, and prepared instrument validation. In the development stage, a website was created via Google Sites by combining teaching materials, GeoGerbra applets that had been created, and online worksheets.

After the media was developed, expert validation was carried out. Initially the researcher only developed one Geogebra applet, but based on the results of the

presentation, suggestions were made to create a Geogebra applet for each student activity. Suggestions regarding arranging the layout so that it doesn't look boring. So the researchers added up to 7 Geogebra applets according to learning straight-line equations and made improvements according to the suggestions given.

The development of geogebra-assisted straight-line equation learning media was carried out through several stages until it met the criteria of being valid, practical and effective (Akker, 1999). The first stage, expert validation was carried out by a lecturer at the UM Mathematics Department and a mathematics teacher at MTsN 1 Malang City. In the second stage, the media is tested directly on students. The trial was carried out on class 8 students at MTsN 1 Malang City in the odd semester of the 2022/2023 academic year.

Participants

A limited class trial of this research was carried out on Masters of Mathematics Education students. Meanwhile, a wider trial was carried out on grade 8 students at MTsN 1 Malang City. The number of students who participated in this research was 56 students spread across classes 8B, 8G, 8I, and class 8J.

Instrument

The instruments used in this research were student worksheets, questionnaires and tests. The student worksheet developed refers to guided discovery learning. The steps in guided discovery learning consist of: providing stimulation, stating the problem, collecting data, processing data, verifying, and drawing conclusions. The questionnaire in this research was used to obtain information on the practicality and effectiveness of students' use of media.

Data Analysis

After the learning media has been developed, validation is carried out by experts. The media validity criteria used refer to the media validity criteria according to Riduwan (2005) in table 1. The media developed is considered valid if it obtains a minimum score of 61%.

Table 1. Media validity criteria

Percentage (%)	Criteria
81 – 100	Very good
61 – 80	Good
41 – 60	Fair
21 – 40	Less
0 – 20	Very Less

▪ RESULT AND DISSCUSSION

Media Development Results

The Google sites that have been developed are composed of a home page and student activities which are divided into meeting page 1, meeting page 2, meeting page 3, and meeting page 4. On the first page there are instructions and brief information

regarding the stages of activities that will be carried out by students as well as a navigation bar that can direct students to all the pages of the website being developed.

On the student activity page there is an explanatory video, learning objectives, instructions, questions, and Geogebra applets, as well as a Google form for reporting activities that students have carried out. The Geogebra applet at each meeting is made differently, according to the learning at each meeting. Learning instructions are delivered via video so that students feel interested and learning becomes more interactive (Brame, 2016).

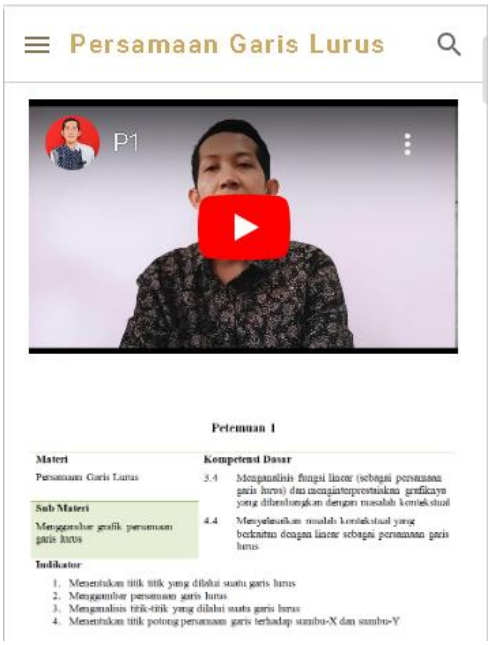


Figure 1. Explanation and learning objectives

In this research, the Geogebra applet was designed based on the needs for each learning activity. Through this designed Geogebra applet, students can carry out experiments, manipulate and carry out simulations so that it will support students in learning the material meaningfully and conceptually (Ocal, 2017). Besides that, the use of geogebra will also increase students' interest in learning if the applets used are prepared well (Arbain & Shukor, 2015).

The geogebra applet at the first meeting was about differences in straight-line equations in the form y = ax+b. Users can change variable values a and b, and observe the changes in the graph directly. The geogebra applet in the second meeting was about graph shapes with different slopes. straight-line equation in the form y=ax+b. Users can change the slope of the graph and observe changes and differences in graphs that have different slopes.

In the third meeting, the geogebra applet was designed so that users could discover how to create straight-line equations. There are two geogebra applets at the second meeting; Geogebra applets for straight-line equations that contain a slope value and one coordinate point through which they pass and Geogebra applets if two coordinate points (x_1,y_1) are known to be passed through. The geogebra applet in the fourth meeting is

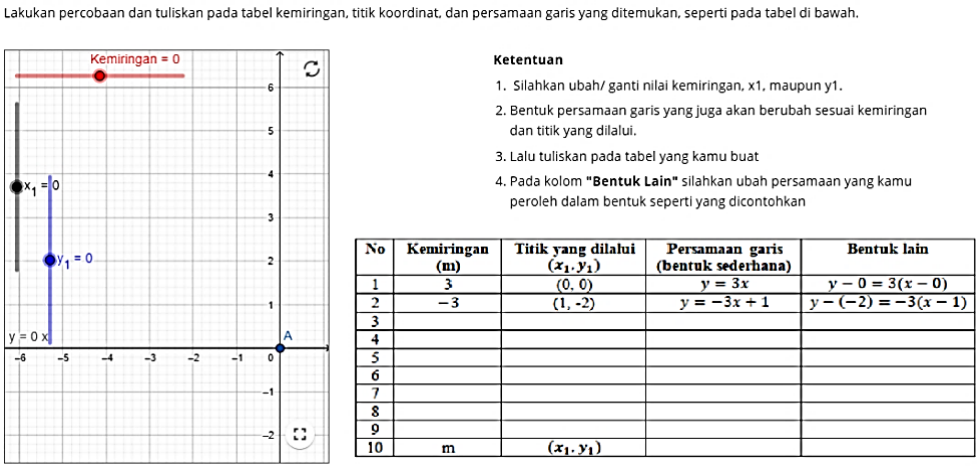
designed so that users can find the characteristics of line equations based on the slope and the same constant value.

All Geogebra applets that have been developed are combined with worksheets arranged based on the stages of guided discovery learning. Guided discovery learning is composed of several stages: providing stimulation, stating the problem, collecting data, processing data, verifying, and drawing conclusions. Guided discovery is considered capable of making students active and think critically (Silver-Hmelo, 2004).

Guided discovery learning is a learning activity carried out by exploration, observation and reasoning based on guidance and direction from educators (Kholid et al., 2020). In this research, the guidance and direction of educators is realized in the form of steps contained in student activities. Guided discovery has been proven to increase students' understanding of mathematical concepts. This is in line with research conducted by Baroody et al. (2019); Fahmi et al. (2019); and Simamora et al. (2018).

At the stimulation stage, several screenshots of the Geogebra applet are displayed. In the screenshot, a straight-line is displayed along with its equation based on the slope value and the coordinates that the line passes through. At this stage the researcher displays four screenshot images from the Geogebra applet with a predetermined slope value and coordinate point. Then students are instructed to write the slope, point coordinates, and equation of the line in the four screenshots. After paying attention to the picture given, students make questions from the information on the slope, coordinates, and equation of the line given. This stage is the problem statement stage. This activity aims to make students able to state problems that they must solve independently.

At the stage of collecting data, students conduct trials entering slope values and various coordinate points, as well as determine the equation of a straight-line through the provided geogebra applet. Next, students write it on the table that has been prepared.



No	Kemiringan (m)	Titik yang dilalui (x_1, y_1)	Persamaan garis (bentuk sederhana)	Bentuk lain
1	3	(0, 0)	$y = 3x$	$y - 0 = 3(x - 0)$
2	-3	(1, -2)	$y = -3x + 1$	$y - (-2) = -3(x - 1)$
3				
4				
5				
6				
7				
8				
9				
10	m	(x_1, y_1)		

Figure 1. Data collection stage

At the data processing stage, students change existing equations into other forms according to the examples given. This activity is carried out to change the equations that appear in the Geogebra applet into a general algebraic form. This activity is carried out to find the general equation of a straight-line equation that knows the slope value and one coordinate point through which the equation passes.

In carrying out algebraic manipulation, most students were able to work as expected according to the examples given, but there were students who were still confused about the steps they had to carry out. So, teacher assistance is needed to direct and provide scaffolding for these students.

In the verification section, students use the general form they have discovered to create a straight-line equation manually. Then, to find out whether the general formula they found is correct, students enter the coordinates of the point they pass and its slope in the Geogebra applet provided. If the line equation obtained is the same as the test results on the Geogebra applet, then the student's algebraic form findings are correct. If the straight-line equation obtained is different, then the student must repeat processing the data until the appropriate algebraic form is found.

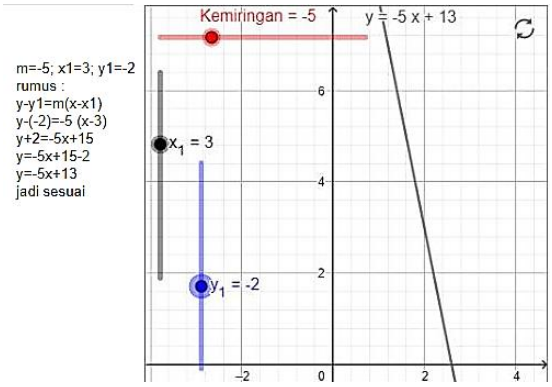


Figure 2. Example of student verification response

At the conclusion drawing stage, students write down the conclusions obtained after analyzing the equations they obtained. This stage is only carried out by students who have obtained the correct algebraic form of straight-line equations. Students who succeed in proving that the general shape they obtain can be used to determine the equation of a straight-line that corresponds to the shape obtained in the Geogebra applet then write a conclusion in the form of a formula for determining the equation of a straight-line.

Expert Validation Results

The development of straight-line equation learning media with the help of Geogebra was carried out through several stages until it met the criteria of being valid, practical and effective. In the first stage, students' media and activities were assessed through a limited class test by experts consisting of mathematics lecturers at the State University of Malang, educators in the field of mathematics at MTsN 1 Malang City and Master of Mathematics Education students at FMIPA UM. Assessment of media development products and student worksheets is obtained based on expert appraisal. Meanwhile, student responses were obtained from questionnaires during limited class tests.

The validation results show that the content aspect of learning media is quite valid with a percentage of 89.3%, the usability aspect of the media is very valid with an average score of 85.7%, while the form and appearance aspects are quite valid with an average score of 83.9%. In detail, the results of the assessment and limited tests are as follows:

Tabel 2. Expert validation

Aspects	Score	Result
Content		
Learning media can help students learn mathematics	89.3%	Very Valid
Learning media can help students build mathematical understanding	96.4%	Very Valid
The activities provided allow for positive interaction between students and learning media	85.7%	Very Valid
Activities when using learning media are in accordance with learning objectives	85.7%	Very Valid
Learning media does not create ambiguity	89.3%	Very Valid
Usefulness		
Can be used to help students achieve learning goals	85.7%	Very Valid
Can be used as a support for mathematics learning.	85.7%	Very Valid
Can encourage students to be more active	82.1%	Fair
Display		
The display of learning media is attractive	85.7%	Very Valid
Proportional media form	82.1%	Fair

Based on the results of expert validation, the media meets the valid criteria in detail: the content aspect of learning media is very valid with a percentage of 89.3%, the usability aspect of the media is very valid with an average score of 85.7%, while the form and appearance aspects are quite valid with an average score -average 83.9%. However, revisions and improvements are needed in aspects of the appearance and language used so as not to cause misinterpretations and double meanings.

Readability Test Results

The readability test was carried out on grade 8 students at MTsN 1 Malang City. The time used for implementing limited class trials is 4 meetings. Each meeting is held for two hours of learning (2x40 minutes).

Analysis of the results of the limited class test questionnaire concluded that the presentation of the material was quite good with a score percentage of 83.8% and the form and appearance aspects were quite good with a score percentage of 82.3%. Based on the existing results, it is concluded that the learning media meets the practicality criteria. Limited class test results are as follows:

Table 3. Limited test

Aspects	Score	Criteria
Presentation		
Geogebra media in mathematics learning is easy to use	79.2%	Fair
Presenting problems in learning media helps understand mathematical concepts	87.5%	Very Valid
I enjoy learning mathematics through this learning media because it is interesting	79.2%	Fair
This learning media makes me like mathematics	87.5%	Very Valid
This learning media makes me want to understand mathematics further	85.4%	Very Valid

Language and Layout		
The instructions and information presented were easy for me to understand	83.3%	Fair
The color display, type and size of the font used are attractive	81.3%	Fair

During the trial, the results of observations showed that the media was stated to be practical. The results of observations of learning activities in the aspect of material presentation obtained an average score of 83.8%. Meanwhile, the language and display aspects achieved an average score of 82.3%. However, the language and appearance can still be improved. The language can be adjusted so that it is not too technical for the age of students at junior high school level. The appearance can be made even more attractive. This learning media is designed in the form of a worksheet so that students can discover the concept of straight-line equations independently. Students follow the directions given by researchers in the form of commands, questions, or videos that have been inserted on Google sites. So this learning media can be a support so that students can learn independently (Mukti et al., 2020).

The combination of the Geogebra applet which allows students to work independently and Google Sites which students can access anytime, anywhere, and via any device (smartphones and laptops) makes this media beyond the boundaries of space and time. So that students become more motivated in learning mathematics (Setyadi & Qohar, 2017) anywhere and anytime. Added Sa'dijah, et. al (2021), that the use of semi-real media can also help increase students' interest and motivation. Apart from that, using Geogebra via the Google site can help students find out how to determine the equation of a straight-line. This is in accordance with Mayangsari and Mahardhika (2019) who stated that learning media can help students discover mathematical concepts better using objects that can be seen directly. Apart from that, the guided discovery learning steps applied in this lesson are able to build the concept of straight-line equations independently in accordance with the research results of Wulandari et al. (2018).

In general, this straight-line equation learning media can help students independently discover the concept of straight-line equations. Students are also able to better understand the characteristics of straight-line equations if they know the slope and the points through which they pass. These results are in accordance with the test results of students after limited trials showing that 26 out of 32 or 81.3% of students got a score above the minimum completion criteria. Therefore, it can be concluded that the learning media for learning straight-line equations has met the effectiveness criteria. This is in line with research by Saha et al. (2010) who stated that Geogebra media can help improve students' abilities in geometry material. However, this learning media still has shortcomings. Among them, the language used is still too advanced and technical. There are still students at the junior high school level who do not understand the researchers' instructions well. The appearance of Google sites can also be improved so that students don't get bored and are more interested in this media.

▪ CONCLUSION

Based on research results, this straight-line equation learning media meets the three criteria according to Akker (1999). These criteria consist of valid, practical and effective. Media validity criteria were obtained from expert validation and obtained an average

score of 85.6%. Meanwhile, the practicality and effectiveness criteria were obtained from the readability test with a score of 83.0%, and 81.3% for the effectiveness score.

Apart from that, the resulting learning steps are: 1) providing stimulation through pictures, videos and questions as a stimulus for students; 2) statement of the problem based on pictures, videos and questions in the section providing stimuli, 3) data collection based on the results of students' trials on the Geogebra applet provided, 4) processing of trial results data to draw conclusions, 5) verification by answering questions based on test results, and 6) drawing conclusions by writing them on the Google form at the end of the activity. This straight-line equation learning media has been designed to help students learn straight-line equations independently, but still requires assistance from educators. Assistance from educators is needed when students start to get confused and deviate from what has been planned. When students start to get confused, educators can communicate by asking questions and providing sufficient scaffolding so that students can complete their activities well.

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