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Development Learning Design of Linear Inequality of Two Variables with GeoGebra Classroom Assisted Discovery Learning Model

Derel F. Kaunang [1*], Victor R. Sulangi[2], Milytia C. Kamu [3]

[1,2,3]Pendidikan Matematika, Fakultas Matematika, Ilmu Pengetahuan Alam dan Kebumian, Universitas Negeri Manado

[*]e-mail: derelkaunang@unima.ac.id

ABSTRAK

Penelitian ini bertujuan untuk menghasilkan desain pembelajaran pertidaksamaan linier dua variabel dengan model pembelajaran kelas Discovery Learning GeoGebra yang valid, praktis dan efektif dengan menggunakan metode Educational Design Research (EDR). Tahapan yang dilakukan meliputi tahap analisis, tahap perancangan, tahap evaluasi, tahap pematangan intervensi dan tahap implementasi. Hasil validasi menunjukkan rata-rata nilai total validasi RPP sebesar 96,4%, rata-rata nilai total validasi Lembar Kinerja Siswa sebesar 93,2%, rata-rata nilai total validasi THB sebesar 95% dengan kategori sangat baik sehingga memenuhi valid kriteria. Hasil angket respon siswa >80% berada pada kategori baik, sehingga produk desain pembelajaran yang dikembangkan dapat dijelaskan secara praktis. Hasil belajar siswa yang menggunakan desain pembelajaran yang dikembangkan dijelaskan secara efektif karena lebih terlihat dibandingkan siswa yang tidak menggunakan desain pembelajaran yang dikembangkan, hal ini ditunjukkan dari hasil uji normalitas dan uji T dengan menggunakan SPSS. Oleh karena itu, disimpulkan bahwa desain pembelajaran yang dikembangkan dinyatakan valid, praktis dan efektif.

Kata kunci: Pengembangan Desain, Model *Discovery Learning*, Kelas GeoGebra

ABSTRACT

This study aimed to produce a linear inequality of two variables learning design with a GeoGebra classroom discovery learning model that is valid, practical, and effective using the Educational Design Research (EDR) method. The phases performed include the analysis phase, the design phase, the evaluation phase, the intervention maturation phase, and the implementation phase. The validation results showed that the mean total value of lesson plan validation was 96.4%, the mean total value of Student Performance Sheet validation was 93.2%, and the mean total value of THB validation was 95% with a very good category so it met the valid criteria. The results of the student response questionnaire >80% were in the good category so the developed learning design product was explained practically. The learning outcomes of students who used the developed learning design were explained effectively because this was more apparent than those who did not use the developed learning design, as shown by the results of the normality test and the T-test using SPSS. Therefore, it was concluded that the developed learning design was declared valid, practical, and effective.

Keywords: Development design, Discovery Learning Model, GeoGebra Classroom

INTRODUCTION

Education has a significant role in our life. Education is one of the ways to improve the quality of human resources in a country. Having quality human resources is one way to become a developed country (Pakpahan, Regar, & Kaunang, 2020). Education is a provision for decent work and one of the determining factors for the development and progress of a nation. Competition in the era of Industrial Revolution 4.0 requires education to adapt to the dynamics of life to improve the quality of education. The presence of the coronavirus pandemic is impacting all areas of life, including education. For the continuity of teaching and learning activities, the learning system in the educational world has changed to Limited Face-to-face Learning.

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Mathematics is an important subject. Mathematics is a subject studied at the elementary through college level. Mathematics plays an important role in developing the potential of Human Resources (HR). Moreover, from the latest developments, we can see how mathematics affects computerization reciprocally. Mathematics holds a significant role in pushing the development of STEM. In addition, mathematics can also affect many different kinds of non-STEM fields, such as social finance, sciences, risk analysis, logistics, etc. In addition, we argue that mathematics (Gravemeijer et al., 2017).

Linear inequalities in two variables are one of the subjects discussed. When learning this topic in class takes place, it is not uncommon for students to find it difficult to solve problems on systems of linear inequalities in two variables. This fact is in line with research conducted by Annisa et al (2022) (in Manik, Simanjuntak, & Simanjuntak, 2023) that students' difficulties in solving problems on systems of linear inequalities in two variables are based on students' inability to identify aspects of mathematics, determine which formula should be used to solve a problem, and how to draw graphical solutions to inequalities correctly.

Based on the results of an interview with one of the mathematics teachers at SMA Negeri 1 Langowan, the understanding of mathematical concepts, especially on the material of linear inequalities in two variables, still appears to be very flawed. When learning the topic of linear inequalities in two variables, the teacher only uses the classroom and WhatsApp as learning media, making it difficult for students to understand the material and causing a lack of interest in student learning. It requires optimization of the math learning process using online media. Teachers should be proficient in designing information and communication technology (ICT) based learning, as stated in the 2013 curriculum technical guidance guide that understanding math teachers will be more interesting if they are delivered with innovative and creative methods, for example through using information and communication technology, such as the Internet, props and other multimedia tools (Indah & Farida, 2021). There are several benefits of utilizing learning media. They are as follows: (1) the learning process becomes more interesting and can motivate the students; (2) students can achieve learning goals since the learning topics can be understood easily; (3) teachers can combine different learning methods; and (4) students become actively participate in learning activities. This research requires innovation of learning media so that students can concretely construct the concept understanding of *Pertidaksamaan Linear Dua Variabel* (PtLDV) or linear inequalities in two variables and get motivated to participate in the learning process.

When learning mathematics, GeoGebra can be applied as a learning medium. GeoGebra is accessible online anytime, anywhere for students or teachers with Android or computers. GeoGebra is a software with a variety of interesting features that can be a learning tool to demonstrate or visualize mathematical concepts to be more concrete (Yohannes & Chen, 2023; Fitriani, Maifa & Bete, 2019). Geogebra already has a Learning Management System (LMS) feature, namely Geogebra Classroom, which can be used for teaching and learning activities (Lestari, 2018). Students using teaching materials by using GeoGebra software experience a better understanding of concepts compared to students before using teaching materials (Tambunan, 2013).

Designing Geogebra-based learning requires an appropriate learning model and in line with the current curriculum. The Discovery Learning model is one of the models related to the 2013 curriculum. The six stages of the Discovery Learning model require students to be active in learning and the Geogebra classroom can be used in stages, from the Discovery Learning fashion model. Developing learning resources with a discovery learning model, supported by the GeoGebra classroom, can improve students' problem-solving skills (Sitepu, 2019).

Based on this, the researcher considers it important to research developing a learning design for the topic of linear inequalities of two variables using the GeoGebra classroom-assisted Discovery Learning learning model. The generic development design model is used as a guide to produce products that are practical, valid, and have a good potential effect on the continuity of learning to make it easier for students to understand mathematical concepts.

METHODS

The research design used is Educational Design Research, this research is research that focuses on the process of designing and developing designs that deliver products and solutions to educational problems. Education Design Research combines the systematic development, scientific investigation, and implementation of solutions to challenges in the education field (McKenney & Reeves, 2018). What was developed in this study was a two-variable learning design for linear inequality with a discovery learning model assisted by the GeoGebra classroom to produce valid, practical, and effective products. In this research a mathematical didactic design model, the Generic Research Design Model was used as product development model Susan (McKenney & Reeves, 2018). Research and development activities with the generic model are divided into three main phases, namely analysis, design and evaluation, and two main outputs, namely knowledge and intervention. The subjects in this study were students of class XI MIPA 2 of 32 students as the class being treated (the class that used learning design development) and class XI MIPA 1 consisting of 32 students as the control class (the class that did not use learning design development) at SMA Negeri 1 Langowan. In this study, an interview guide instrument was used to identify problems.

To answer the problem statement, research tools are used to assess the quality of valid, practical, and effective products, in the form of Lesson Plans, Student Worksheets, and Learning Outcomes Tests. Before the instrument is put into use, the instrument is first validated by asking the validator to assess, correct, and provide input.

Data collection methods in this study were interviews, validation sheets, and user questionnaire answer sheets. This study used the descriptive analysis technique for data analysis technique. The data collected is both qualitative and quantitative data. The qualitative data were the results of interviews with teachers to determine the initial learning conditions and response data and input validation from open questionnaires filled by experts. Meanwhile, the quantitative data analyzed were closed questionnaires that included the feasibility of the linear inequality in two variables learning design and student responses as subjects. This data analysis is used as a guideline for reviewing the product of the linear inequality in two variables learning design development with the GeoGebra classroom discovery learning model. The learning designs that will be validated are Lesson Plans (*Rencana Pelaksanaan Pembelajaran*), Students Worksheets (*Lembar Kerja Peserta Didik*), and Learning Outcomes Tests (*Tes Hasil Belajar*). For assessment using the Likert scaling technique, namely by providing an assessment score for each criterion (Arikunto, 2018). It can be seen in Table 1 below.

Table 1. Expert Review Guidelines

No.	Skor	Criteria
1	1	Poor
2	2	Fair
3	3	Good
4	4	Very Good
5	5	Excellent

The data obtained from the score is converted to percentages using the formula (Djumanan, 2021).

$$\text{Ideal Score (Criteria)} = \text{number of item} \times \text{maximum skor} \quad (1)$$

$$P = \frac{\text{total scores achieved}}{\text{Skor criteria}} \times 100\% \quad (2)$$

Description:

P = Percentage of eligibility

Furthermore, the obtained values are categorized based on the classification of the percentage results (Arikunto, 2018). The obtained percentage results are categorized according to the interpretation in Table 2 below.

Table 2. Category Interpretation Range Percentage Eligibility Criteria

No.	Percentage	Criteria
1	$P > 80\%$	Excellent
2	$60\% < P \leq 80\%$	Very Good
3	$40\% < P \leq 60\%$	Good
4	$20\% < P \leq 40\%$	Fair
5	$P \leq 20\%$	Poor

In this study, the rating is determined with a minimum value of B, which is Good. The product developed is therefore suitable for use if the results of the assessment fall into the category. Data on the outcomes of student responses to the implementation of learning were analyzed using descriptive statistics with percentages.

The percentage of students can be seen directly on the Google form and can be categorized according to the criteria for interpreting student response scores (Fauzi, 2021) as shown in Table 3 below.

Table 3. Interpretation criteria for student response scores

No.	Percentage	Criteria
1	0 % - 20 %	Very weak
2	21 % - 40 %	Weak
3	41 % - 60 %	Enough
4	61 % - 80 %	Powerful
5	81 % - 100 %	Very Strong

Student responses are positive if the percentage of responses from students is at least in the sufficient category. The data for the assessment of the learning outcomes test is carried out at the end of the lesson by distributing questions online via Google Forms. Two classes participated in the learning outcomes test assessment, namely class XI MIPA 2 with 32 students as the class following the learning process using the development of a two-variable linear inequality learning design with a discovery learning model assisted through the GeoGebra classroom. Class XI MIPA 5 with 32 students as a class that follows the learning process by not using the development of a two-variable learning design for linear inequality with the GeoGebra classroom-assisted discovery learning model.

The data on the effectiveness of the teaching and learning design will be analyzed using the data on the assessment of student learning outcomes obtained from the Learning Outcome Test using the statistical T-Test test.

T-test is a test to find out if the mean value (mean value) of a distribution of values (group) deviates significantly from the mean value of the distribution of other groups. To obtain the difference in the mean value of two value distributions, a t-test or t-test was performed. The test is performed with a significance level of 0.05 ($a = 5\%$) (Sugiyono, 2013)

The hypothesis is accepted or rejected based on the following criteria:

1. H_0 is rejected if the significant value of $t < 0.05$ which means there is a significant effect between one independent variable on the dependent variable.
2. H_0 is accepted if the significant value of $t > 0.05$ which means that there is no significant effect between one independent variable on the dependent variable.

The T-test that will be used is the Independent Sample T-Test, which is a comparative test (difference test) that aims to test whether there is a significant difference in the mean (mean) between two free samples or not. A normality test is used to determine whether the scores for the variables are normally distributed or not. To test the normality of the data, it was tested using the One-Sample Kolmogorov Smirnov test using the SPSS application. The criteria that must be met when performing the One-Sample Kolmogorov Smirnov test are:

1. The data has a normal distribution if the significant value of $t < 0.05$.
2. The data do not have a normal distribution if the significant value of $t > 0.05$.

If the value is greater than 0.05, the data distribution is declared to meet the assumption of normality, and if the value is less than 0.05, it is interpreted as abnormal. The homogeneity test or variance agreement test is done to find out which t-test will be used. To test the homogeneity of variance, the Levene test was used using the SPSS application (Yusri, 2021).

The criteria that must be met when performing the Levene test are:

1. If the significance value is > 0.05, the data used in the study is homogeneously distributed.
2. If the significance value is < 0.05, the data used is not homogeneously distributed.

If the value is greater than 0.05, it is declared that the data distribution satisfies the homogeneous assumption, and if the value is less than 0.05, it is interpreted as non-homogeneous.

RESULT AND DISCUSSION

The process of developing a learning design using a generic model of research design (McKenney & Reeves, 2018) started with the analysis exploration phase, where at this early stage the interview data showed that for Class XI teaching materials to be developed was linear inequality in two variables. The form of implementation that researchers were conducting at this stage was material and media planning. The next phase was design-construction, this phase starts with the creation of a GeoGebra account by researchers, then the development of learning design starts with a discovery learning model assisted by GeoGebra Classroom, starting with the preparation of a learning implementation plan Learning Implementation Plan, Student Worksheets, Learning Outcomes Test and for product design are validated, feasible to be used and implemented in learning activities after a validation assessment has been performed by the validator team. The total mean value of the obtained lesson plans validation is 96.4 with a very good predicate. For the results of the students' worksheet assessment of the validator team, the mean total value of the students' worksheet validation is 93.2 with a very good predicate. For the total mean value of experts' validation, validation achieved 95 with a very good predicate. Based on these results, the resulting learning design was known to meet the category of very good. This means that the quality of the development product in the form of the resulting learning design was valid so that it is usable.

Furthermore, the learning design product was tested in the evaluation-reflection phase. Conducted in small groups consisting of 9 people with criteria of 3 people with low capacities, 3 people with moderate capacities, and 3 people with high capacities. This pilot phase was conducted to validate the learning design development product with the GeoGebra Classroom-supported discovery learning model that includes lesson plans, students' worksheets, and learning outcome tests. Based on the first trial, improvements were made to the developed product. After the product has been repaired, a test will be carried out on students of class XI MIPA 2 SMA Negeri 1 Langowan. For the implementation of the learning outcomes test, the subjects taking the test consisted of two groups, namely class XI MIPA 2 as class 2 who participated in learning using products developed with a total of 32 students, and class XI MIPA 1 as class 1 who did not use development products with the number of students 32 people.

Learning test results are processed and analyzed using statistical T-test analysis to assess the effectiveness of the developed product. Based on the results of the Kolmogorov Smirnov One Sample test using SPSS, the significant value obtained is $0.128 > 0.05$, it was stated that the distribution of the data conforms to the normal assumption. To test the homogeneity of variance, the Levene test was used using the SPSS application (Sugiyono, 2013), based on the results of the Levene test using SPSS, the significant value was $0.956 > 0.05$, the distribution of the data is said to satisfy the homogeneous assumption. Based on the output of the independent sample test, the value of sig. Levene's test for equality of variances is $0.015 < 0.05$, it can be interpreted that the data variance between class 1 and class 2 is heterogeneous or different. The results of the SPSS prove that the learning outcomes of classes that use the PtLDV learning design with the GeoGebra Classroom-supported discovery learning model are higher than class XI MIPA 1 which does not use the developed learning design so the developed product is declared effective. To measure the usefulness of the learning design, the data from the questionnaire analysis of student responses to the implementation of learning and the completeness of student learning outcomes are used. Data retrieval through the student questionnaire answer sheet was given after learning through the Google Forms distributed in the GeoGebra Classroom. The respondents who will be the respondents are students of class XI MIPA 2 SMA Negeri 1 Langowan with a total of 32 students. Based on the results of the student response questionnaire completed by 32 students who participated in the learning, the PtLDV learning design was practical to use because the questionnaire results showed a percentage of >80%, so it fell into the right category.

The results obtained by researchers in this study are relevant to the results of research (Lestari, 2018), this study shows that mathematics is a subject whose field is abstract and requires logical thinking ability, so to convey it requires media such that students can better understand the material and can solve math problems and this study shows an increase in learning outcomes after using learning resources with the GeoGebra supported discovery learning model. To determine the effectiveness of the developed learning design, tests are carried out during the implementation. In this phase, the learning design is used in learning. Initially, the students were eager to participate in the learning, but there were obstacles, namely disruptions in the Internet network. This problem was solved by using a personal quota, and if there were people who did not have a quota, the researchers asked to share via portable hotspots.

The results of developing learning designs using generic models on linear inequality in two variables materials for discovery learning models with the help of GeoGebra Classroom that have passed the validation phase are in the very good category because they meet the valid, practical, and effective criteria for the resulting learning design product in the form of Lesson Plans, Students' Worksheet and Learning Outcomes Test.

CONCLUSIONS

Based on the results of research and discussion, the conclusions obtained from this research are that the developed learning design products namely lesson plans, students' worksheets, and learning outcomes tests are in the very good category so that they meet the valid criteria with the value of 3 validators. For practice, this can be derived from the results of the student response questionnaire completed by students who participated in learning using the PtLDV learning design with the discovery learning model supported by GeoGebra Classroom, with a percentage of >80% in the appropriate category. It can be concluded that the reactions of the students to the use of lesson plans developed by researchers, students' worksheets, and expert validation are positive. For effectiveness, given the results of the T-test with SPSS AND it is proven that the mean mark XI MIPA 2 is higher than the mean mark XI MIPA 1, it is concluded that the developed learning design meets the effective criteria. The results of the development of the PtLDV learning design with the GeoGebra Classroom-based discovery learning model through the lesson plans, Student Activity Sheets (students' worksheets), and Learning Outcomes Tests with GeoGebra Classroom have valid, practical, and effective categories.

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