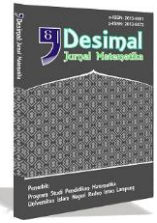




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Development of a two-variable linear inequality system mathematics learning design with a problem-based learning model

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ABSTRACT

Teachers are designers, implementers, and evaluators of learning. The teacher's ability to design learning that favors students will greatly affect the quality of the learning process and the learning outcomes that will then be obtained by students. This study aims to develop a problem-based learning design for the more interesting topic of systems of two-variable linear inequalities. This development research uses the Dick & Carey development model. The Dick & Carey model can be an alternative for teachers in designing pro-student learning because, by design, this model starts with student and context analysis as well as instructional analysis, which will provide sufficient information and evidence about the characteristics and needs of students as well as instructional objectives that are appropriate to the level of their education and stage of development.

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INTRODUCTION

One of the subjects considered difficult from elementary to secondary education by the general public is mathematics (Herawati, Siroj, & Basir, 2013). Science, which plays a very important role in the development of science and technology, cannot be separated from mathematics (Afrilianto, 2012). Mathematics also has an important role in everyday life and in dealing with science and technology progress. That is one of the reasons that mathematics has been studied from the lowest to the

highest level (Khoirudin & Rizkianto, 2018).

The success of learning is largely determined by the design of learning devices. Learning devices are a set of media or facilities used by teachers and students in the learning process in class. Learning devices function to guide the process of learning. Learning device development is a series of processes or activities carried out to produce a learning device. In developing learning tools, there are various types, namely the ASSURE model, the ADDIE model, the Dick & Carey model, the Plomp model, the Kemp model,

the 4-D model, and the Hannafin & Peck model.

In the 2022 PISA survey, Indonesia obtained a score of 396, far below the OECD average score of 489. Indonesia is ranked 9th from the bottom out of 71 countries, before Saudi Arabia. This shows that Indonesia's human resources are still developing. This also applies to the world of education, as can be seen from the condition of Indonesian students, who have low fighting power. Many students are less interested in reading, which relates to a relatively low level of literacy. Low or weak mathematical literacy greatly affects student learning outcomes. It can be seen from the situation of the students in the class, who are less interested in reading long questions and narrative forms. With these various situations, researchers are very interested in various things that support how to improve the learning quality of Indonesian students in terms of mathematical literacy in solving problems.

Contextual-based high school mathematics learning material and its many applications in everyday life are systems of two-variable linear inequalities. This topic discusses maximum estimation and drinking a lot. The researcher chose the mathematical topic System of two-variable linear inequalities (SPTLDV) because this topic touches on contextual problems and requires high mathematical literacy skills and persistence in solving problems. In this SPTLDV topic, students are faced with contextual problems, and then they use this information to construct mathematical models and solve them. With the previous description, it is necessary to design good learning to improve mathematical literacy skills and guide students to be more diligent in solving problems so that the maximum learning objectives of SPTLDV can be achieved.

The problem-based learning model is considered appropriate in designing learning on the SPTLDV topic, namely the Problem Based Learning (PBL) model. Because of the Problem Based learning (PBL), students will be faced with contextual problems and are required to understand each problem with the knowledge they possess. Research by Lestari & Aziz (2022) stated that PBL can increase mathematical literacy, where PBL is a part of the Problem Solving (PS) model. According to Sanjaya (2012), the problem-based learning model has advantages and disadvantages. The advantages of the Problem Based Learning model are:

1. Challenging student satisfaction and giving satisfaction to students who discover new knowledge.
2. Increase student motivation and learning activities.
3. Help students apply their knowledge to understanding real-world problems
4. Helping students develop their new knowledge and be responsible.
5. Develop students' ability to think critically and adapt to their new knowledge.
6. Opportunity to apply new knowledge in the real world.
7. Develop students' interest in continuously learning.
8. Facilitate students' mastery of concepts to solve real-world problems.

Disadvantages of Problem Based Learning are:

1. Using a lot of time.
2. Students who lack intention or confidence can feel reluctant to try.
3. Students will usually learn what they want to learn.

With the previous explanation, the researcher thought it was enough to choose the problem-based learning (PBL) model as a good method to improve student learning outcomes in achieving the goal of studying SPTLDV. The purpose of writing this paper is to design

mathematics learning and motivate teachers to choose the right learning model for solving problems faced by students in learning mathematics, which so far has been considered difficult and boring. This SPTLDV contextual topic will be taught in class XI for senior high school.

METHOD

This research is development research, also known as research and development (R&D). This study aims to design learning and motivate teachers to choose the right learning model for solving problems faced by students in learning mathematics, which so far has been considered difficult and boring. In

this case, the focus of development is instructional design; therefore, the model chosen is the instructional development model (MPI) or learning development (Suparman, 2014). The MPI is developed through three stages, namely: first, identifying instructional needs, and determining general instructional goals. Second, develop, namely through four steps: writing specific instructional objectives, developing learning assessment tools, developing instructional strategies, and developing instructional materials. Third, carry out formative and summative evaluations (Suparman, 2014).

The development flow of this model is presented in Figure 1.

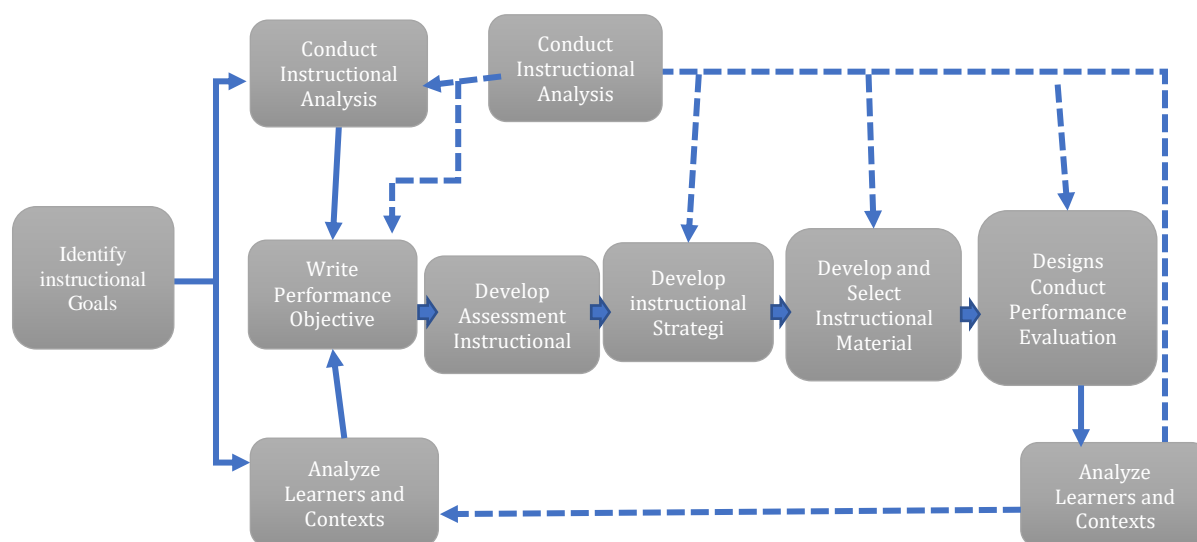


Figure 1. Dick & Carey Development Flow

RESULTS AND DISCUSSION

The purpose of this learning design is to improve student learning outcomes. Linear programming (PL) is one of the research techniques of operational engineering to solve optimization problems (maximum or minimum) by using linear equations and inequalities in order to find optimal solutions taking into account existing limitations (Supranto, 1987).

The results of the study were taken from high school students. Students at the senior high school level have an average age of 15–17 years. Humans at this age are

classified as adults. The stage of thinking has entered abstract thinking. Learning methods and styles at this age lead to critical and logical thinking. The memory of children aged 11 to 12 years and over is getting stronger, and they are able to think strategically and formulate strategies. A researcher from Santrock (2015) said that a child aged 11–12 years is able to remember more pieces of chess information compared to an adult chess player. This shows that children at the age of 11–12 are already able to think strategically and systematically. The ability of children was previously able to

calculate the area of a flat surface, height, and volume, but if a child is aged 11–12 years and over, it turns out to be much different. The mathematical abilities of students at this age are already able to work on complex problems such as root operations and operating high nominal numbers, and they are already able to accept inquiry learning models and student-centered learning (Juwantara, 2019).

Mathematics, which is considered difficult and lacks realization in everyday life, is not quite right. One of the actual mathematical topics that is very close to everyday life is a system of two-variable linear inequalities. Here it will be shown how this topic has a role in economics and other fields to obtain maximum and minimum estimates. SPTLDV problems will be faced by students, and then students will be able to construct mathematical models and solve them properly.

In parallel with the analysis of students and context, it is also necessary to carry out instructional analysis aimed at students who are the subject of the learning being developed. In this case, the purpose of learning the material for the System of Linear Inequalities with Two Variables is to determine the SPTLDV solution and use it to solve related problems creatively and independently. The prerequisite material that must be owned by students before entering the SPTLDV is a thorough understanding of the linear equation of two variables. Students should be able to determine the point of intersection of two equations and describe them in the Cartesian coordinate plane. Students' understanding of the two-variable linear equation is the entry point to learning the two-variable linear inequality system. Previously, a diagnostic test would be carried out to determine the student's initial ability. These diagnostic tests are:

1. Draw the lines $2x + y = 10$ and $x +$

$3y = 8$ and determine the coordinates of the intersection points of the two lines.

2. Draw the lines $x + 4y = 12$ and $2x = 6 - y$ and determine the coordinates of the intersection points of the two lines.
3. Determine the coordinates of the point of intersection of the lines without drawing them:
 - a) $2x = 10 - y$
 $x - 2y = 18$
 - b) $x + 4y = 12$
 $2x = 6 - y$

The owner of a bicycle shop wants to shop in town. He thought he would not spend more than Rp. 42,000,000.00. He wants to buy 25 bicycles for supplies at the store. He wants to buy a mountain bike at a price of Rp. 1,500,000.00 per piece and a racing bicycle at a price of Rp. 2,000,000.00 per piece. The profit of a mountain bike is Rp. 500,000, and the profit of a racing bike is Rp. 600,000. Write down all the mathematical information.

Answer:

Let's say mountain bikes are x and race bikes are y .

$$x + y = 25$$

$$x = 1,500,000$$

$$y = 2,000,000$$

$$1,500,000x + 2,000,000y = 42,000,000$$

The next stage is the determination of the performance objective, which includes components such as skills, conditions, attitudes, and criteria. The learning achievement (CP) of the two-variable linear inequalities system (SPTLDV) is that students are able to solve problems related to the two-variable linear inequalities system. The learning objectives can be distinguished according to the educational aspect, namely:

1. Aspects of knowledge, namely students, can determine the completion of a system of two-variable linear inequalities.
2. Aspects of skills: students can use the

concept of a system of two-variable linear inequalities to solve related contextual problems.

Behavioral goals become the most important goals for students after they complete their learning. Because there are those who oppose the behavior, it turns into performance goals, learning goals, and instructional goals. Marken & Morrison (2013) provide an interesting analysis of objective terminology from the 1970s to the 2000s.

When instructional objectives are transformed into performance objectives, they are referred to as "terminal objectives." Terminal objectives accurately describe non-real-world learning situations. The skills gained from analyzing the steps in an objective are called subordinate objectives. Thus, the goal is a statement about what students can do in the context of performance. Performance objectives stem from skills in instructional analysis. One or more objectives should be written for each skill defined in the instructional objectives. This includes writing goals for entry skills. This is to develop test items.

The second component of the goal establishes certain conditions that are part of the goal. Conditions refer to the environment and resources available at the time the goals are set. In choosing the right conditions, consider both the behavior to be achieved and the characteristics of the target population, as well as the functions of these conditions. Conditions must be adjusted to the target with a knowledge, skill, or attitude subset of clearly identified goals. Specify the conditions of the goal. Conditions refer to the exact set of circumstances and resources that will be available to the learner when the objectives are carried out.

In setting goals, operational verbs are needed that are measurable in each domain (cognitive, psychomotor, and affective). This goal must be able to reveal

the type of behavior that is formulated through the identification process in the learning analysis. Intellectual skills can be described with operational verbs such as identify, classify, show, or produce. This verb refers to specific activities such as grouping similar objects, distinguishing one thing from another, or solving a problem.

The fourth component, namely the criteria, includes factors that need to be considered, including the nature of the observed behavior, the context in which the behavior is observed, and the age of members of the target population.

The next stage of development is developing assessment instruments. Assessments that aim to measure aspects of knowledge are more complex. Aspects of knowledge are usually assessed through objective items, product creation, or performance. Assessment of ability at a higher level will be more difficult because the learning objectives are more complex. There are several forms of questions that are generally used in Indonesia to assess aspects of students' knowledge, namely multiple choice, short essay, description, matching, and complex multiple choice. The form of the questions chosen to assess aspects of students' knowledge is based on the type of test, time, and objectives formulated by the compiler.

After the instrument is developed, the next step is the development of instructional strategies, followed by the development of learning materials. How do learning outcomes support each objective? The learning activity is an application of the learning design that has been made before. Learning activities have an important role in achieving learning objectives, in addition to good learning designs. For this reason, it is necessary to develop a learning plan before carrying out learning in class. In the previous explanation, it was said that learning activities are largely determined by good planning and assessment. This article

discusses and develops general guidelines for instructional learning activities according to Gagne, namely:

1. Gain attention

It is very happy if a teacher gives something that can open students' insights in the form of questions, short stories, games, and various other types before entering the material to be taught. Create an atmosphere of curiosity.

2. Inform students of the objectives

After the students are curious, we continue with the question of why they should study the topic to be discussed. Related to learning objectives, performance required, and performance criteria to be achieved, students can be involved in determining performance criteria to be achieved, not to mention directing their views about applications in everyday life.

3. Stimulate recall of prior learning

Get used to repeating previous material. In order to increase students' memory so that they don't just forget it immediately, and if possible, explain the relationship with the material to be studied next.

4. Delivering the content

Design a more effective and efficient strategy. Organize content according to learning objectives with activities involving: new vocabulary, real examples, models conveyed whether through videos, stories, demonstrations, group work, and others, and use media that is appropriate to the teaching topic.

5. Provide learning guidance

Provide clear guidelines for students to equate perceptions so that students are motivated to learn. This can be in the form of providing support, learning strategies such as concept maps, role-playing, and others, using examples and non-examples, giving cases, analogs, and the like.

6. Elicit performance

Helping students repeat the knowledge discussed in order to gain new skills in relation to the world of work. Invite to think/explore what is being obtained, invite collaboration between students, and help connect newly learned material with a more real context.

7. Provide feedback

At the end of each lesson, give feedback to determine student performance. We recommend personal feedback; after that, it's good if there is further development or continuous learning (remedial or enrichment).

8. Assessment Performance

An assessment of the performance of each learner must be done. There are 3 types of assessment: pre-test to find out prior knowledge mastery, process assessment to find out weaknesses in the learning strategy being applied (formative), and post-test to find out mastery of the content or skills being taught (summative).

9. Enhance retention and transfer.

This must be done by a teacher so that the material just learned can be remembered well and last a long time. Connect it with real life or the right application so that there is meaningful and useful learning.

Should conduct a learning evaluation to measure the achievement of learning objectives. From there, the next learning attitude can be taken, whether to do remedial or enrichment. In the Law of the Republic of Indonesia Number 20 of 2003 concerning the National Education System, Article 57, Paragraph 1, states that "Evaluation is carried out within the framework of controlling the quality of education nationally as a form of accountability of education providers to interested parties, including students, institutions, and programs of education".

Introduction

- Students listen to the opening activities of the Pancasila profile and the learning objectives given by the teacher, which are expected to be achieved by students.
- Students can perceive questions as a stimulus given by the teacher.
- Students can listen to the competencies announced by the teacher and give active reactions regarding the initial competencies given by the teacher.

The main activities

1. Problem Based Learning (PBL) Models
2. Orient students to the problem
3. Organizing students to study
4. Guiding individual and group investigations
5. Develop and present the work
6. Analyze and evaluate the problem-solving process
7. Reflection

Closing

- Provide reinforcement for today's learning process and motivation to keep learning enthusiastically every day.
- Give assignments to do at home, then ask a student to close with a prayer.

The next stage is the evaluation stage, which consists of formative and summative evaluations. At the stage of designing and conducting formative evaluation, the tool for collecting data is called formative evaluation. Then the data can be analyzed, and the results are used to revise the learning design. Because the formative evaluation is a source of information about certain errors, including the evaluation design of instruments, procedures, and personal needs.

Pay attention to the questions below:

Ani is a student at a private high school. In the morning, Ani studies like other children her age. After school, Ani has to sell in front of a paper factory whose employees leave at 17.00 WIB. Ani sells Klepon cakes at a price of Rp. 1,000.00 per

piece; fried tofu costs Rp. 3,000 per 2 seeds. Ani sells no more than 20 Klepon and 30 pieces of fried tofu every day to help her family survive. The cakes sold were taken from a cake maker at a price of 90% of the selling price. Before Ani goes to sell, she takes care of the household chores because her mother suffers from anemia. How much will Ani earn if she works 20 days and her sales are sold out? From these problems, I found a lot of information. It will be seen whether students can solve the linear inequalities of the two variables effectively and efficiently. If some difficulties or obstacles are found for students in solving them, they can revise the design of the learning model that is being carried out. Revisions can be made in the learning phase using PBL.

The final stage in this development is designing and conducting a summative evaluation. Summative evaluation is carried out at the end of a learning process in one topic, chapter, or competency with the aim of measuring the effectiveness of a program or learning design. Whether the learning model is suitable or there is another model that is more suitable.

Good preparation in designing learning by Dick & Carey and entering the correct learning process can certainly achieve learning objectives, as in this study using the problem-based learning (PBL) model. Interesting learning comes from using the material discussed in everyday life. The purpose is notified by the teacher, and the teacher first analyzes and recognizes student behavior, conditions, and criteria. The problems given by the teacher in questions can generally be understood well by students.

CONCLUSIONS AND SUGGESTIONS

The current education policy emphasis on student learning requires a systematic design. Dick & Carey's

systematic learning development model can be used for the purpose of designing pro-student learning. This model, by design, begins with student and context analysis as well as instructional analysis. This initial stage will enable teachers to identify the needs and characteristics of students as well as instructional goals that are tailored to their educational level and stage of development. The results of this analysis will provide information on the conditions and needs of students as a starting point for further development. With this information, the teacher will have a strong basis for selecting strategies and instructional materials that favor students, as well as appropriate instruments that can provide information on their learning progress and achievements.

Researchers suggest teachers always design learning well before teaching. Choose the right method because each of these methods has compatibility with the topic you want to teach. The questions and discussions in the learning process must be related to the events of everyday life so that students can apply them and the knowledge is useful.

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