

# Development of Interactive Learning Video on Linear Program

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**Abstract** The current condition of the Covid-19 Pandemic requires students to study independently. One of the learning media that can help students solve problems is video-assisted learning. The development of learning video is beneficial to assist teachers in teaching and learning activities. In addition to increasing students' learning interest, learning videos can also help students enter deeper mathematical understanding. The mathematical material is abstract that usually makes students think that mathematics is a difficult lesson. Linear Program at senior high school level is applied mathematics with mathematical models compiled from multiple equations or linear equivalencies to determine the maximum or minimum value. This study aims to develop learning media for linear program mathematics content. This research uses research and development (R&D) method with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The sample of the research is one of the high schools in West Java, Indonesia. The validation results of media experts and material experts show learning video is feasible to be implemented to students. The school implementation also established a learning video that using the problem-solving steps is constructive for students to create the mindset and understand the basic concepts in a linear program. This study's results also contribute to the achievement of the objectives of learning mathematics for the better based on the use of video-based learning in improving the mathematical abilities of high school students.

**Keywords** Interactive Learning Video, Linear

Program, Senior High School

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## 1. Introduction

In recent years, video-based learning is growing very rapidly on the Internet. Various forms of free learning video can be found on websites or social media for the purpose of learning. One of them is YouTube. The use of video in education experienced a significant increase after 2005. This is evidenced by the research and observation that has been done on the effect of video-based learning. Teachers usually use a lot of learning videos to support teaching and learning activities in the classroom [1]. It also has a key role in improving student mathematical skills. The use of learning video in schools is used in the classroom to assist teachers in teaching and learning activity, distance learning, or as additional course material [2]–[4].

Increasing the use of learning video makes improve interactive features included in the video. The interactive features in learning video have been improved better like buttons for pausing in the middle of the video and playing back video, speeding up or slowing down the video. The features can help student stop the video in places where students don't understand. Slow down the video when students want to see clearer animations. It has a better learning function compared to videos that do not have a control button to interpret, replay and change the speed of

the video so you can only watch the video until it's finished.

Mathematics lesson using traditional methods is not very effective and should be updated such as the use of technology in teaching and learning activities both in the form of mathematical software or learning video [3]–[9]. Many studies have shown that the use of technology in teaching and learning activities is better than using traditional methods [10]–[21]. Such research has been done by Bernard and Chotimah to improve mathematical reasoning ability by using the open-ended approach of assisted VBA for PowerPoint [22]. Wijaya used VBA for Excel to improve the ability of students' mathematical understanding on trigonometry material [23]. VBA-based learning media on trigonometry material [24]. Wijaya also developed learning media on trigonometry material using Hawgent Dynamic Mathematics Software [25]. Develop learning media for arithmetic materials in elementary schools that are combined with ethnomathematics [26]. Develop learning media on vector algebra using Hawgent Dynamic Mathematics Software combined with 6 questions cognitive theory [27]. Based on the results of research, it can be concluded that technology-based learning can improve students' mathematical abilities and also help students to achieve deep understanding.

A lot of mathematical material is abstract. One of the materials that are difficult for students to understand is geometry. Dogruer and Akyuz [28] said that Students are difficult to understand because mathematics lesson is monotone. Another abstract material is linear program studied at the senior high school level in class XI as compulsory mathematical subjects. A linear program can be said to be part of applied mathematics with mathematical models composed of multiple equations or linear equivalencies. A system that contains a development program to solve a problem. Linear program is applied to solve problems in areas such as economic, military, and social problems. Therefore, it is important that the linear program material be mastered by students which will later be useful when students enter the world of work.

The basic competencies in linear program materials include 1) students can understand the problem of optimization in a system, 2) students can create a mathematical model from real problem in daily life 3) students can create models of linear programs and be able to resolve these problems 4) students understand the concept related to the material of linear program 5) students can solve the problem of the linear program with the help of graph 6) students know the problem of linear program of maximum value.

Based on the background that has been described above, it can be concluded that the linear program is very important to be mastered by students because it is very useful in daily life. In addition, realizing it or not, the use of technology in education has grown rapidly in recent

years and the development of technology-based learning media has become the main goal. In this research, researchers made learning media using video-based learning on linear program.

## 2. Materials and Methods

This research uses research and development (R&D) method with ADDIE model (Analysis, Design, development, Implementation and Evaluation) [29]. The sample in this study is one of high schools in West Java. Researchers took 1 class with 38 students at the analysis stage to make observations about students' difficulties in understanding linear program. Based on observation results, the researcher designed the lesson using learning video-assisted by Hawgent Dynamic Mathematics Software. After a learning video is made, the learning video enters the development stage where the learning media are validated by media experts and material experts. At the implementation stage, learning video is given to teachers in schools to implemented to students. And in the last step, the revision and evaluation of learning media are based on the inputs from the teachers and students in the school. The ADDIE working steps can be viewed in Figure 1.

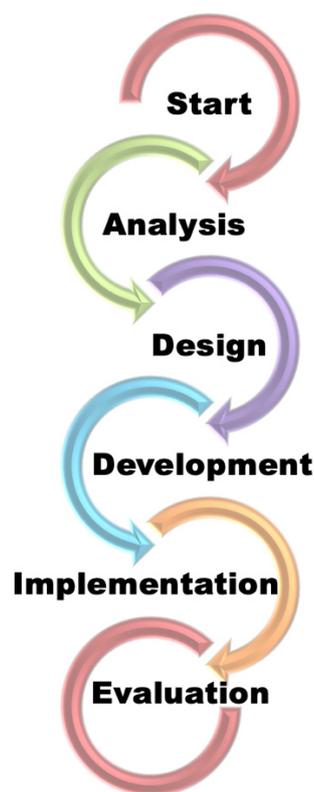


Figure 1. ADDIE framework to create learning video

The learning Video is made not more than 10 minutes so it doesn't divide the students' concentration. The

research that has been done suggests that effective learning video is around 10 minutes. When the media are learning more than 10 minutes, it is better if the learning video is divided into 2 or 3 videos. That way, increasing the curiosity of students to watch all the videos [30], [31].

Hawgent Dynamic Mathematics Software is used to solve linear program problem. Animation of solving linear program questions using Hawgent Dynamic Mathematics Software is included in the learning video to help students visualize how to draw graphs from two linear and determine the area for solving linear program problems. Hawgent Dynamic Mathematics Software is a software from Guangzhou, China [27]. The development of Hawgent Dynamic Mathematics Software is based on the needs of mathematics education. With the aim of helping teachers and students to learn mathematics and focus on deep learning. Hawgent Dynamic Mathematics Software has been used by teachers in schools to teach mathematics lesson and get a positive response from teachers and students [32]. The students feel the use of technology in teaching and learning activities can make them have more understanding of the concept and not easily forget. They also said that the use of technology in class made them interested and not sleepy in class. There have been many studies using Hawgent Dynamic Mathematics Software in various materials such as, arithmetic, trigonometry, plane geometry, etc. [27], [33]–[35].

### 3. Results and Discussion

#### 3.1. Analysis

Before the learning media using Hawgent Dynamic Mathematics Software was created, the researcher gave students a pretest to see what mistakes students often made on linear program. Researchers gave 3 questions of pretests that were adopted from the national exam in 2018-2019. So that the pretest questions given will not make it difficult for students and the standards are in accordance with the government. Taking the questions of the national exam to give to students not only be the standard reference in making questions, but can make students adapt in doing national exam questions exam. So that students do not feel afraid and confused again when facing national exams. Based on the observation results, researchers see that most of the students' mistakes at the time of changing the sentence form the story into mathematical form. So, when student drawing the graph, students' interpretation area is incorrect. Small errors still occur in the elimination or substitution operation or finding the intersection point between 2 straight lines. These things happen because students may not really understand the basic concepts of linear program, so that when the teacher changes the question into a more difficult or confusing one, Students can be deceived and make mistakes (see Table 1).

**Table 1.** Students' difficulties in working on linear program

No	Students' difficulties	Number of students	percentage
1	Determine the Interpretation Area	20	52.63%
2	Calculate the intersection of two straight lines	18	47.36%
3	Students are not careful	12	31.58%

When a researcher asked how a teacher teaches the material in the class, researchers got information that usually on linear program materials, students are given 2 linear equations. From these two linear equations, students are directed to draw a function graph and determine the intersection point of the 2 linear functions. After that, students determine the coordinate points of completion and determine the maximum or minimum answer according to the questions.

Transforming the mathematical story into a mathematical form requires deep understanding of the basic concept. So, when students don't master the basic concepts of the material, students will have difficulty interpreting the question. The way to make students easier to understand the meaning of the question and to master the basic concepts of material is by using technology in learning. The use of technology in learning is carrying out the basic concept, hearing and practicing it directly. So, when students are working on more difficult levels, students are used to thinking using basic concepts and developing patterns according to the basic concepts that have been taught.

#### 3.2. Design

The learning video applies the problem-solving process which consists of Analysis, Planning, Implementation, Reflection to make learning video. This process follows a pattern that has been developed by Polya which directs students to master the material deeply and not easily forget the material being studied. In the video, in the analysis stage, the researcher uses 1 question for the 2019 National Examination (UN) on linear program. Examples of questions taken can be seen in Figure 2.

At the analysis stage, learning video directs students to understand the problem of using contextual approaches using interactive animations. So, when students learn for the first time and see the linear program questions, students do not feel that a linear program is a complex material and difficult to understand. Linear program is around the student's life and directs students to think that linear program is a very important material to use in everyday life. When students are interested and feel that mathematics is an important material, students will easily remember and understand the material. So, when students enter calculus lessons in the university, students still feel that the lessons of linear program and calculus are not difficult and still understandable. This concept can lead students to deep learning.

SMA—Linear Program



the boss has a land area of 10,000 m<sup>2</sup> that will be built type I and type II houses. Type I houses require 100 m<sup>2</sup> of land and type II houses require 75 m<sup>2</sup> of land. maximum house only 125 units. Type I house is Rp250,000,000.00 per unit and type II house is Rp200,000,000.00 per unit. The maximum income that the boss can earn is?



Figure 2. Animation on video at the analysis stage of the problem

SMA—Linear Program



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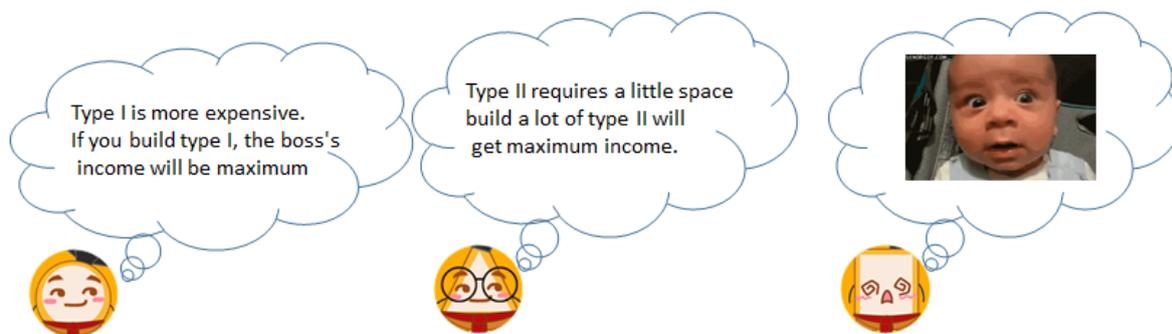


Figure 3. Example of linear program question on the learning video

At a next stage, students will make a plan How to change the problem form of the story to mathematical language, before students draw a straight-line equality graph to determine the coordinate points of the problem-solving. In the video, researchers designed a mind mapping diagram to help students change the form of questions in the form of story problems into mathematical language, see what the important points in the problem are and needs to be considered. The next step of the researcher in the Learning video, insert the animation of 3 students named Bubu, Titi and Koko who

tried to answer the suspicion about the maximum value that can be produced. as Seen in Figure 3, Bubu replied that the value would be maximum if the businessman built all the land with the house type I, Titi answered the house type II requires a small amount of land so can build many houses type II. That way the income of a home entrepreneur will be maximized. At the same time, Koko is still confused and can't answer the question.

The planning process shown in the learning video is designed as interesting as possible. So, it increase students' curiosity at a further stage about the next answer.

Learning video makes students think when they have problems, either problem in mathematics lessons or in everyday life, first students must be analyzing the problem before make a plan to solve the problem. If the students have mastered the pattern, then when the student finds the question with another type, the student will analyze the problem first, collect information from the available questions, then do the planning according to the information that is already in the get.

At the next stage, students implement the results of analysis and planning. Draw the graph and define shading areas. Find the intersection of 2 linear inequalities. As well as determining points of settlement coordinates. Learning video shows where mistakes are usually made

by students. Figure 4, it looks Bubu tried to answer the linear program question. But Bubu incorrectly determines the shading area. So Bubu's answer is not correct. From here, students can pay attention to where mistakes are often made. Students will be more careful in doing linear programs question.

After students understand and analyze the mistakes that are often made, learning video use Hawgent Dynamic Mathematics Software to find the area of completion and the intersection. The hawgent design that is dynamic and easy to use is very helpful for researchers in its application. The use of Hawgent Dynamic Mathematics Software on learning video can be seen in Figure 5.

## SMA—Linear Program



the boss has a land area of 10,000 m<sup>2</sup> that will be built type I and type II houses. Type I houses require 100 m<sup>2</sup> of land and type II houses require 75 m<sup>2</sup> of land. maximum house only 125 units. Type I house is Rp250,000,000.00 per unit and type II house is Rp200,000,000.00 per unit. The maximum income that the boss can earn is?

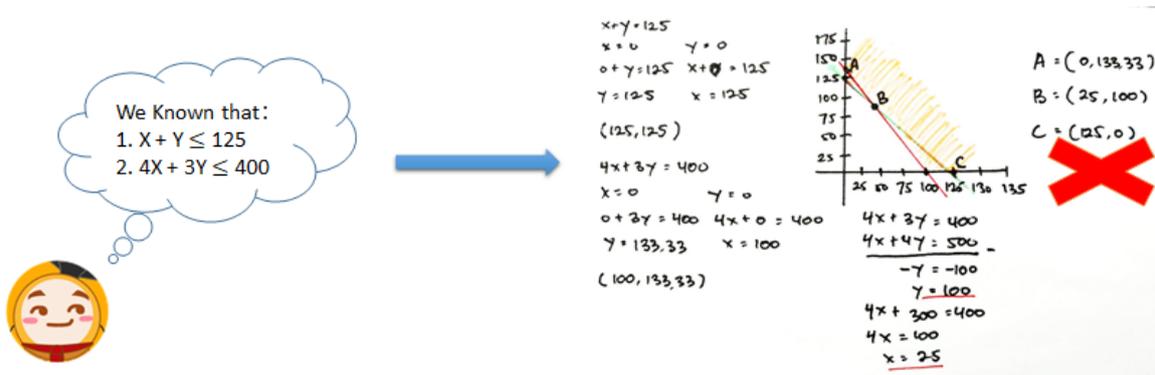


Figure 4. Learning video show mistakes often made by students

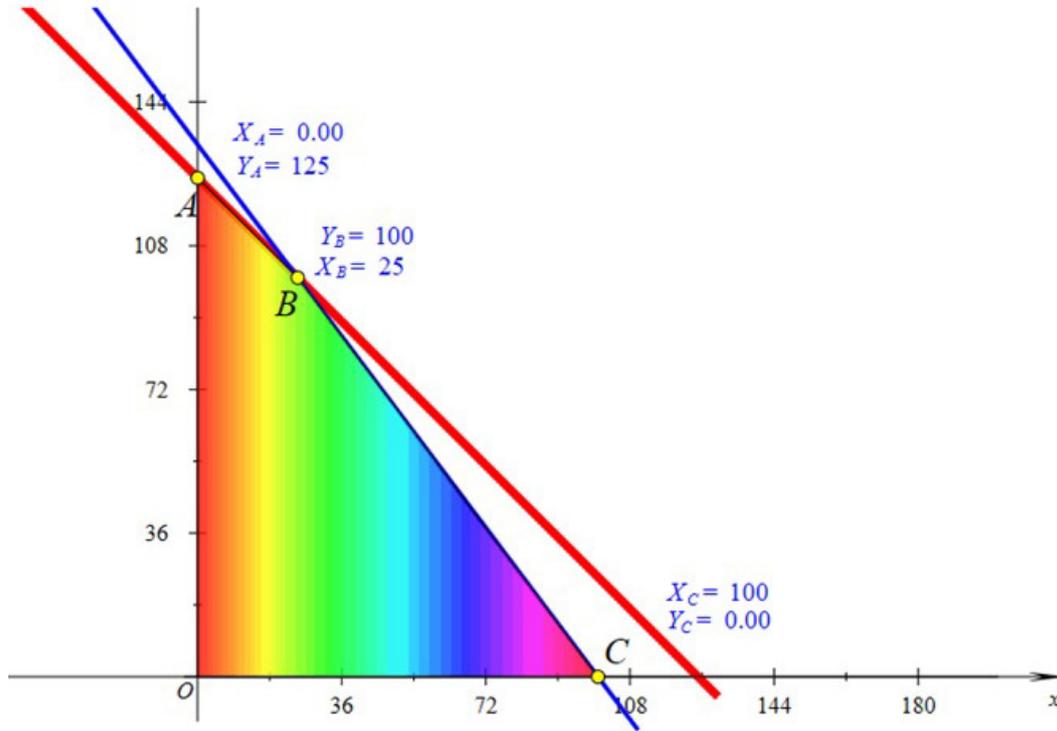


Figure 5. Hawgent Dynamic Mathematics Software is used to find the area of completion

SMA—Linear Program



	$f(x, y) = 250x + 200y$
A (0, 125)	$250 \cdot (0) + 200 \cdot (125) = 25000$
B (25, 100)	$250 \cdot (25) + 200 \cdot (100) = 26250$
C (100, 0)	$250 \cdot (100) + 200 \cdot (0) = 25000$

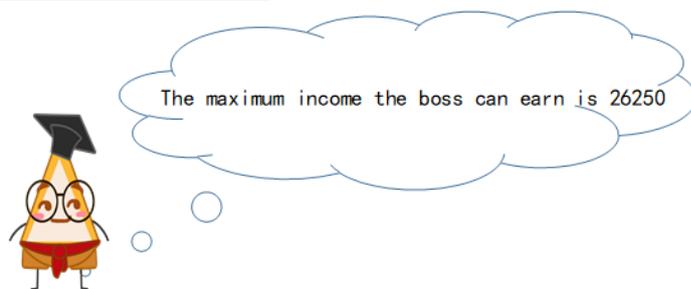


Figure 6. Finding the maximum value and determining the answer

After the students find the coordinates of the completion points, the student inputs these coordinate points in the equation functions and determines the maximum value obtained. In Figure 6 can be seen that the maximum value is obtained at the point of coordinate B (25,100) where it can be interpreted that the value of maximum sales of boss will be maximum if the boss builds 25 house type I and builds 100 types II house.

In the final stage, learning video helps students to evaluate what they have been analyzed, planned and

implemented so that the answers produced are correct and minimize the small mistakes. As a complement, at the end of the learning video completed with practice question, to help students improve the patterns and concept that students already get in the learning video.

3.3. Development

The learning video is carefully made and pays attention to the knowledge and benefits of various viewpoints.

After learning video is complete, 3 Media experts and 3 material experts validate the learning video before the video is implemented at school. Media experts and material experts are professors and Doctor from Guangxi Normal University, China. There are 2 aspects assessed by the material experts that are in the suitability of the learning video with the national curriculum including the learning objectives and basic competencies of students also content that directs students to a deep learning of concepts. While in the media validation, there are 3 aspects that the media experts assessment is in the ease of use of learning video in the classroom, in the side of the video animation, the use of motion pictures or cartoons not too much that makes students more interested to see the cartoon than the solving of the problem. The size of the text, text and numbers are easy to see, the colours are not too bright, the arrangement and steps of learning video that make the learning video perfect. The validation results of material experts and material experts can be seen in Table 2.

**Table 2.** Validation results of material experts and media experts

no	validator	aspect	Assessment result	Criteria
1	Material	curriculum	78.33%	Feasible
3	Material	content	86.67%	Very feasible
4	Media	Easy to use	81.67%	Very feasible
5	Media	Animation	91.67%	Very feasible
6	Media	Design	85%	Very feasible

Based on the results of the validation in table 2, it can be seen that the video learning curriculum aspect is 78.33%, on the content aspect it is 86.67%, so the average percentage of the material aspect is 82.5% with the very feasible category. In the media aspect, the assessment consists of easy to use, animation and design, respectively getting a percentage of 81.67%, 91.67% and 85%. Then the average percentage based on media experts is 86.11%. Based on the decision of all validators, the video learning in this study is valid and can be continued in the implementation stage.

### 3.4. Implementation

A revised learning video according to inputs from media experts and material experts is tested to be one of the schools in West Java, Indonesia. Researchers saw learning video brings a new atmosphere into the classroom. Student expressions illustrate that students are interested in linear program presented through the video. At the end of the video, students look very serious doing the question of the exercise in the video. Some students were seen in discussion with nearby friends. Instantly learning in the classroom came alive. This proves that

using learning video in the classroom is more effective than listening to teacher explanations in the classroom. This is similar with the research that has been done, that the use of technology in the classroom increases student interest in learning and the effectiveness of teaching and learning activities [6], [7], [19], [20], [24], [27], [36]–[41], [11]–[18]. Researchers took some students to represent the class about their responses to the use of learning video in the Classroom (see Table 3).

**Table 3.** Student responses to learning video on linear program

student	statement
AB	Mathematics lesson using learning video is very interesting
TM	I do not feel boring with mathematics lessons if using learning Video
TS	learning video brings a new atmosphere
BK	make me more understand the basic concept of linear program
AT	Learning video program makes me understand the linear program

Students hope that each material can use learning video so they can more understand a basic concept. They think the learning video makes them have a good basic and thought to solve a problem. With these basic, students can be more careful in solve problems and minimize the mistakes that are often made.

Further research can develop learning video to improve students' mathematical ability. Subsequent research can also develop learning video on another mathematics lesson. Lack of this study is not to analyze the effect of learning video on students' mathematical abilities. This research is only focused on the research development of learning media-based learning video based on the student difficulties. Suggestions for teachers, in order to develop learning video to help students understand the mathematical topic more deeply.

### 3.5. Evaluation

Some suggestions for learning video from teachers after implementation are, 1). The back sound is too hard, so it makes students not focus on the main concept. 2). The length of the video was too long so that some students behind the class were seen sleepy. 3). The fonts used in the video are too small, some important points on the video can be enlarged and the size is clarified. After video learning has been revised, video learning can be widely disseminated using WhatsApp or other social media.

## 4. Conclusions

Linear program is material taught at Senior high school level. Based on preliminary analysis, students have difficulty doing on linear program problems. The use of technology in teaching and learning activities can increase students' learning interests and direct students to deeper learning. Hawgent Dynamic Mathematics Software

combined with learning video makes learning video more interesting. Directing students to conduct problem-solving pattern consisting of analysis, planning, implementation and evaluation. To make students accustomed to forming the mindset of problems solving both in daily activities and in doing math problems at school.

Research related to the development of mathematics learning videos on linear program material has not been widely studied. So the researchers suggest that broader analysis be carried out in the development of mathematics learning on linear program material, especially in developing countries.

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