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Interactive Learning Media with Realistic Mathematics Approach: Facilitating Distance Learning on Linear Program Materials

Lisa Mei Lindasari*
Universitas Islam Negeri Raden Intan Lampung, INDONESIA

Farida
Universitas Islam Negeri Raden Intan Lampung, INDONESIA

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Abstract

This research produced an interactive learning media for Linear Programming material using a valid, engaging, and practical, realistic mathematics approach to facilitate distance learning. This research was development research using the ADDIE development model. The data analysis techniques used were validation analysis of media and material experts, students' responses questionnaire, and Effect Size test. The sampling used was cluster random sampling. The test subjects were fourth-semester students of classes A, C, D, E of the Mathematics Education Study Program of UIN Raden Intan Lampung. The media expert's validation obtained an average score of 3.37, and the average score of material experts' validation was 3.53, both within the "valid" category. The attractiveness test during the small-scale trial obtained a score of 3.52 (very attractive), and the large-scale trial obtained a score of 3.56 (very attractive). The effectiveness of the developed product obtained through the Effect Size test was 0.43 (moderate category).

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INTRODUCTION

The dynamics of human life are inseparable from the development of information and communication technologies along with human needs and activities (Jazuli et al., 2018). Upon entering the era of the industrial revolution 4.0, humans are familiar with the Internet and are proficient in using it. However, when entering society 5.0, it is not only the Internet that humans use, but human becomes dependent on the Internet (Maharani, 2019)(Puspita et al., 2020). The rapid development of technology is used for various purposes, one of which is to support learning activities (Maskur et al., 2020).

During the teaching and learning activities, teachers must understand several aspects of supporting learning activities, one of which is the learning media. Learning media can be an intermediary that helps teachers stimulate students' attention, feelings, thoughts, and interest (Netriwati dan Mai Sri Lena, 2017). Teachers must choose the right media to facilitate students in the learning process. The effectiveness of the learning media is closely related to the delivery of material. Innovative learning makes the delivery of material go according to plan and achieve learning objectives. The selected media must be appropriate and can be used to facilitate students to obtain knowledge, skills, and attitudes(Mutiara et al., 2021). Today's innovative learning media are widely developed to adapt to the times, especially learning media in the form of software. Software for making interactive learning media makes learning interesting and makes students free to choose what they want to study (Aliffuddin et al., 2018)(Ekawati, 2016)(Alfiani et al., 2020).

* **Corresponding author:**
Lisa Mei Lindasari, Universitas Islam Negeri Raden Intan Lampung, Indonesia. ✉ meilindasari1805@gmail.com

Technological developments are also increasingly needed during the COVID-19 pandemic. Policies for studying, worshiping, and working from home are implemented to prevent the transmission of COVID-19. As the COVID-19 pandemic spreads, teaching and learning activities must continue. One of the policies is online learning (Ahmad, 2020). This policy aims to reduce crowds on campus. In addition, E-learning media can be used to support distance learning (Iqbal & Fradito, 2020).

Learning independence needs to be nurtured in distance learning (Kusuma, 2020). The millennial generation must cultivate learning independence because teachers merely act as facilitators and provide directions. The students have full control. The Linear Programming material requires fairly broad reasoning, especially in solving mathematical models. There are many story questions in the linear programming course, so students must understand the meaning of the problem.

Based on the results of the pre-research on 90 students who have studied linear programming material, the data of learning media used in distance learning is presented in Figure 1.

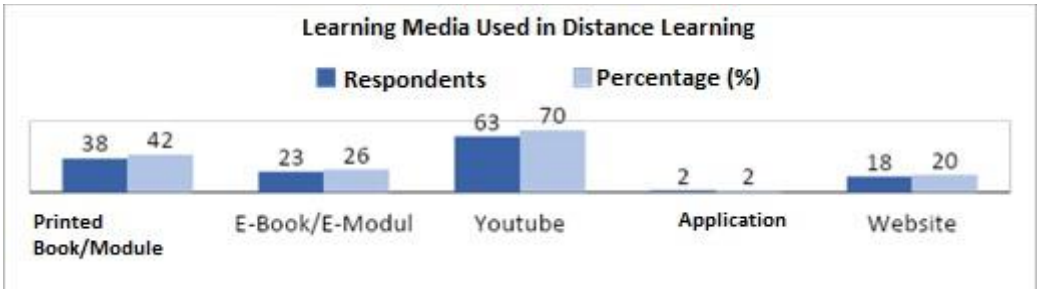


Figure 1. Learning media used during distance learning.

Figure 1 shows that the learning media used during distance learning are books/printed modules (42%), E-Books/E-Modules (26%), Youtube (70%), Applications (2%), and websites (20%).

Learning media innovation must continue to be developed to create interesting and meaningful learning and increase students' understanding (Nurdyansyah & Fahyuni, 2016)(Shalikhah et al., 2017). Interactive media makes the delivery of material interesting and not boring (Istiqlal, 2017). Learning media with a realistic approach is needed to solve the problems and make mathematics learning more meaningful (Haryonik & Bhakti, 2018). Independent learning is necessary so that students can understand the material. The accuracy of the media makes learning objectives can be achieved properly, and knowledge can be conveyed completely (M. Ramli, 2015). The learning media developed in this research was assisted by the Articulate Storyline application to create interactive learning media.

Previous research similar to this research is the development of learning media assisted by sparkol videoscribe on linear programming material using the ADDIE development model. It can be concluded that the product is feasible and interesting according to students' responses (Indriyani & Putra, 2018). Previous research related to distance learning concluded that distance learning is a modern learning method that utilizes ICT that helps to learn without face-to-face contact (Bali, 2019). Previous research developed learning media with the realistic mathematics approach, resulting in a practical, effective, and valid, realistic mathematics approach (Hamdunah et al., 2017). However, research that develops learning media in interactive web-based applications that use the realistic mathematics approach to linear programming material to facilitate distance learning has not been carried out.

Based on the description and previous research, the students of the Mathematics Education Study Program of UIN Raden Intan Lampung have not used learning media in the form of interactive web-based applications. However, based on the questionnaire data, 96% of students stated that they needed web-based applications. Therefore, the researchers developed learning media in interactive web-based applications with the realistic mathematics approach to facilitate distance learning.

METHOD

This research employed the research and development (R&D) method with the ADDIE development model. The ADDIE development model consisted of five stages: the analysis stage, the design stage, the development stage, the implementation stage, and the evaluation stage. The development model can be seen in Figure 2 (Bakhri, 2019):

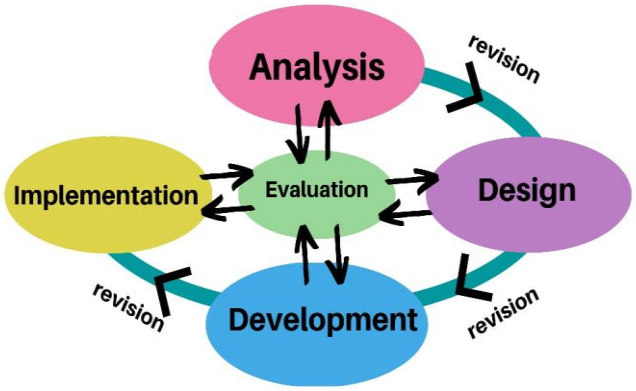


Figure 2. ADDIE Development Model

The steps of the ADDIE model, namely analysis-evaluation-analysis-design-evaluation-design-development-evaluation-development-implementation-evaluation-implementation-evaluation.

Place and Time of the Research

This research was conducted at the Mathematics Education Study Program of the Raden Intan State Islamic University of Lampung. The respondents were students of the Mathematics Education Study Program. The research was carried out in April-May 2021.

Research Subjects

A population is a group related to whom the generalization of the research results applies so that it becomes the attention of researchers (Hermawan, 2019). The population in this development research were students of the Mathematics Education Study Program of UIN Raden Intan Lampung. The sample during the pre-research consisted of three classes (B, D, and G) of the Mathematics Education Study Program. Furthermore, the sample during the research consisted of five classes (A, C, D, E, F). The samples were determined using the cluster random sampling technique.

Research Instruments

The instruments used in this research were questionnaires, interviews, and tests (Nugroho et al., 2017). The instruments used during the pre-research were interviews and questionnaires. The instrument for expert validation was a questionnaire. In addition, a student responses questionnaire was used to see the attractiveness of the product, and the test instrument was used to test the effectiveness of the product (Purwaningsih et al., 2018).

Data Analysis Techniques

The data analysis techniques used in this development research were expert validation data analysis (Media and Materials), student response data analysis, and the Effect Size test. The following is an explanation of the data analysis techniques used in this research.

Expert Validation Data Analysis

The validation score of each answer choice can be seen in Table 1.

Table 1. Expert Validation

score	Feasibility
4	Excellent
3	High
2	Low
1	Poor

The results of the assessment scores were then calculated and converted. The score conversion can be seen in Table 2.

Table 2. Expert Validation Criteria

Score Quality	Feasibility Criteria	Description
3.26 < (x) 4.00	Valid	No Revision
2.51 < (x) 3, 26	Sufficiently Valid	Partial Revision
1.76 < (x) 2.51	Less Valid	Partial Revision and Material Review
1.00 < (x) 1.76	Invalid	Total Revision

Table 2 describes that the score range of 3.27 to 4.00 is categorized as valid. Next, the score range of 2.52 to 3.26 is categorized as sufficiently valid. Next, the score range of 1.77 to 2.51 is categorized as less valid. Finally, the score range of 1.01 to 1.76 is categorized as invalid and needs a total revision.

Analysis of Student Response Questionnaire

The questionnaire consists of four answer choices with different scores. The scoring can be seen in Table 3.

Table 3. Score Assessment

Score	Category
4	Very Attractive
3	Attractive
2	Less Attractive
1	Unattractive

The assessment results were then converted according to the statement for the product. The conversion score can be seen in Table 4.

Table 4. Student Response Criteria

Score Quality	Eligibility Criteria	Description
3,26 < x 4.00	Valid	Very Attractive
2.51 < x 3.26	Fairly Valid	Attractive
1.76 < x 2.51	Less Valid	Less Attractive
1.00 < x 1.76	Invalid	Unattractive

Table 2 describes that the score range of 3.27 to 4.00 is categorized as valid. Next, the score range of 2.52 to 3.26 is categorized as sufficiently valid. Next, the score range of 1.77 to 2.51 is categorized as less valid. Finally, the score range of 1.01 to 1.76 is categorized as invalid.

Effectiveness Test

The effectiveness test uses the results of the pretest and posttest. The effect size test was used to determine the effectiveness of the developed product (Hanifah & Putri, 2020) (See figure 3).

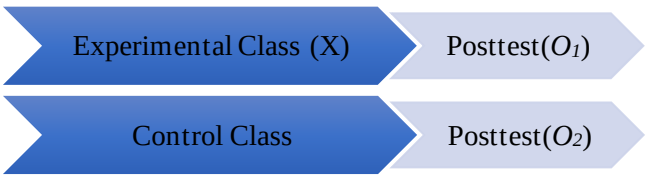


Figure 3. Effectiveness Design Model

Description:
X = Learning using learning media
O1 = The experimental class that will be given a posttest
O2 = The control class that will be given a posttest

The effectiveness level can be calculated using the Effect Size formula according to the Cohen criteria in Hake. The effect size test is used to determine how much influence one variable has on other variables.

$$d = \frac{(M_2 - M_1)}{SD_{Polled}} \quad \text{with} \quad \mathbf{SD_{Polled}} = \sqrt{\frac{SD_1{}^2 + SD_2{}^2}{2}}$$

Description:
d = Effect size
M_1 = Mean score of posttests in the control class
M_2 = Mean score of posttests in the experiment class
SD_{Polled} = Pooled standard deviation
SD_1 = Standard deviation of posttest in the control class
SD_2 = Standard deviation of posttest in the experiment class

The deviation standard (SD) for posttest in the control class and posttest in the experimental class can be found using the following formula:

$$\boldsymbol{SD} = \sqrt{\frac{\sum \boldsymbol{X}^2 - \frac{\sum \boldsymbol{X}^2}{\boldsymbol{N}}}{\boldsymbol{N}}}$$

Description:
$\sum X$ = Students' score
N = The number of students
$\overline{X}$ = $\frac{\sum \boldsymbol{X}}{\boldsymbol{N}}$ = Students' mean scores

The effect Size category is shown in table 5,

Table 5. Category effect size

Score Quality	Feasibility Criteria
d 0.8	High
0.2 < d < 0.8	Moderate
d 0, 2	Low

Based on Table 5, if the score is less than or equal to 0.2, the interactive learning media has low feasibility. The score range of 0.2 to 0.8 means that the interactive learning media has moderate eligibility criteria. A score of more than or equal to 0.8 means that the media has high feasibility criteria.

RESULTS AND DISCUSSION

The Analysis Stage

The analysis stage consisted of needs analysis, curriculum analysis, and analysis of student characteristics (Liana & Leonard, 2016). The analysis was carried out by distributing questionnaires and conducting interviews (Nurrohmah et al., 2018). The results discovered that 96% of respondents needed interactive learning media with the realistic mathematics approach to facilitate distance learning on linear programming material. The curriculum they used was the IQF curriculum. It can be concluded that the students needed learning independence during distance

learning. They needed learning media that can be studied independently and can be reviewed after learning. They need interesting media to attract their interest in learning linear programming. From the analysis results, it was concluded that the researchers should develop interactive learning media with the realistic mathematics approach to linear programming material based on the IQF curriculum. This media was designed to facilitate distance learning to support independent learning. In addition, the interactive learning media with the realistic mathematics approach can assist teachers in explaining the material.

The Design Stage

This stage consisted of media preparation (designing login page, homepage, foreword, learning objectives, materials, practice questions, references, developer profiles, and media). Besides, the researchers planned the teaching materials according to basic competencies and materials from relevant sources. They planned the instruments in the form of expert validation questionnaires (offline using sheets checklist), student response questionnaires (online using Zohoform), and posttests for media effectiveness. The practice questions that used everyday life problems were presented in-story questions. Figure 4 displays practice questions using the realistic mathematics approach.

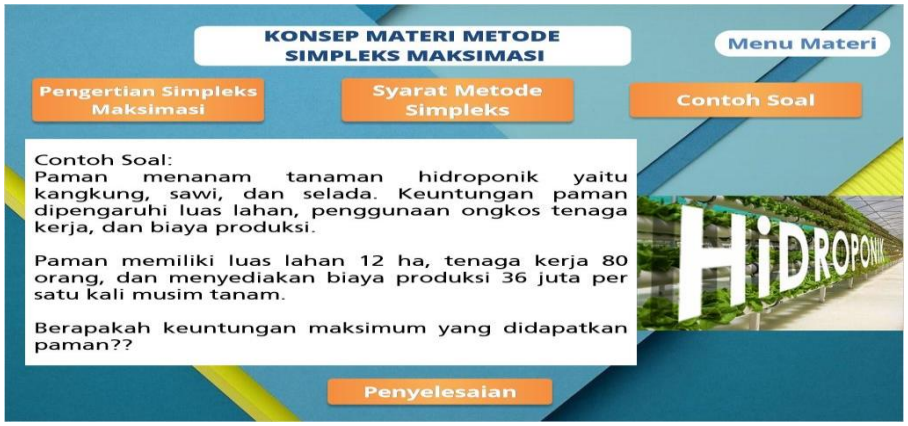


Figure 4. The Display of the Practice Page

After the design stage had been performed, design evaluation was performed by the validators. The validators suggested that the teachers must prepare more practice questions so that the questions can be varied. Figure 5 displays the login page.

Figure 5. The Login Page

The Development Stage

At this stage, the researchers developed media using Articulate Storyline 3. The media consisted of the login page, homepage, foreword, learning objectives, materials, practice questions, references, profiles developers, and media. The media was then validated by three media experts and three material experts. The results of media expert validation are presented in Figure 6.

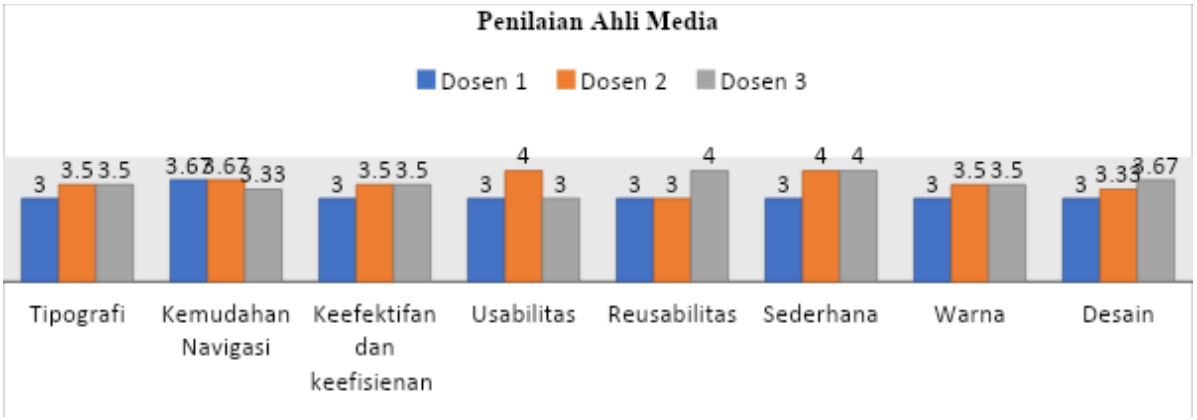


Figure 6. Media Expert Validation Results

Figure 6 shows the results of three media expert validation. The validation consisted of eight aspects of media feasibility. The average score obtained was 3.37 (valid). Therefore, it can be concluded that the interactive learning media can be declared as valid and can be used in the teaching and learning activity after it had been revised based on the experts' notes. The validation results from the material experts can be seen in Figure 7.

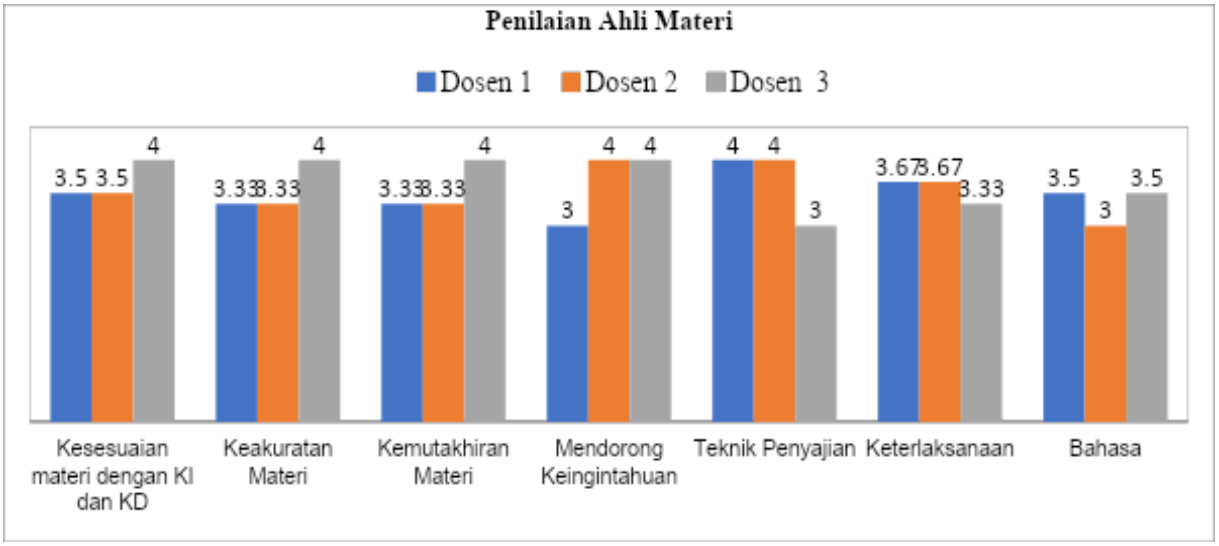


Figure 7. The Results of Material Expert Validation

Figure 7 shows the results of material expert validation by three material experts. The validation consisted of seven aspects. First, the average score obtained was 3.53 (valid). Therefore, It can be concluded that the interactive learning media with the realistic mathematics approach was valid. Next, the product was revised according to the suggestions of media experts and material experts. The revision results are presented in Table 6 and Table 7.

Table 6. The Product Display after Revision based on Media Experts' Suggestion

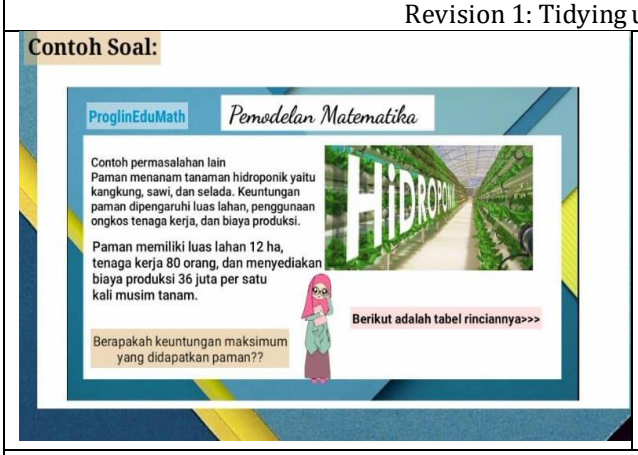
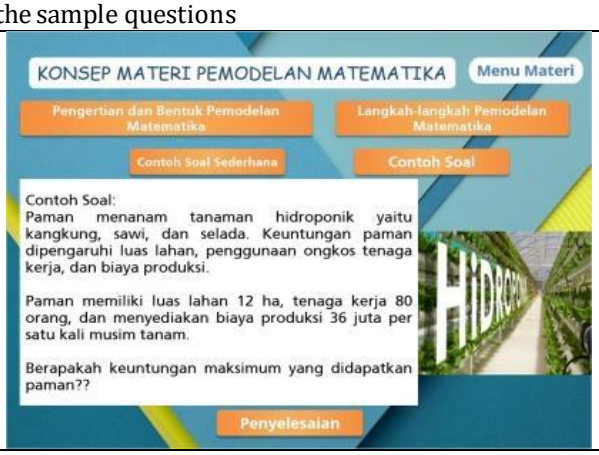
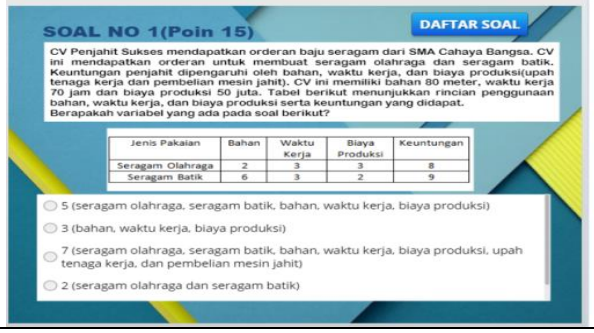
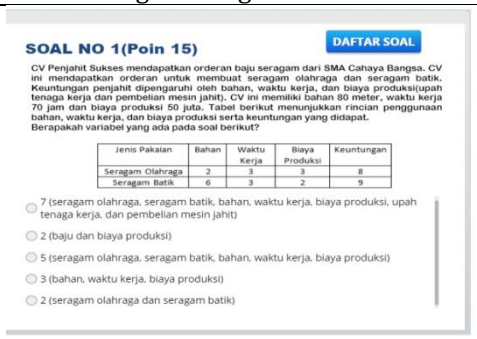
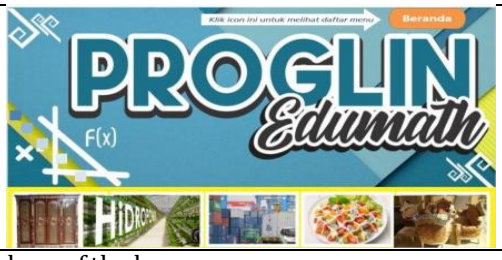
Before Revision	After Revision
	
Revision 1: Tidying up the sample questions	
	
Revision 2: Focusing on the problem and resizing the image.	
	
Revision 3: Changing the practice background to white and increased the answer choices to 5	
	
Revision 4: Cleaning up the slide show of the homepage	

Table 6 displays the revision based on the media expert validation by tidying up the sample questions, focusing on the questions and resizing the image, changing the practice background to white, increasing the answer choices to 5, and tidying up the homepage slide show.

Table 7. The Product Display after Revision based on Material Experts' Suggestion

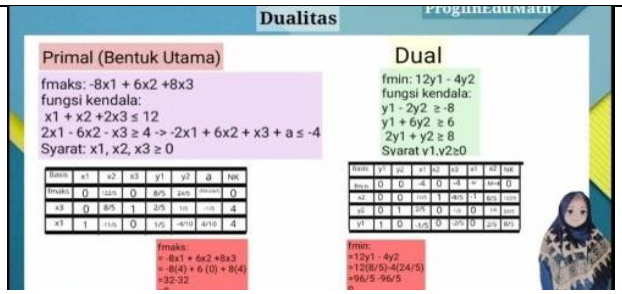
Before Revision	After Revision
	
Revision 1: Changing the word "more" into "least."	
	
Revision 2: Tidying up the sample questions on the concept of the graphic method	
	
Revision 3: Adding instructions and tidying up the variables	

Table 7 describes the revision results based on material experts' validation by changing the word "more "into "least," tidying up the sample questions, adding instructions, and tidying up the variables. After that, an evaluation of the development stages was carried out.

The Implementation Stage

The product's effectiveness and attractiveness were tested in small-scale tests and large-scale tests (Herawati et al., 2020). In addition, the attractiveness data was obtained from students' questionnaire responses. Furthermore, the product effectiveness was analyzed to see the effectiveness of the interactive learning media during the learning activities.

The product attractiveness was tested in the small-scale trial consisting of 15 class D students of the Mathematics Education Study Program of UIN Raden Intan Lampung and in the large-scale trial consisting of 35 class D students of the Mathematics Education Study Program UIN Raden Intan Lampung. The students were given questionnaires to find out the attractiveness of the product. The small-scale trial obtained an average value of 3.52 (very attractive). The result indicated that the developed media was attractive and can be used in linear programming. The large-scale trial obtained an average value of 3.56 (very interesting). The result shows that the product was attractive and can be used when learning linear programming. The average score of the small-scale trial was 3.52, and the large-scale trial was 3.56. Figure 6 shows compare the score between the small-scale trial and the large-scale trial.

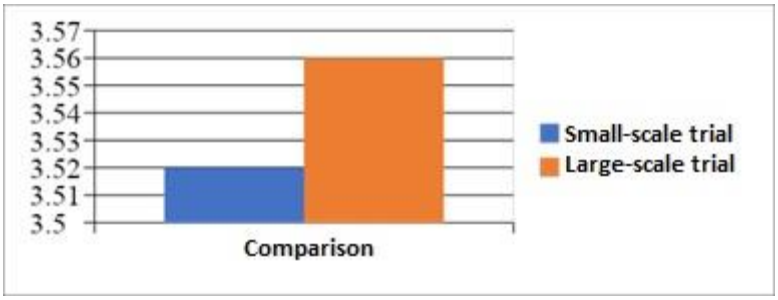


Figure 6. The Comparison between the Small-Scale Trial and the Large-Scale Trial

Figure 6 shows the comparison between small-scale and large-scale trials. The small-scale trial was attended by 15 students with an average feasibility score of 3.53 (very attractive). The large-scale trial was attended by 35 students with an average feasibility score of 3.56 (very attractive). Furthermore, the effectiveness test was conducted to class C as the control class and class A as the experimental class. The Effect Size formula was used to calculate the test. The results of the calculations are shown in Table 8.

Table 8. The Effect Size Calculation Results

Category	N	Average	Standard Deviation	Effect Size
Control Class (C)	32	50.9	61.29	0.43
Experimental Class (A)	32	99, 84	96.53	

Based on the calculation results, the average value of the control class (C) was 50.9, and the average value of the experimental class (A) was 99.84. The standard deviation of the control class (C) was 61.29, and the standard deviation of the experimental class (A) was 96.53. The effect size obtained was 0.43 (moderate category). Therefore, it can be concluded that the interactive learning media with the realistic mathematics approach was effective and can be used during the distance learning of linear programming material.

The Evaluation Stage

The final stage of the ADDIE development research model is the evaluation stage. The researchers evaluated the product based on the validation by the media and material experts and student response questionnaires. The evaluation stage was carried out at each stage of development, and it was stopped after the product had met the valid, attractive, and effective criteria. Finally, the evaluation stage declared that the developed product was valid based on the media expert validation (3.37), material experts' validation (3.53), student questionnaire responses (3.52 in the small-scale trial and 3, 56 in the large-scale trial), and the results of the Effect Size test with a score of 0.43.

The developed digital learning media with the realistic mathematics approach was developed using Articulate Storyline3 software, which did not require a coding process (programming language). It has complete features (login page, homepage, foreword, learning objectives, materials, exercises questions, references, developer profiles, and media). The material in the application is design for one semester. Each material consists of material concepts, learning videos, and practice questions. The learning media has a colorful display to attract students' interest in learning. It is also equipped with trigger buttons, pop-up menus, and animations that make learning media interactive. The backsound openings and instruments are appropriate. The problems and pictures are related to everyday life problems (realistic mathematics approach) so that mathematics learning is more meaningful, and students know the learning objectives of the material. The media can be used to support distance learning or to foster students' learning independence during face-to-face learning.

The developed learning media also contains weaknesses. First, it can only be accessed online. Second, the learning material is limited only to linear programming material. Third, it can only be accessed via laptop.

Previous researchers have developed an animation-based interactive learning media with the media experts validation score of 89.05%, practicality score of 87.95%, and completeness score of 87.50% (Widjayanti et al., 2018). In addition, research on the development of learning media with the realistic mathematics approach can improve students' mathematical problem-solving abilities (Rahman, 2017). The development of learning media to facilitate distance learning has also been carried out by developing iLearning Plus, making it easier for lecturers to convey learning materials without having to meet face-to-face because they are directly connected to the Internet.

CONCLUSION

Based on the research and the discussion, it can be concluded that the developed interactive learning media with the realistic mathematics approach have been developed using the RND method (Research and Development) with the ADDIE development model (analysis, design, development, implementation, and evaluation). This media is made using the Articulate storyline3 without coding (programming language). This learning media can be used as a support for distance. The average score obtained in the media experts validation stage was 3.37 (valid) and in the material expert validation stage was 3.53 (valid). The attractiveness score based on students' responses to the questionnaires during the small-scale trial was 3.52 (very interesting), and the score during the large-scale trial was 3.56 (very interesting). The Effect Size score was 0.43 within the medium category. Based on the research results, it is recommended for further researchers to develop other interactive learning media with different materials and approaches. Furthermore, the developed interactive learning media with the realistic mathematics approach can only be used online using a laptop. Therefore, it is recommended to create learning media that can be accessed offline and using mobile phones.

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