Development of MATLAB GUI-Based Mathematics Learning Media with ADDIE Model to Enhance Students' Mathematical Connection Ability

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Corresponding author:	Abstract
Fikri Haykal Kusuma Putra fikrihaykal0709@gmail.com	Research was conducted to develop learning media using Matlab GUI to enhance students' connection abilities. The aim was to create media containing valid, practical, and effective arithmetic and geometric sequences and series to support mathematical understanding. The study involved 10 randomly selected eleventh-grade students. Data was collected from validation results, tests, and student questionnaires. The research followed the ADDIE model in five stages: analysis, design, development, implementation, and evaluation. Media validation test results showed 86.5% validity, while student use scored 85.67% for practicality. Effectiveness testing revealed an average student score of 85.84%, demonstrating high effectiveness. These findings indicate that the Matlab GUI-based learning media successfully meet valid, effective, and practical criteria for enhancing students' mathematical connection abilities.
Keywords: Learning media; GUI matlab; ADDIE models; Mathematical connections; Sequences and series	

INTRODUCTION

Mathematics is a basic scientific discipline that has a major role in developing understanding, thinking logically, creatively, and critically in pursuing mastery of knowledge and overcoming various obstacles in today's world (Yolanda & Wahyuni, 2020). Thus, mathematics is one of the subjects that makes a significant contribution to the development of students' mathematical abilities. Mathematical connection ability is very closely related to understanding (Isnaeni, et al 2018). This is because students are required to be able to understand and connect various concepts (Sugandi & Bernard, 2018).

Mathematical connection ability is one of the five standard mathematical abilities that must be possessed by students. Rawa, et al (2016) also argue that mathematical connections are important in learning mathematics, including relationships with everyday life to develop students' understanding and abilities. Thus, the importance of having mathematical connection skills is contained in the objectives of learning mathematics in secondary schools, namely: understanding mathematical concepts, explaining the interrelationships between concepts and

applying concepts or algorithms in a flexible, accurate, efficient, and precise way in solving problems (Permatasari & Nuraeni, 2021).

Based on the facts obtained by researchers, this student's mathematical connection ability is one of the abilities that is still considered low in learning at school. This is in accordance with the results of the study by Sulistyaningsih (Pitriyani, et al. 2018) stating that in general students' abilities in mathematical connections are still low, affecting the quality of learning which has an impact on the low achievement of certain students at school. As for the causes of low mathematical connection ability when viewed from the learning process in class, this learning process tends to be teacher centered learning, and students often passively accept in class and learn less. Students have less awareness and sense of responsibility, which causes students to become lazy and don't want to solve problems (Putri & Santosa, 2015).

Another fact was obtained in accordance with Ruspiani's statement (2000) in (Effriyanti, et al 2016) that students' connection abilities are still low, while the average is less than 60 which is an ideal value of 100, namely the relationship between mathematical concepts is approximately 22.2%, the relationship between mathematical concepts and other subjects is approximately 44.9%, and the relationship between mathematical concepts and the problems of everyday life is approximately 37.3%. As for another statement from Isfayani, et al (2018) stated that the results of his research for the mathematical connection abilities of high school students were still low, namely less than 60 on a score of 100 on a percent scale obtained (22.2% in connecting to other subjects, 44% in connecting with other fields of study, and 67.3% in connecting to everyday life). From the two statements above, it shows that the mathematical connection ability of the students obtained is still relatively low when assessed from the three connection indicators.

The use of mathematics software for learning can help solve the problems described above, especially the weak mathematical connection ability of students, namely MATLAB (Matrix Laboratory) which can be used to design learning media. According to Parenduri, (2018) Matlab is a high-level programming language developed by MathWorks and is devoted to numerical computation, visualization and programming. Yulia Fitri et al., (2020) also argues that MATLAB (Matrix Laboratory) is an interactive software application for numerical computation and data visualization. Since Matlab is a high-level programming language, it is easy to use.

Matlab provides a development tool in the form of a graphical user interface (GUI) in which there are choices of buttons, menus, images, text, and other elements that can be changed interactively by the user using a mouse and keyboard (Parinduri, 2018). Matlab was chosen as the foundation because it includes a development tool in the form of a GUI (Graphic User Interface) which makes it easy to design and create media, especially in the form of simulated interactions (Sa'diyah & Buditjahjanto, 2013). Development of a GUI (Graphical User Interface) application in Matlab as a program that can help Matlab users solve math problems more easily. (Dewi & Ananda, 2020).

The use of Mathematics Matrix Laboratory (MATLAB) software for learning, is expected to help high performance for computing engineering problems in a model that is very easy to use where problems and their solutions are expressed in familiar mathematical notation (Apriansyah & Baysha, 2018). The use of MATLAB in learning mathematics is very helpful as a medium in computer-based learning to develop students' mathematical abilities, including prospective mathematics teacher students (Muharani & Riska, 2022).

Matlab development will be successful if it is accompanied by an appropriate, practical, and effective development model. The ADDIE model or better known as (Analysis, Design, Develop, Implement, Evaluate) is a development model that features an easy-to-try and straightforward design process. According to Thim-Mabrey (2006) the ADDIE model is one of the most frequently used models in the field of instructional design guides to produce efficient designs. This research and development approach is more reasonable and comprehensive than the 4D model in terms of product development process (Define, Design, Development, and Disseminate). This model, among others, can be used to create models, learning techniques, learning media, methods, and teaching materials. The approach with the ADDIE model is used to create this learning media, and has the advantage of being more basic, regular, and widely used in creating effective learning programs and materials that have been validated by experts. (Soesilo & Munthe, 2016).

Based on the description above, the authors are encouraged to conduct research that focuses on developing learning media based on the Matlab GUI on arithmetic and geometry sequences and series material for class XI with the ADDIE (Analysis, Design, Develop, Implement, Evaluate) model approach which is valid, practical, and effective to support the mathematical connection ability of class XI high school students.

RESEARCH METHOD

This study uses the ADDIE research model. This is a model that uses problem solving related to learning resources, depending on the needs and characteristics of students. The ADDIE model has five steps or stages that can be applied to product development, namely, Analyze, Design, Development, Implement, and Evaluate. The researcher chose the ADDIE research model aimed at describing the development of valid, practical, and effective GUI-based Matlab media for high school students. As a result, this study aims to develop a learning product that is valid, effective, and practical to support students' mathematical connection abilities using the ADDIE development model as a reference in building media that is effective, dynamic, and supports the performance of the media itself with the advantage that there is an evaluation on each step.

This Matlab GUI-based learning media development research adopts research and development procedures (Research and Development) which refer to the procedure for developing the ADDIE development model. When developing learning media based on the Matlab GUI, the researcher conducted an analysis to obtain data, then the product design stage was followed by the development stage.

After carrying out the development stage, the researcher validated the product with media experts to test the validity of Matlab GUI-based media before trying it out on students. After going through the development stage, the researcher carried out the implementation phase by testing the media to 10 students of class XI SMA for then the product would be evaluated by providing criticism and suggestions for GUI-based Matlab media. The following is the procedure for developing Matlab GUI-based learning media which refers to the ADDIE development model:
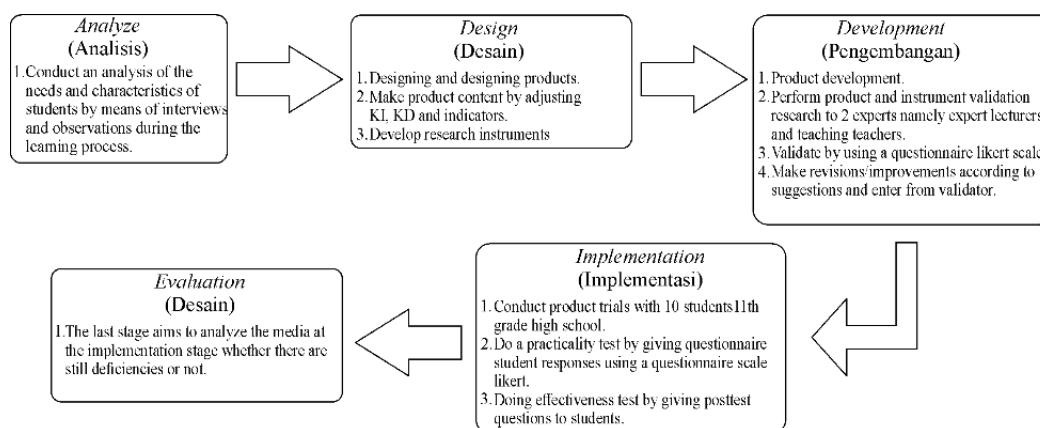

Figure 1. The procedure for developing GUI-based Matlab learning media which refers to the ADDIE development model

The initial step taken by researchers in this research and development is an analysis that aims to obtain information on the needs used in the development of learning media based on the Matlab GUI. Researchers use needs analysis which includes analysis of activities in the mathematics learning process in class and to obtain data about teaching materials needed to make learning media, determine students' needs while they are at school, identify problems in schools leading to the development of problem analysis. While the characteristics of students include problems that students have during the learning process in class. Both of these analyzes were carried out by interviewing and observing students during the learning process in class. This section presents the research results that have been processed in accordance with the data. Presentation of research results can use tables or graphs as a means to explain the results of the study. The results of the research are in line with the problems posed, so that the explanation in this section can be explained through sub-sections.

In the process of developing GUI-based Matlab media, the researcher carried out the validation stage in testing the feasibility of the media, appearance, suitability of the material with basic competencies, and the effectiveness of the language used in the media. The results of the expert validation questionnaire use a Likert scale of four with detailed points on positive and negative questions as follows:

Table 1. Media Validity Likert Scale

Score	Description
4	Very Valid and Decent
3	Valid and Decent

2	Less Valid and Inadequate
1	Invalid and Inadequate

After completing the questionnaire, the number of values obtained will be known, then it will be processed using the following formula:

$$P = \frac{\sum S_h}{K} \times 100\%$$

P $= Percentage\ Gain$

$\sum_k S_h = Total\ score$

k $= Total\ maximum\ score$

The next step is to compare the percentages obtained with the media eligibility criteria, namely:

Table 2. Media Validity Criteria

Achievement Level (%)	Validity Criteria
$80 < VR \leq 100$	Very Valid
$60 < VR \leq 80$	Valid
$40 < VR \leq 60$	Les Valid
$20 < VR \leq 40$	Invalid
$0 < VR \leq 20$	Totally Invalid

RESULTS AND DISCUSSION

Research and development in order to develop learning media based on GUI Matlab for class XI high school students. The description of the results of each step is as follows:

a) Analysis

The results of observations and interviews with teachers are that teachers still use teaching materials in the form of textbooks, PPTs, or student worksheets (LKS) which can cause students to quickly feel bored and bored when receiving learning materials. The response presented was that some students were enthusiastic about learning using the media, but the weakness was that students were still unable to think critically in responding to the lessons given. In addition, students also have different skills in receiving learning material. Likewise in solving problems in mathematics and students are sometimes lazy to study mathematics because it is considered difficult, so students have their own method.

Based on these problems, the researcher developed a mathematics learning media based on the Matlab GUI for learning mathematics material for arithmetic sequences and series and geometry for class XI high school students, where the researcher hopes that this learning media can support students' mathematical connection abilities in learning mathematics material for arithmetic sequences and series and geometry and also makes it easier for teachers to teach in order to make the process of learning mathematics more effective in class.

b) Design

At the design stage, learning media based on the Matlab GUI were designed based on the results of the analysis that had been obtained. Before making the media, the first step is to determine the material to be used in the Matlab GUI-based learning media. The material used is about sequences and series. The next step is to make a flowchart and storyboard. Flowchart is used to determine the flow of the media.
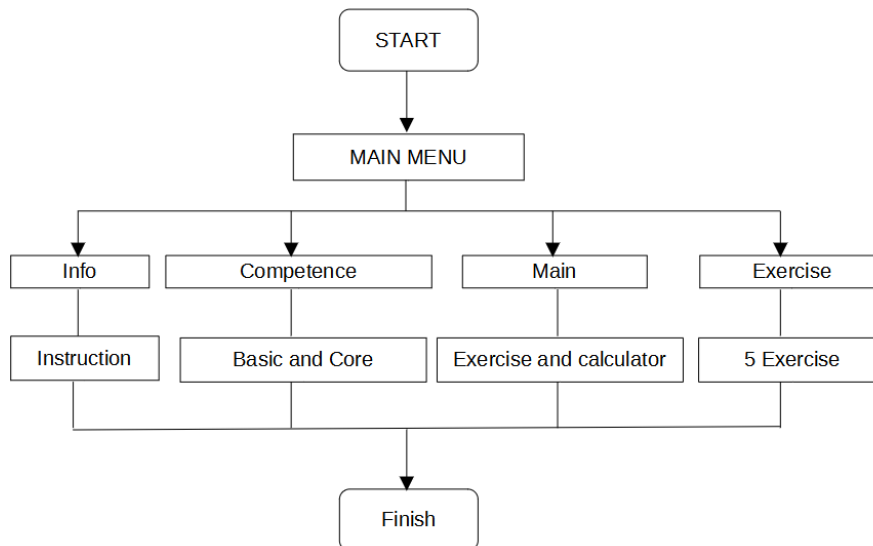

Figure 2. Matlab Learning Media Flowchart

Figure 2. is a flowchart of Matlab GUI-based learning media which explains that when it starts there will be a cover that will go to the main menu. On the main menu there are 4 sub menus namely info, competence, main, practice questions. The info contains instructions for use and button functions, then competencies which contain core competencies, basic competencies, and indicators. For the main part there are questions and a calculator regarding arithmetic and geometric sequences and series, while the practice questions menu has 5 multiple choice questions along with a column for the value of the work done. In addition to the flowchart, there is also a storyboard which contains an overview of the media design to be developed. Storyboards are useful for facilitating the process of developing Matlab learning media.

c) Development

At this stage, namely developing the media according to the design that has been designed. the process of preparing the media starts from the start page of the media, menu, info, competency, main, and exercises.
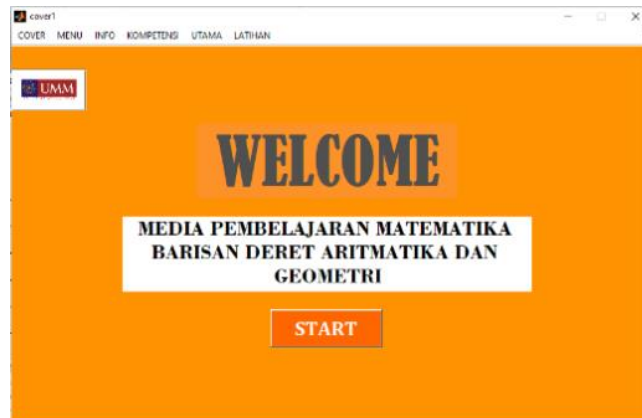
Figure 3. Initial view of the media

In Figure 3, this display is used to enter the learning media entitled Mathematics learning media for arithmetic and geometric sequences by clicking the start button.

Figure 4. Menu display on the media

In Figure 4. the menu display has four menus to choose from, namely the info button, competency button, main button, and training button. In addition there are also additional buttons including the back button which is used to return to the previous page, and the next button which is used to continue to the next page.

Figure 5. Main view

Figure 6. Display of questions and calculators in the arithmetic sequence
section

In Figure 5, the main display has four buttons to choose from, namely the arithmetic sequence button which contains questions and the calculator regarding arithmetic sequences which uses the interrelationships of mathematical ideas. The arithmetic series button contains questions and a calculator regarding arithmetic series which also uses the association of mathematical ideas, can see in Figure 6. Geometry sequence button that contains questions and a calculator regarding geometric sequences that apply mathematical ideas in everyday life. Geometry series button that contains questions and calculators regarding geometric series that use mathematical ideas with other fields of study or science. The four buttons each contain and relate to indicators of students' mathematical connection abilities.

After the learning media has been developed, it is then validated by media expert lecturers and mathematics teachers. The other instruments, namely the validation of posttest questions and student response questionnaires, were also validated by lecturers and teachers of mathematics subjects. Validation was carried out to assess the quality and feasibility of the Matlab learning media that had been developed. The validator provides an assessment, as well as comments and suggestions related to material and media which will later be used as a revision benchmark in improving Matlab learning media. Validation is carried out until the Matlab learning media can be declared feasible so that it can be implemented to students. The following are the results of validation conducted by media experts:

Table 3. Media Validation by Media Experts

No.	Rated aspect	Validator	
		1	2
1.	The background color matches the text color	4	3
2.	Clarity of writing or symbols on Matlab media	4	3
3.	Interesting media display	3	3
4.	Matlab media does not contain negative elements	4	4
5.	Matlab media is equipped with the use of language in accordance with the correct rules	2	3

6.	Media Matlab uses communicative language	3	3
7.	Media Matlab has the use of variations of letters that are not excessive	3	4
8.	Matlab media is not monotonous	3	4
9.	Matlab media is easy to use	4	3
10.	Buttons work fine	3	4
	Total Value	33	34
	Total	69	
	Max Score	80	
	Percentage	86,25%	

Based on Table 2. the results of the validation of media experts and mathematics teachers obtained a percentage of 86.25%. So based on Sugiyono's statement (2016), learning media based on the Matlab GUI are stated to be very valid.

d) Implementation

The media trial was conducted face-to-face with 10 class XI students at LBB English House Mojokerto. This media trial was carried out to find out how the process of student responses to the Matlab GUI-based learning media that had been developed by giving posttest questions to students and giving response questionnaires to students. Students will learn calculators regarding arithmetic and geometric sequences and series using Matlab learning media, after students learn calculators regarding arithmetic and geometric sequences and series students are directed to the question practice menu on learning media, after students have finished working on posttest questions, students are given a response questionnaire regarding matlab learning media.

At this stage a practicality test and an effectiveness test of Matlab learning media were also carried out on the material of arithmetic and geometric sequences and series. Practical tests were carried out by students as research subjects. The purpose of the practical test is to find out the positive response of students to the Matlab learning media. The instrument was in the form of a student response questionnaire by taking the research subject consisting of 10 students. This test gets the following results:

Table 4. Student Response Questionnaire

No.	Respondent	Total Score Respondent	Maximum Score Response
1.	Respondent 1	50	60
2.	Respondent 2	53	60
3.	Respondent 3	53	60
4.	Respondent 4	51	60
5.	Respondent 5	49	60
6.	Respondent 6	51	60
7.	Respondent 7	52	60
8.	Respondent 8	50	60
9.	Respondent 9	52	60
10.	Respondent 10	53	60
	Total Score	514	

Maximum Total Score	600
Percentage	85,67%

Based on Table 3. the results of the percentage of obtaining scores on practical results are 85.67%, the media is said to be practical if it is more than 70%, so based on Saddadi's statement (2019) Matlab learning media is stated to be practical. Next is to test the level of effectiveness of Matlab learning media by giving posttest questions. This test was carried out face to face with 10 students in class XI at LBB. The first step is that students try or use the Matlab learning media to the training section on the media. Furthermore, students are directed to work on the posttest with the help of the media. The purpose of this test is to test the effectiveness of the media used. The instrument was in the form of posttest question sheets by taking research subjects consisting of 10 students. The following is Table 4.3, the results of the test questions based on the aspects measured in the problem of mathematical connection ability.

Table 5. Student Question Test Results Based on the Aspects Measured

No.	Respondent	Rated Aspect			Total Score
		1	2	3	
1.	Respondent 1	4	4	4	12
2.	Respondent 2	4	3	3	10
3.	Respondent 3	4	4	4	12
4.	Respondent 4	4	4	4	12
5.	Respondent 5	4	2	3	9
6.	Respondent 6	4	3	2	9
7.	Respondent 7	4	4	2	10
8.	Respondent 8	4	2	2	8
9.	Respondent 9	4	3	3	10
10	Respondent 10	4	3	4	11
Percentage of Each Aspect		100%	80%	77,5%	
Total number of scores					100
Maximum total score					120
Average Percentage					85,84%

Based on Table 4. the results of the percentage of score acquisition on the effective result is 85.84%, the media is said to be effective if it is more than 75%, so according to Budiarti's statement (2017) Matlab learning media is declared effective.

e) Evaluation

The last stage is evaluation, evaluation is a process to analyze the media at the implementation stage whether there are still deficiencies or not. Matlab learning media in the material of arithmetic and geometric sequences and series has been declared valid, practical, and effective. The following table describes the description of matlab learning media.

Table 6. Description of Matlab Learning Media

No.	Aspect	Score	Description

1.	Media validity	86,5%	Very Valid
2.	Practicality	85,67%	Practical
3.	effectiveness	85,84%	Effective

Based on the feasibility table, it can be concluded that the product developed, namely learning media based on the GUI Matlab on arithmetic and geometric sequences and series materials, has met the predetermined criteria and is very valid, effective, and practical to use in the learning process at school. It can be said that the development of learning media using the Matlab GUI can be done to support learning activities. especially in mathematics learning which includes material on calculations and drawing graphs.

CONCLUSION

The development of learning media based on the GUI Matlab on material for arithmetic and geometric sequences and series using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model has met the valid, practical, and effective categories. Based on the results of validation by media experts, it shows that Matlab learning media is very valid with a percentage of 86.5%. For the practical category, it was obtained from the student response questionnaire which obtained a percentage of 85.67% which stated that the Matlab learning media was practical. The last category is effective, the effectiveness is obtained from the results of student test scores which get a percentage of 85.84% which states that Matlab learning media is effective. Based on the results of the analysis above, it can be concluded that learning media based on the Matlab GUI on arithmetic and geometric sequences and series material is valid, practical, and effective. GUI-based learning media Matlab can be used in the learning process. Suggestions for further research are the deficiencies found in the Matlab GUI-based mathematics learning media which only focus on calculators.

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