



# Optimizing the Use of Matlab GUI Attributes in the Creation of Calculus Learning Media: An Effort to Measure Students' Innovative Attitudes

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## ABSTRACT

### Keywords:

GUI Matlab;  
 Innovative Attitude;  
 Learning Media;  
 Calculus Problems.

Calculus learning requires a high level of visualization in instilling concepts optimally to students. Therefore, the purpose of this study is to look at students' innovative attitudes in developing matlab GUI-based learning media in solving calculus problems and see the influence of the ability to use matlab GUI attributes on the level of innovation of the students in developing learning media. In the early stages, the students developed media according to the given topic. In the second stage, the product was assessed in terms of its validity. The students' innovative attitudes were assessed by a team of experts using questionnaires with 5-point Likert scale. From the 16 media successfully developed, validation results were obtained with an average score of 3.83 which means "valid". Meanwhile, from the assessment of innovative attitudes, the students' attitudes are in the category of "innovative" with an average score of 3.61. In addition, the results of the regression tests revealed that the innovative attitudes are influenced by the ability to use the matlab GUI attributes by 84.2%. The rest is influenced by other factors with similarities:  $\hat{Y} = 0.789X + 0.851$ . Lastly, the results of the assessment showed that the media belonged to the category of "very effective" (score 81.2%).



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## A. INTRODUCTION

Calculus is one of basic courses at higher education institutions. It is commonly used in various fields, especially engineering. Calculus is divided into two parts, differential calculus and integral calculus. Based on the references used in calculus learning in Indonesia, differential calculus materials include real number systems, decimal numbers, rational and irrational numbers, inequality, absolute values, function operations, trigonometric functions, limit theorems, tangent equations, derivatives (algebra and trigonometry) (Ramdani et al., 2021),(Hidayati & Ikasari, 2020). On the other hand, integral calculus materials include anti-derivative, indefinite integral, notation of number and sigma, polygon area, number of Riemann, integral of course, fundamental theorem of calculus, integral substitution technique, partial integral, area of a curve, the volume of objects in the field, volume of rotary objects, and length of a curve.

Some calculus materials such as derivatives and integrals have complex applications in the field of engineering, thus requiring accurate and optimal simulation and visualization media. Therefore, in embedding the concept of calculus, a teacher or lecturer must use assistive

software such as pen tablet (Ario et al., 2020), learning management system (Rifa'i, 2019), flipped classroom (Ario & Asra, 2018), wondershare quiz creator (Sugiharni, 2019), matlab (Santosa et al., 2018), (Syaharuddin et al., 2017), maple (Indrajaya, 2014), adobe flash (Kumalasari & Erika, 2018), and geogebra (Maskar & Dewi, 2020).

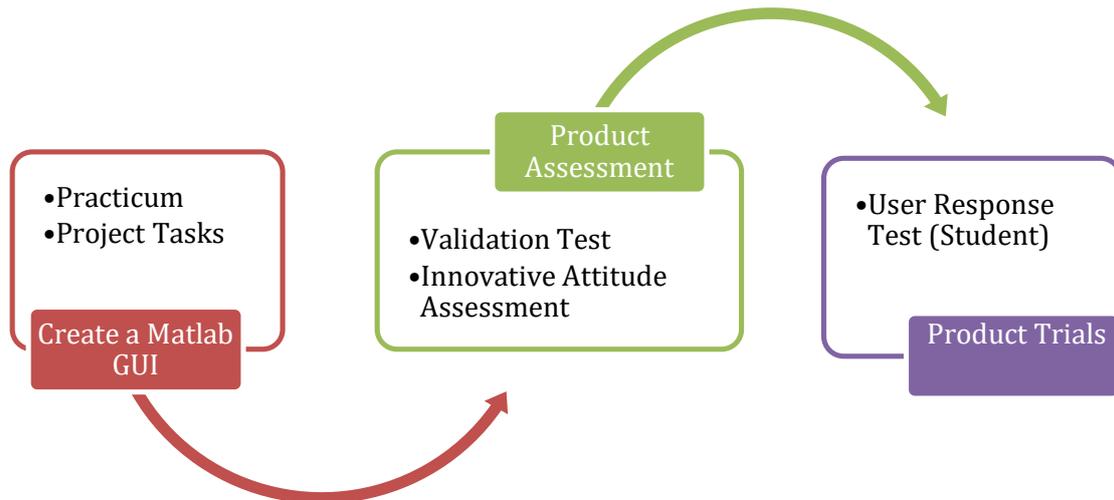
Maple and Matlab software is a fairly popular tool when compared to other software. Maple is a computer program which manipulates symbols that can construct and manipulate algebraic, numerical, and geometric objects (Afgani, 2016). Maple software is commonly employed for simulation and visualization of calculus problems to increase students' learning motivation (Suhandri, 2016), improve mathematical communication skills (Paradesa & Ningsih, 2017), improve students' reasoning and representation (Andriani, 2012), and improve students' understanding of concepts and learning motivation (Lestari, 2014). An effort to improve the understanding of concepts, of course, requires a good and careful visualization method because it will affect the ability of students to solve problems manually and computationally.

Matlab software is slightly different from other software. Because this software has two parts that can be used for simulation or visualization of graphics, namely worksheet and graphical user interface (GUI). The second part called GUI is one of the features built with the development of computational forms and scripts. Users can develop a GUI-based application with adequate and appropriate attributes. The development of the Matlab GUI in calculus learning has been widely done. Majid et al. (2013) have assessed the effectiveness of the use of Matlab software on students' attitudes and motivation towards the use of technology in teaching and learning techniques and their impact on learning. The results of a study by Eyasu et al. (2018) reveal that the use of Matlab software can improve students' conceptual understanding even though their math skills are weak. Godfred et al. (2021) also reveal that spatial-visualization skills correlate with students' problem-solving skills in vector calculus.

The process of visualizing calculus problems is very important. However, the limitations of tools on some software, especially through windows command on Matlab, lead to the need to develop Matlab GUI-based learning media. The development process must be taught early on to students of educational study programs, especially in the field of mathematics who will later teach the concept of limits, derivatives, and integrals at the high school level. Therefore, this study not only teaches the concept of calculus thoroughly but also emphasizes how students can develop independently the marketing media based on GUI Matlab to solve calculus problems. The results of this study are expected to improve students' innovative attitudes in developing learning media and conducting trials on the media they have developed.

## **B. METHODS**

This study employs the mixed-method design. In the early stages, all students participated in practicum activities in the mathematics laboratory. Practicum activities are devoted to the development of calculus learning media, covering introduction to calculus, limit, derivative, and integral according to the final task they get. The development model used is 4D Thiagarajan which is modified to 3D only includes define, design, and development. The second stage was validation tests involving two experts, media or design experts and computer programming experts. In addition, during the process of developing computer programs or learning media, the team of experts assessed students' innovative attitudes towards the use of GUI Matlab attributes as well as the feasibility of the computer program developed. In the last stage, students conducted field tests to see the response of other students to the results of the development that has been done. The research stage is shown in Figure 1.



**Figure 1.** GUI Creation and Assessment Steps.

In the validation stage, the expert team assessed the learning media developed by each student using a five-point Likert scale, consisting of very less good (score 1), less good (score 2), good enough (score 3), good (score 4), and very good (score 5). The number of questionnaires for media experts is 6 statements, while the number of questionnaires for programming experts is 8 statements. The results of the questionnaire are calculated for each score and determined by average to determine the level of validity.

The same team of experts also conducted an innovative level assessment of each student in developing learning media. The assessment of innovative attitudes also uses a five-point Likert scale questionnaire of 10 statements covering aspects of media novelty (2 indicators), aspects of media impact in calculus learning (2 indicators), aspects of ease of application of media (4 indicators), and aspects of media sustainability (2 indicators). The decision as for the indicator of innovative attitude assessment according to Table 1.

**Table 1.** Indicators of student innovative attitude assessment

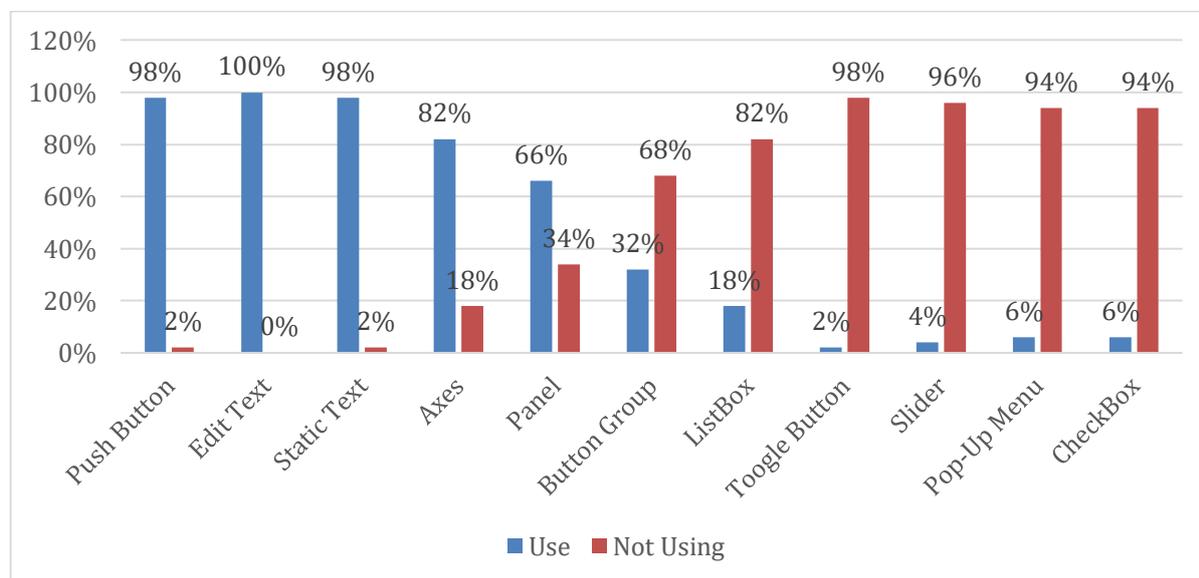
	Aspects	Assessment Indicator
1	Aspects of Media	There are unique things that other media do not have.
2	Novelty	Can be used for simulations and solutions of many sub-materials
3	Aspects of Impact in	Improve students' understanding
4	Calculus Learning	Assist students in solving math problems
5	Aspects of Ease of	Users easily understand their operating flow
6	Media Application	Can be used in general in learning
7		Provide detailed answers and good simulations
8		Easily disseminated/replicated by users (students)
9	Media Sustainability	Can be used for a long period
10	Aspects	Open to further development

## C. RESULT AND DISCUSSION

### 1. Level of use of Matlab GUI attributes in learning media development

Students have developed as many as 4 field focuses from calculus, namely (1) graph concepts and functions as many as 9 GUI, (2) trigonometric concepts as many as 4 GUI, (3) concept limits as much as 1 GUI, (4) derivative concepts as many as 2 GUI, and (5) integral

concepts as many as 2 GUI. Judging from the media that have been developed, students optimally used the attributes of GUI during the development process. Matlab's GUI attributes consist of pushbuttons, edit text, static text, axes, panels, button groups, Listbox, toggle buttons, sliders, pop-up menus, checkboxes, and ActiveX control. Each attribute has a different shape and function. The percentage of use of GUI attributes is shown in Figure 2.



**Figure 2.** Percentage of GUI attribute usage

Figure 2 shows that the three most widely used attributes are "push button", "edit text", and "static text". This indicates that the students have appropriately used attributes in the creation of the media. These three attributes are always used in every creation of application program. Push-button is the execution button of a command or m-file that has been written. Usually, this button is used as many as 3, namely the count, delete, and close the application button. Meanwhile, the edit text and static text are always used in pairs because the static text is used as a label of input (edit text). On the other hand, the "axes" attribute is commonly used for the creation or visualization of function graphics of both 2-dimensional and 3-dimensional functions.

## 2. Assessment of students' innovative products and attitudes

Furthermore, in the validation stage with the expert team, the validation results from media design experts obtained an average of 3.88 which means "valid", while the average from computer programming experts was 3.77 which means "valid". These results show that the learning media developed by the students has been qualified for product trials after making some revisions such as (1) input-output-process layouts which should be separated using group buttons, (2) output table improvements in the case of finding the root of function equations, (3) font sizes that are too small and cannot be viewed remotely, (4) the use of list boxes as an additional attribute to see solutions to problems that are solved, (5) function equations which have not appeared at the top of axes, and (6) the addition of 3D attributes to each application program graph function. Innovative attitudes are judged on students' ability to use GUI attributes and visualizations on each learning medium developed. The results of innovative attitude assessment are presented in Table 2.

**Table 2.** Results of the assessment of students' innovative attitudes

Indicator	Average	Category
Novelty	3.48	Innovative
Impact in Learning	3.53	Innovative
Ease of Application	3.56	Innovative
Sustainability	3.86	Innovative
<b>Average</b>	3.61	Innovative

In addition to student innovative level testing, the researchers also propose the hypothesis that optimal use of GUI attributes affects students' innovative attitudes. To answer this hypothesis, regression tests were performed using JASP software. The results of the tests are presented in Table 3 and Table 4.

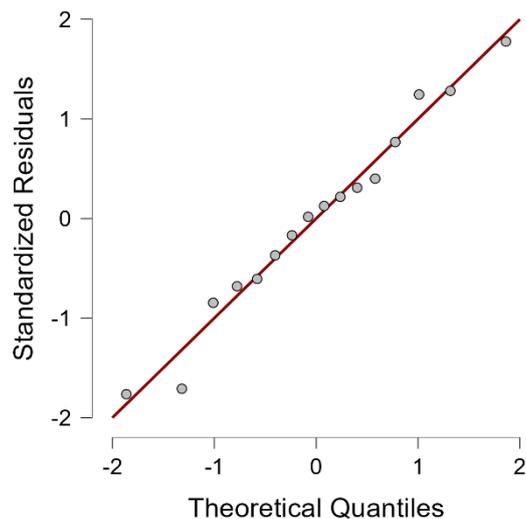
**Table 3.** Model Summary - Y

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	RMSE
H <sub>0</sub>	0.000	0.000	0.000	0.361
H <sub>1</sub>	0.917	0.842	0.830	0.149

**Table 4.** Coefficients

Model	Unstandardized	Standard Error	Standardized	t	p
H <sub>0</sub> (Intercept)	3.725	0.090		41.325	<.001
H <sub>1</sub> (Intercept)	0.851	0.335		2.539	0.024
X	0.789	0.091	0.917	8.627	<.001

Table 3 shows that optimal use of attributes has an influence rate of 84.2% on students' innovative levels, while the remaining 15.8% is influenced by other factors. Next, Table 4 presents a regression equation  $\hat{Y} = 0.789X + 0.851$ . From this equation, the data pattern closely follows the linear lines formed on the graph, as seen in Figure 3. The ability to use attributes cannot be separated from other abilities such as coding in writing scripts and solving calculus problems to be solved. This is in agreement with Sullivan & Melvin (2016) who state that written communication and computer programming are basic skills that must be possessed by all mathematics computing students to solve the given problem correctly. The Matlab GUI is used not only in the completion of basic calculus, but also at the top level as conducted by Tepljakov et al. (2017) who developed the Matlab GUI on fractional-order systems (FOS) as a standalone tool that can be used by students interested in that field. The Matlab GUI is also used in solving vector calculus problems (Lohgheswary et al., 2018) and numeric methods (Bhatti et al., 2016), as shown in Figure 3.



**Figure 3.** Q-Q Plot Standardized Residuals

### 3. Field Trial Results

From the results of the development that has been carried out by students, there are 16 Matlab GUI-based learning media combined in one project. After the expert validation process, then students conduct field trials with other students at the initial level who are studying Calculus. Field trials are conducted by way of presentations related to media usage procedures, simulations of solving calculus problems and ending with media assessments by respondents. Assessment includes aspects of programming, aspects of material content and evaluation questions, and aspects of media display. The results of the assessment showed that the media belonged to the category of "very effective" (score 81.2%). These results were obtained from 40 respondents. Some important points that were improved during the field test were setting the layout of process-input-output attributes, too small graphics, and the use of background colors that lacked variation.

### 4. Obstacles and solutions faced by students

Although it has been statistically shown that the ability of students in developing MATLAB GUI-based learning media is relatively high, in general, the students faced some obstacles. The first is the lack of mastery of basic materials of algebra and geometry. This makes students have to relearn basic theories related to calculus such as drawing function graphs, the concept of trigonometry in determining the area and circumference of triangles. The second is the lack of competence in translating mathematical languages into programming languages, which has an impact on the speed and accuracy of the students in correcting running errors on m-files that have been compiled.

The solution is creating a small group as a form of teamwork and build good communication between team members. This group division was carried out since the beginning of the development to make it easier for students to complete the learning media development. This is part of the general requirements in STEM-based learning (science, technology, engineering, and mathematics) that require small-learning-community (SLC) to facilitate the completion of the given project (Liron & Steinhauer, 2015).

#### D. CONCLUSION AND SUGGESTION

Innovative attitudes are needed in the calculus learning process, especially in the application using Matlab GUI-based learning media. Students have made a good contribution in developing learning media. This is evidenced by the validation of a team of experts with an average score of 3.83 which means "valid". The assessment of innovative attitudes of the students during the development process obtained the category "innovative" with an average score of 3.61 which means "innovative". Furthermore, the results of field tests by looking at aspects of programming, aspects of material content and evaluation questions, and aspects of media display obtained information that these media belong to the category of "very effective" (score 81.2%). This innovative assessment is based on 16 learning media in the field of calculus that have been developed to the fullest. Therefore, the author recommends that future research should use advanced calculus cases with a more optimal level of graph visualization.

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