Development of wolfram mathematica application-assisted learning module on derivative in high school

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Abstract. One of the benefits of studying derivatives is determining the best way to solve a problem. The available textbooks seem monotonous and do not allow students to understand the derivative concepts presented actively. This study aims to develop teaching materials in learning modules in the Function Derivative material assisted Wolfram Mathematica application using the ADDIE development model (Analysis, Design, Development, Implementation, and Evaluation). Data obtained from experts and students were analyzed using descriptive quantitative. Experts assess that the learning module made through the ADDIE stage is very eligible for students. Students also assess that the module is very suitable for use. This research and development still require a further assessment at the evaluation stage with summative types to obtain a maximum final product.

1. Introduction

Derivatives are one of the essential materials in Senior High School. Some of the benefits of studying derivatives are determining the speed and acceleration of an object, determining the slope of a line, determining the best way to solve a problem. The derivative is part of the Calculus, which states the changes of one variable to another variable. Another part of Calculus material is Integral material. There is a relationship between derivative material and Integral material; that is, integrals are the inverse operations of derivatives. Based on the 2013 Curriculum for Senior High Schools, the teacher provides Derivative material before Integral material. So, it is crucial to be able to understand the concept of derivative before studying Integral material.

Learning derivatives should be done with an exciting and fun process because it is a prerequisite for other subjects and teaching materials for high school students. Based on the observations at one of the high schools in Tangerang, the researcher found that one of the reasons for students' difficulty in learning derivatives was the limited use of learning resources by students. The available textbooks seem monotonous and do not allow students to understand the derivative concepts presented actively. So that students become easily bored and less motivated in learning. Thus, students need other media that can be used as additional learning resources to overcome these problems. In this case, the learning module.

One of the six principles of learning mathematics is the use of technology[1]. Technology can be used as a learning tool to practice skills and understand necessary mathematical abilities. Meanwhile, the module is one of the learning media that contains materials and learning methods. It functions to clarify verbal material, overcome space limitations, time, and senses, encourage students to learn
actively, and avoid misunderstandings of a concept [2]. So that in learning mathematics, in this case, the derivative material requires technology-based learning modules. The integration of the use of technology in the module can increase student activity in learning activities. The increasing activity can happen because students do more learning activities. Students listen to what the teacher explains, but there are other activities, such as observing, doing, demonstrating, and others[3].

Computers are a technology product that is used in various fields, including in learning activities. Computer-based technology is divided into two, namely hardware and software. Many computer software can be used as learning media, one of which is the Wolfram Mathematica application. This application is a computer algebra system (CAS) that integrates computing capabilities (symbolic, graphic), visualization (graphics), programming language, and word processing into an easy-to-use environment[4]. Mathematica's systems have great flexibility. Mathematica gives students easy and effective access to many representations of derivative concepts [5]. Mathematica software provides easy and effective access to students to many representations of derivative concepts [5]. Anyone can also use a practical and straightforward programming language without learning programming first [6]. Mathematica can motivate and help students develop essential mathematical concepts and skills needed in their fields [5].

In the literature, several studies examine the use of Wolfram Mathematica software in mathematics learning in the course of Linear Algebra [7-9], material limit Function [6], and specifically derivative materials [5]. Mathematica software seems to be used in college students but not in high school students. In fact, functional derivative material is essential for high school students as the initial foundation for other high school material and other material at higher levels. Besides, it has not yet reached the development of teaching materials in the form of a complete module containing the material and learning steps to measure student learning success in SMA. The module will allow students to learn independently about derivative topics, and students can explore their knowledge with guidance.

Based on previous research that carried out the development of learning modules, the resulting product is valid, useful, attractive, practical, and suitable for use [10-11]. This study aims to present the steps for developing a learning module of derivative material assisted by the Wolfram Mathematica application and check the module's eligibility. Besides, it is also to determine students' responses to the derivative modules assisted by the Wolfram Mathematica application produced.

2. Methods

This research is a type of Research and Development. The model used is the ADDIE model, with stages: Analysis, Design, Development, Implementation, and Evaluation [12,13].

2.1. ADDIE Stages

Visually, the steps in the ADDIE model can be seen in Figure 1.

![Figure 1. Development stage with the ADDIE model [13].](image-url)
2.1.1. Analysis Phase. The activity at this stage is to analyze: 1) the need for teaching materials in derivative material, it turns out that the current one is not by the needs of the target and technology, 2) the literature on teaching materials used currently by students and teachers in the classroom, and 3) towards the mathematics learning curriculum on calculus material in high school class XI which includes Core Competencies (KI) and Basic Competencies (KD) which will later be included in the learning modules that will be made.

2.1.2. Design Phase. This activity is a systematic process that starts from setting learning objectives according to curriculum analysis results in the first stage. After that, designing scenarios or teaching and learning activities, designing learning modules to be made, designing learning materials, and formulating evaluation tools to determine the feasibility of learning modules. This learning module's design will be the basis for the next learning module's development process.

2.1.3. Product Development Stage. The results of the analysis and planning stages become a reference in the development stage. However, apart from the development carried out on instructional media, several evaluation stages were also carried out. Evaluation by material experts, evaluation by media experts, and evaluation by field practitioners are carried out to produce quality prototypes of instructional media. After that, the learning media was tried out on the subject.

2.1.3.1 Development of Learning Media. This stage is the stage of making the learning module developed, consisting of 1) Installing the Wolfram Mathematica application using a Compact Disc. 2) Making a cover containing the module title, and 3) Preparing the subject matter using Ms. Word.

2.1.3.2 Validation and Revision. Experts then validate designed learning modules. The results in the form of suggestions, comments, and input can be used as a basis for analyzing and revising the developed learning modules and as a basis for conducting product trials on students.

2.1.4. Implementation. At this stage, previously developed learning modules were tested in real situations in class. During implementation, the learning module design that has been developed is applied to small groups. The material is delivered following the learning module. After applying the learning module, an initial evaluation is carried out to provide feedback on implementing the next learning module. At this stage, the researcher tested the learning module in small group students to get input as revision material.

2.1.5. Evaluation Phase. The evaluation stage assesses the learning module's eligibility in three aspects: material, language, and interest.

2.2. Technical Data Analysis
According to experts and student responses, data processing in this study obtains information about the learning module's feasibility. The experts consist of material experts, media experts, and learning design experts. The subjects at the trial stage consisted of ten high school students who had studied derivative material. The data obtained through a questionnaire were analyzed using quantitative descriptive techniques.

Experts validate two components of the learning module. The first component is the quality of content and objectives, consisting of three aspects: conformity, accuracy, and completeness. The second component in the form of instructional quality consists of the systematic aspects of presentation, instructional editorial, and instructional interactions. Students evaluate the module from the aspects of language, material, and interests.

The assessment of the learning module on the questionnaire used a Likert scale with the criteria Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD), by giving a score (4, 3, 2, 1) [14]. Table 1 showed the scoring instructions for the questionnaire.
Table 1. Assessment guidelines.

| Score | Criteria          |
|-------|-------------------|
| 4     | Strongly Agree    |
| 3     | Agree             |
| 2     | Disagree          |
| 1     | Strongly Disagree |

Calculation of the average score for each criterion using the formula:

\[
\bar{x} = \frac{\sum x}{n}
\]

Where \(\bar{x}\) represents the average score, \(\sum x\) represents the sum of data, and \(n\) represents the number of data.

Finally, calculate the feasibility of each aspect, with the formula:

\[
P = \frac{\text{Total scores obtained}}{\text{Total score criteria}} \times 100\%
\]

The total score criteria are the highest score for each item times the number of items times the number of respondents. \(P\) is the percentage of eligibility foreache criterion of the learning module. The eligibility criteria are shown in Table 2.

Table 2. Criteria of assessment score guidelines.

| Score Percentage (%) | Interpretation | Explanation |
|-----------------------|----------------|-------------|
| 81 – 100              | Very Eligible  | excellent or ready to be used and does not need revision |
| 61 – 80               | Eligible       | excellent or ready to be used but need to be revised |
| 41 – 60               | Decent         | Enough or usable but need to be revised |
| 21 – 40               | Inadequate     | Weakness and recommended not to be used because of extensive revisions |
| \(\leq 20\)           | Not feasible   | Can not to be used |

(Product development will stop when the assessment score meets the eligibility requirements, both in terms of content quality and objectives and instructional quality.)

3. Results and Discussion
This research and development result is in learning modules on derivative material in high schools assisted by the proper Wolfram Mathematica application. Research and development have using the ADDIE design. Description of the development procedure at each stage as follows:

3.1. Analysis Phase
At this stage, there are three essential activities carried out, namely:
3.1.1. Field Study Analysis. Field studies include conducting interviews with teachers and observing students. In general, students experience difficulties with the Derivative Function material. Learning media can increase student interest and motivation in learning and make it easier for students to understand learning material inside or outside the classroom [16,17], but they feel limited in using it.

3.1.2. Literature Analysis. Literature analysis relates to competencies, fundamental competencies, and learning objectives that must be achieved in the derivative function material following the 2013 curriculum [18]. These literature analysis results are essential competencies, learning objectives, and indicators on functional derivative materials applied to the learning module.

3.1.3. Analysis of Technology Development. Based on the results of literature analysis and field study analysis, at this stage, an analysis of the suitability of the Wolfram Mathematica application is carried out, including its advantages and disadvantages [5,19,20].

3.2. Design Stage
Designing is the second stage of the ADDIE model. Activities carried out at this stage are:

3.2.1. Manuscript Design. The manuscript's design is to prepare learning material that refers to the literature analysis results carried out in the previous stage. The material presented is the derivative of the function, and it steps using the Wolfram Mathematica application.

3.2.2. Module framework design. The activity carried out is to create a module structure or framework that describes the module's contents. Consisting of a cover, introduction, table of contents, introduction, material, formative tests, answer keys, glossary, and bibliography.

3.2.3. Preparation of assessment instruments. The assessment instrument is a learning module validation questionnaire validated by three experts and a student response questionnaire to the learning module. There are two indicators of evaluation materials needed validation by experts, namely: (1) quality of content and objectives from the aspects of conformity, accuracy, and systematic presentation, and (2) instructional quality from the systematic aspect of the presentation, accuracy in using symbols, the accuracy of grammar, legibility material, and clarity of instructions. While the student response questionnaire instrument is based on indicators (1) material, (2) language, and (3) interest.

3.3. Development Stage
This stage consists of two phases.

3.3.1. Development of learning modules. In general, doing derivative learning modules based on Wolfram Mathematica consists of the following stages: installation, making covers, and making materials. An example of the material that has been made is in Figure 2.

Figure 2 contains an example of a material for using the Wolfram Mathematica application and the application steps.
3.3.2. Expert Judgement. This stage is intended to determine the learning module's quality and the shortcomings used as revision material. Three experts carried out the learning module's judgment based on a questionnaire compiled at the design stage. Table 3 shows the results of the content quality validity test and objectives.

| #  | Rated Aspect            | Score | Category     |
|----|-------------------------|-------|--------------|
| 1. | Conformity              | 80    | Eligible     |
| 2. | Accuracy                | 92    | Very Eligible|
| 3. | Completeness            | 92    | Very Eligible|
|    | Overall Rating          | 88    | Very Eligible|

Based on Table 3. The learning module assisted by the Wolfram Mathematica application obtained a very eligible category on the components of content quality and objectives. Suggestions for improvement for the conformity aspect from experts are adding some examples following the concept of the chain rule's material. Meanwhile, for the aspect of accuracy and completeness, there are no revisions. The conformity aspect includes the conformity of the illustration object, the conformity of the sample questions presented, and the exercise's conformity. Aspects of accuracy include the accuracy of the material presented. Meanwhile, the completeness aspect is the completeness of the instructions for completion.

Furthermore, the learning module's evaluation results by experts on instructional quality are shown in Table 4.

| #  | Rated Aspect            | Score | Category     |
|----|-------------------------|-------|--------------|
| 1. | Presentation Systematics| 84    | Very Eligible|
| 2. | Instructional Editors   | 95    | Very Eligible|
| 3. | Instructional Interaction| 88  | Very Eligible|
|    | Overall Rating          | 89    | Very Eligible|
The learning module assisted by the Wolfram Mathematica application also received a very eligible category in the instructional quality component. Experts give very eligible categories on the systematic aspects of presentation, instructional editors, and instructional interactions. This category means that the module is excellent or ready to use and does not need revision. The presentation’s systematic aspect includes the flow of the material presented. The instructional editorial aspect includes redaction of material presentation, grammatical accuracy, and accuracy in using spelling, punctuation, symbols, and mathematical symbols. The last aspect, namely instructional interaction, includes the clarity of the instructions given.

Based on Table 3 and Table 4, the assessment's two components have met the very eligible criteria. Thus, the Wolfram Mathematica application’s learning module can be implemented in the field by incorporating improvements from experts.

3.4. Implementation Stage
The prototype of the development product was tested and used by students. Due to time constraints, the development module is implemented in small groups. After implementing small groups consisting of ten students, they were asked to assess the learning modules that had been developed.

3.5. Evaluation Phase
According to the ADDIE development model, evaluation can be done at each step in the ADDIE model [11]. The results of small group student trials can be seen in Table 5.

| Rated Aspect | Score Acquisition (%) | Category       |
|--------------|------------------------|----------------|
| 1. Material  | 85.63                  | Very Eligible  |
| 2. Language  | 84.17                  | Very Eligible  |
| 3. Interest  | 84.17                  | Very Eligible  |
| Overall Rating | 84.75                | Very Eligible  |

Material aspects consist of clarity of material, examples, and sequence. The language aspect consists of clarity of instructions for use, teaching materials, and illustrations. In comparison, the aspect of interest includes presenting the module that can attract student interest and learning motivation. Based on Table 5, the result of trials in a small group of students was 84.75%, with very eligible criteria. This criterion means that the Wolfram Mathematica application’s learning module is very eligible for students and can be used on a broader scale without the need for revision. The statement follows the results of research conducted by Afrahamiryano and Ariyani [21] that teaching materials are declared valid or suitable for use if they are in accordance with the needs of teaching materials, the substance of the material is clear and precise and can motivate students. In addition, the language used is communicative, clear, consistent, and in accordance with the rules of good and correct Indonesian. This study is also related to the results of research conducted by [7], who concluded that learning using Wolfram Mathematica-based teaching materials in the linear algebra course had achieved good criteria.

4. Conclusions
Researchers can produce a learning module assisted by the Wolfram Mathematica application on derivative material with the ADDIE, Analysis, Design, Development, Implementation, and Evaluation steps. Based on the experts’ judgment from Content Quality and Objectives and Instructional Quality Indicators, it is concluded that the Wolfram Mathematica module's development is suitable for implementing the field. Furthermore, the module is implemented in small groups; it can be concluded that it is very eligible for use. This research and development still require a further assessment at the
evaluation stage with summative types to obtain a maximum final product. Further research is needed
to determine the effectiveness of using modules.

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