

# Development of Web-Based Differential Equation Learning Media

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**Abstract:-** This research have done to describe how the development and results of the development of media defenders distance Differential Equations web based are valid, practical and effective way to improve the learning outcomes of prospective teacher students. This research was conducted using a development research method and involved 80 prospective teacher students of the Mathematics Education Study Program at the Universitas PGRI Banyuwangi who was currently taking Differential Equation courses.

Based on the results of the test, evaluation and revision phases carried out, it was found that the resulting prototype was declared valid by the validator with valid criteria with small and practical revisions , based on the results of the evaluation, it was found that students could access and do all the tasks in learning media, and based on the results of the media effectiveness test, it was found that the student's response to the media developed was very good and based on the test results it was found that 85% of respondents experienced an increase in learning outcomes. Thus the resulting learning media can be declared valid, practical and effective in improving student learning outcomes.

**Keywords:-** *Web-Based Learning; Instructional Media; Differential Equations Courses; R&D; Prospective Teacher Student.*

## I. INTRODUCTION

Effective learning can help students to improve their abilities according to the basic competencies that must be achieved. To improve effective learning methods, it is necessary to pay attention to the internal, external conditions, and the learning strategies and approaches used [9]. Effective learning will be carried out if educators can choose the right learning strategies and models so that maximum results are achieved [1], [4]. Besides that, an important stage in learning activities that must be considered by educators is the selection or determination of appropriate teaching materials in order to help students achieve the desired competencies.

Sources of teaching materials other than books that can be used are teaching materials that are in accordance with the development of science and technology [12]. The development of science and technology has brought changes to learning materials. Dick and Carey in [10], state that there are two types of learning material, namely *written* teaching material and mediated teaching material or also called printed teaching material and non-printed teaching material. Non-printed teaching material is a teaching material developed to enrich students' understanding of the subject matter in addition to filling in deficiencies that arise due to problems of reading culture, limited time and to answer the diversity of learning styles of students.

Computers according to Arsyad [3] as a form of learning media can accommodate students who are slow to receive lessons, because they can provide a more effective climate in a more individual way, never forget, never get bored, are very patient in carrying out instructions such as desire program used. In addition, computers can stimulate students to do exercises, do laboratory activities or simulations because of the availability of animated graphics, colors and music that can add realism [7]. Abstract or imaginative things that are difficult for students to think about can be presented through computer simulations [6], [8]. This of course will further simplify the way students think in understanding mathematics [11].

Differential equation course was one of the compulsory courses for prospective teacher students at Universitas PGRI Banyuwangi. In addition, based on the results of the author's informal interviews with several Universitas PGRI Banyuwangi students who have taken Differential equations courses, information was obtained that this course is a difficult subject, because it only consists of symbols that are not easy to understand. Based on the results of the interview, the authors suspect the reasons why Differential equations courses are said to be difficult, including: learning materials that are too abstract, learning methods that are often used in lectures, so that they are less interactive and unattractive. To solve this learning problem the researcher tries to highlight the aspects of the use of web-based learning media, with the hope that the material is not too abstract and learning becomes more interesting and students can repeat the material that has been given at home and with unlimited time so that understanding and learning outcomes students can increase.

## II. RESEARCH METHODS

### A. Research Procedure

This research is intended to develop learning media as a research product. To develop a product, the type of research used is research and development design (Research and Development) which is often referred to as development research [2]. This is in accordance with the opinion of Sugiono [13], which states that research that produces certain products and tests the effectiveness of these products includes development research. The Instructional media in this study using the steps in solving the problems of education as a frame of reference. Plomp [9] divide steps those actions hierarchically to 5 phase, namely: ( 1) preliminary investigation phase, ( 2) design phase , ( 3) réalisation / construction phase , ( 4) test, evaluation, revision phase and ( 5) implementation Phase.

Based on Plomp's steps [9], the development of learning media is carried out in 4 phases, namely: (1) Initial investigation, (2) Design, (3) Realization / Construction / Production, (4) Test, Evaluation, and Revision. The implementation phase, in terms of implementing solutions developed in problem situations, was not carried out in this study. This is based on the reason that this research is a development research whose orientation is to produce products according to predetermined criteria. To achieve these criteria can be done by testing, evaluation and revision. In addition, this study does not aim to make generalizations, so that the implementation step is considered irrelevant. The activities of each of these phases can be described as follows.

#### 1) Analysis Phase.

It has been explained earlier that the initial assessment phase is a careful observation of the ongoing learning conditions. Activities carried out in this phase include; (1) investigation of prerequisite knowledge, (2) material analysis of intact units, (3) analysis of the conceptual scope of the material and its level of difficulty, (4) investigation of supporting sources, and (5) selecting good material to convey, in terms of difficulty level and can be geometric .

#### 2) Design Phase

The design / design phase contains activities for making web-based learning media based on the results of the initial investigation that the developer has done. The activities covered in the design of the device include;

- (a) Designing the material organization into complete units, based on the quantity, material characteristics and time allocation,
- (b) Mapping relevant learning materials and activities,
- (c) Designing lecture plans (RPS) and web-based learning tools according to the scope of the material

#### 3) Realization / Construction / Production Phase

Plans a design that has been made and having regard to the ongoing implementation then realized to be the prototype

of instructional media. In realizing the learning plan, the activity of designing the material displayed on the teaching material is carried out. Each prototyping should focus on three main characteristics (content, support and interface). Content must consist of chapters, sections, paragraphs, and others. Structure (structure) should be reasonable and flows and constructed of chapters and sections above. Interface (display) contains visual aspects such as images, graphics, colors and others and must be interactive. The material designs displayed include learning materials, sample questions, and evaluation questions (quizzes) and links that can connect with other learning media.

#### 4) Test, Evaluation, Revision Phase

In this phase there are two activities carried out, namely validation and testing in real situations in the field.

##### (a) Validation.

The activities covered in this validation process include;

- Asking experts and practitioners about the feasibility of prototypes that have been made. This assessment uses the validation sheet given to the validator together with the device to be assessed. The validity test conducted is the content validity test and the construct validity test. The validity test is carried out by the validator who is the material and media expert who will examine the content, support, and interface of each prototype. Suggestions - advice obtained from the validator is used to revise and stated that the media produced a valid and practical.
- Analyze the results of the validator's assessment to determine further action.

##### (b) Testing

This trial was conducted to empirically assess the effectiveness of this learning media. This trial needs to be supported by devices that are in accordance with the characteristics of the media and instruments for recording the results of the experiment. Because of that, tools and instruments were also developed. The trial steps are as follows;

- Field trials and recording of trial results using student response questionnaires and test results,
- Analysis of the test results,
- Make decisions based on trial results.

### B. Research Instrument

The instrument developed in the study aims to assess learning, instructional media and their devices. For this reason, instruments were developed which include; (1) learning validation sheets and learning media, (2) student response questionnaires, and (3) teaching material mastery tests. The aspects assessed, the data recorded, the instruments used and the respondents are summarized in the table below.

Rated aspect	Recorded data	Instrument	respondents
Validity and practicality	The validity of learning tools and research instruments	Validation sheet	Experts/ Practitioners
Effectiveness	Mastery of teaching materials	Test	Research subject
	Student response	Response questionnaire	Research subject

Table 1:- Tables of assessed aspects, recorded data and instruments used and respondents

The subjects of this research are prospective teacher students and are in the second year which consists of three classes, namely classes A, B, and C. Trials will be carried out on 15 students in each class with low, medium and low ability levels high.

### III. RESULT AND DISCUSSION

#### A. Result

Based on the research procedures outlined in the previous chapter, which is divided into four stages, namely, 1) initial investigation, 2) design, 3) realization, 4) Test, Evaluation, and Revision. The research results were obtained as follows;

##### A.1. Initial Investigation Phase Realization Phase

Initial investigation into the development of this tool includes four things, namely; (1) investigation of prerequisite knowledge, (2) material analysis of complete units, (3) analysis of the conceptual scope of the material and its level of difficulty and (4) Investigation of supporting sources. The results of the initial investigation carried out on these four matters are as follows:

##### 1. Results of prerequisite knowledge investigations.

In the previous semester, prospective teacher students who were research subjects had attended prerequisite courses including calculus I, Calculus II and Linear algebra. Therefore, in order for adaptation to occur between known knowledge and knowledge to be studied, the presentation of the differential equation material to be discuss, starts with the concept of equations, derivatives and anti-derivatives of a function as well as examples of using knowledge about differential equations in everyday life.

##### 2. The results of the analysis of material units

The material used in this research is ordinary differential equations and their applications and after attending this lecture students are expected to be able to:

1. Understanding Differential Equations
2. Solving Differential Equation problems
3. Solving system problems of Differential Equations
3. Results of the Analysis of the Conceptual Coverage of the Material

The results of the material coverage analysis are as follows;

- a. The differential equation in question includes the first and second order differential equations,
- b. Differential equation problems used in the material are everyday problems that can be solved using the concept of differential equations.

#### 4. Results of investigations of supporting sources

Learning support sources include:

1. Darmawijoyo, (2011). Ordinary Differential Equations an Introduction. Jakarta: Erlangga, [5] and,
2. William E. Boyce, Richard C. DiPrima (2001). Elementary Differential Equations and boundary Value Problems. John Wiley & sons, Inc. New York[14].

##### A.2. Design Phase

The results of this design phase are the Lecture Plan (SAP) and the web-based Learning Media Design. The design of learning steps in SAP contains the design (1) Presentation of Information, (2) student activities that will be displayed on the web as a learning medium for differential equations, (3) determining the web hosting used in web-based learning media ([www.dosen.unibabwi.ac.id](http://www.dosen.unibabwi.ac.id)).

##### A.3. Realization Phase

The designs that have been compiled in the next design phase are realized in order to obtain the initial prototype of the web design. The learning tools produced at this realization stage include:

- 1) Instructional design of the differential equation course includes instructional analysis, and learning reference units.
- 2) Lecture contract
- 3) Lecture handouts in the form of PowerPoint slides,
- 4) Test Sheet,
- 5) Student response questionnaire.

All of learning device that produced in uploaded on the website so that students can access learning tools produced easily.

##### A. 4. Test, Evaluation and Revision Phase

The results of this phase can be divided into two, the results of validation and field trial. Validation results are used to judge the validity of instructional media and media practicality made prior to the implementation of the field trial, whether made of instructional media still needs revision or not. While results Field trials are used to assess the effectiveness of the media produced. The results of field trials become the basis for making decisions, whether the prototype learning media produced is final or still needs revision and retrying.

##### 1. Learning Media Validation Results

The results of the validation of web-based learning media are presented in the table 2 below.

aspect	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_3$
Content eligibility	4	3.5	3
Media presentation	3.3	3.7	3
Language and writing	4	4	3
Useless	3	4	3

Table 2:- Summary of expert validation results

Based on data validation results above, and criteria validity of the set indicates that the media that have been prepared meet the validity criteria for the overall average aspect assessed was 3,42 and this value is included in the category valid with minor revisions .

While the comments of the validator's suggestions about learning media can be seen in the following table 3.

Suggestion	Response
(a) The words used in the indicators are not operational	Suggestions are accepted and editorial changes are made to some of the indicators referred to
(b) There are still some questions that are made to measure indicators that are not appropriate	Suggestions were accepted and changes were made to several items.

Table 3:- The validator's suggestions for learning media and researchers' responses

2. Field Trial Results

The results of this trial are the results of an empirical assessment of the practicality and effectiveness of the resulting learning media. The learning media that was tested was a web-based Differential Equation learning media. The subject that was tested was the Integral topic Differential Equation course.

Field trials were conducted on Wednesday, September 26, 2018. This trial was conducted in the computer lab room of the Universitas PGRI Banyuwangi. Respondents who attended were 45 students and done in two sessions. The first session was attended by 22 students and the second session was attended by 23 students. The first session was held at 7.30 WIB and the second session at 9.30 WIB.

This trial was observed by two observers who were in charge of observing the activities and events that occurred during the trial. And at the end of the session students were asked to work on test questions and fill out the response questionnaire that had been provided. The results of the trials and the results of the analysis carried out were as follows.

a. Practical Learning Media.

The practicality of learning media includes 3 aspects, namely; the implementation of the learning sequence, the ease with which students operate, and the students' completeness in doing the exercises in the prepared learning media. The practicality of the learning media from the trial results is presented in the following table 4.

No.	Rated aspect	Score		
1.	Skills	3.7	3.7	3.3
2.	Presentation of Concepts	3.0	3.7	3.3
3.	Interaction and Communication	2.7	3.7	3.0
4.	Benefits	3	4	3

Table 4:- Result of observations media practicality.

Overall, the average feasibility of web-based learning media that has been compiled is 3,4. So, according to the criteria of practicality that have been set, it can be concluded that the practicality of web-based Differential Equation learning media can be categorized as high.

b. The Effectiveness of Learning Media

The effectiveness of this web-based Differential Equation learning media is calculated using two aspects, namely; (1) mastery of teaching materials using tests and (2) student responses. The results and analysis for each aspect are described below.

(1) Mastery of teaching materials

The results of mastery of teaching materials are determined from the test scores carried out at the end of the trial. Data on mastery of teaching materials can be seen in appendix 10. A summary of the mastery of teaching materials for all respondents is presented in the table 5 below.

	Test Results		Mastery of Teaching Materials
	Before	after	
Class average	57.07	73.44	Increase by 16.37
Standard deviation	7,18	6.56	Decreased 0.62

Table 5:- Recapitulation of mastery of teaching materials

Test Results mastery of the material as seen in the table above shows that all students study subjects had an average 73,44 with a standard deviation of 6.56. This shows that the results of the mastery of the material do not vary relatively. And when compared with the test before the use of web-based learning media there is an increase in mastery of the material. So it can be concluded that the use of web-based learning media can improve student learning outcomes for the better.

(2) Student Response

Student responses in this study can be identified through the results of the questionnaire responses given to the student research subjects. The questionnaire given contains ten statements. Each item is given four answer choices, namely 1, 2, 3, and 4. The meaning of each answer choice it has been described in the development method in the previous chapter. This data was taken in the last 10 minutes during the trial phase. To ensure the objectivity of the student data, it is permissible to not put their identity on the questionnaire sheet.

In addition to answering the questionnaire based on items such questions in the questionnaire, students are also allowed to submit suggestions, comments or impression with how to write suggestions and comments in the box provided a complete response. Summary of student responses to the instructional media made are presented in the following table 6.

Response Aspect	Item number	Average
Ease of access	1,3,4	3.12
Web Appearance	2,5,6	3.15
Benefit	7,8,9,10	3,2

Table 6:- Recapitulation of student responses

The average student response to web-based learning media is more than 3. This shows that the student's response to web-based learning media is in a good category for all aspects.

Based on the test results and the response of students in table above, then tests on a prototype developed, namely instructional media Differential Equations web based has criteria of effectiveness. So, the prototype was declared as a valid, practical and effective media.

#### B. Discussion

Based on the results of the research that has been stated, there are several technical obstacles encountered during the implementation of the research, including (1) there are still many students who can't access web-based learning media, (2) many complaints from students are related to time management in working on quiz questions given online, (3) there are still many students who do not dare to explore all the icons provided by the developer.

During the research goes, the researchers found that: 1) most of prospective teacher students are interested and give a positive response to media web-based learning that have been produce. 2) Developing media that do encourage students to openly admit the difficulties they experienced during learning.

#### IV. CONCLUSSION

Web-based learning in the course differential equations are implemented in the academic year 2018 /2019 has a positive impact on student learning outcomes. If there is a lesson in this subject, besides students getting material in class, students can also access material they have not yet understood outside the classroom and whenever they have the chance.

From the student learning outcomes obtained based on Table 5, it was found that the difference in the average value before the implementation of web-based learning and afterwards. In general, student learning outcomes have increased, this means that web-based learning has a positive impact on student learning outcomes.

#### RECOMMENDATIONS

From the results of the distributed questionnaire, the expected suggestions are to provide a computer that can be used by students at any time if the laboratory is not used for lectures, and the appearance of the blog is changed to an attractive color for students. Meanwhile, from the results of the research, it is hoped that web-based learning can be carried out in courses other than statistical methods alone, can be developed in other subjects.

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