Jurnal Pendidikan Matematika Indonesia
Volum 5 Nomor 1 bulan Maret 2020 Page 10 - 15
p-ISSN: 2477-5967 e-ISSN: 2477-8443

DEVELOPING ICT-BASED CALCULUS LEARNING MEDIA

Tri Hidayati[1)], Ines Heidiani Ikasari[2)]

[1,2)] Department of Informatics Engineering, Faculty of Engineering, Pamulang University

[1)] *E-mail: dosen01385@unpam.ac.id*

[2)]*E-mail: dosen01374@unpam.ac.id*

Abstract. The purpose of this study is to produce information and communication technology/ICT-based calculus learning media that meets the valid, practical, and effective criteria. This type of research is development research. The development model used is the ADDIE model. One of the learning system design models with basic stages of learning system design that is simple and easy to learn is the ADDIE model. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. Validity data was obtained from validation results by material experts, media experts, and user lecturers. While practicality data is obtained from lecturers' decisions, student responses and the implementation of the learning process (lectures). For effectiveness analysis, it is done by determining the percentage of students who reach the minimum high category for the motivation questionnaire and determining the percentage of completeness of students' scores on classical learning achievement tests. Modules will be categorized as valid and practical if each review minimally is considered to the "good" category, whereas it is effective if students who achieve classical completeness of at least 80% for achievement tests and a minimum questionnaire assessment of the "good" category.

Keywords**:** learning Media, ICT, Calculus, ADDIE

I. INTRODUCTION

Calculus is one branch of mathematics that studies problems related to change (Arhami, 2018). This is in line with the science of geometry which studies shapes and algebra that explains operations and their application to solving an equation. In calculus includes systems of numbers, functions, limits, derivatives, integrals and infinite series. Calculus plays an important role in its application in various fields, including civilians, economics, and engineering. Where in calculus is able to solve problems that cannot be solved using elementary algebra. Considering its importance, the calculus is required basic courses at the college level. In the field of Informatics Engineering in particular, by studying calculus, it can boost the students' logical thinking.

Learning is an adjustment process form environmental influence (Pritchard, 2017)The success in achieving learning objectives is strongly influenced by several factors, such as learning strategies, learning methods and approaches, as well as learning resources used both in the form of books, modules, worksheets, and media. The use of media in learning can help educators with limited information and limited class hours. The media functions as a source of information on learning material as well as a source of practice questions.

In our technology-driven world. Its critical and timely to study the intersection between learning and technology (Harasim, 2017). Learning and its media can be created and designed in accordance with current technological developments. One of the ICT-based learning media that can be used is learning media that is operated on smartphone devices with the Android operating system. Currently, the Android operating system is the most popular operating system and it is widely used by the public, especially among students.

ICT (information and communication technology) has enormous potential as a means or tool for developing learning process skills. Mac Kinnon (in Muderawan, 2011) states that technology would help develop all types of thinking skills ranging from the most basic to the level of critical thinking skills. Therefore, in modern education, lecturers are required to be able to integrate ICT in the learning process. Nurchaili (2011) also stated that the use of computers in learning could provide many and varied learning experiences, increase learning motivation and

Jurnal Pendidikan Matematika Indonesia
Volum 5 Nomor 1 bulan Maret 2020 Page 10 - 15
p-ISSN: 2477-5967 e-ISSN: 2477-8443

develop ICT (Information Technology and Computer) skills of students.

The use of ICT (information and communication technology) in the field of mathematics principally adapts to the characteristics of mathematics itself, in which mathematics has characteristics of abstract study objects and requires logical thinking. ICT (information and communication technology) has enormous potential as a means or tool for developing learning process skills. Mac Kinnon (in Muderawan, 2011) stated that technology would help and developed all types of thinking skills ranging from the most basic to the level of critical thinking skills. Therefore, in modern education, lecturers are required to be able to integrate ICT in the learning process.

From the explanation above, it can be seen that there is necessity and urgency to constitute a learning process that involves students actively, so students are able to find and shape their own knowledge by utilizing existing technology as one of the learning media. Therefore, researchers are interested in developing learning media that contains elements of technology, both in the form of tools to dig up information and as a means of information. Teaching materials that developed in this research is an e-modules (Android-based modules). Based on this perspective, the researcher conducted development research on ICT-based calculus learning media with the orientation to enhance student motivation and learning achievement.

ICT (Information and Communication Technology)

According to Abdulhak & Darmawan (2005, p. 413) there is a classification of the use of ICT into three types, namely: first, ICT as an educational media (tool) that is only as a complement to clarify the details conveyed. Second, ICT as a source that is a reference to information and seeking information. Third, ICT as a learning system. Then with the existing ICT (Information Communication and Technology) condition, educators can plan relevant learning strategies for a particular learning topic (Warsita, 2008, p. 150).

Thus, ICT-based learning is learning process that utilize and based on computer and multimedia learning. ICT-based education (Information Communication Technology) is currently growing rapidly in various regions. The demand for interactive media increase, it given the condition that development of information technology is growing rapidly.

Learning Media

Romiszowski (in Hamalik, 2003, p. 201) formulates teaching media ".... as the carries of massages, from some transmitting sources (which may be a human being or an intimate object) to the receiver of the massages (which is our case) is the learner).Meanwhile, according to Djamarah and Zain (in Cicih Juarsih, 2014, p. 41), the media is a tool that can be used as a distributor or messenger to achieve teaching objectives, while learning according to Warsita (2008, p. 85) is an effort or activity to make students study well.

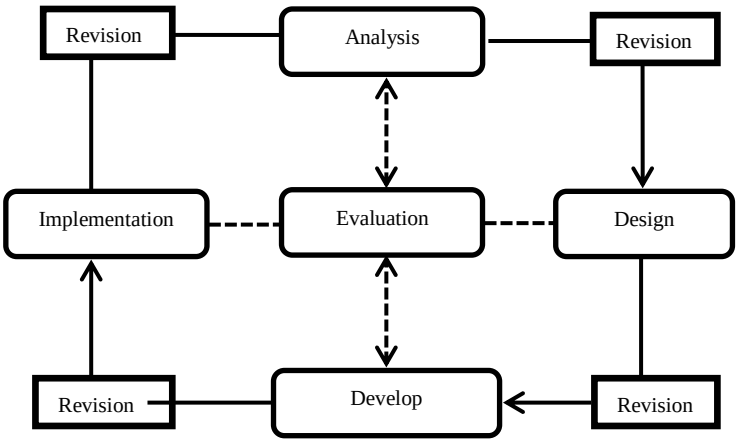
Learning media consists of two important elements, namely, the element of equipment or hardware and the element of the message it carries (software). The element of equipment (hardware) is a means or equipment that is used to present messages. While the message element is information or material or teaching material in a particular learning theme or topic that will be delivered or studied by students. Quoting from Hasnida (2014, p. 35) if you already have two important elements (elements of equipment and elements of messages), then it can be said as a learning medium.

According to Pribadi (2009, p. 125) one of the learning system design models that shows the basic stages of learning system design simply and easily was the ADDIE model. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. ADDIE emerged in the 1990s developed by Reiser and Mollenda. One of the functions of ADDIE is to become a guideline in building effective and dynamic training program tools and supporting the training performance itself.

II. RESEARCH METHOD

a. Types of research

This type of research is development research. The development model used is the ADDIE model. ADDIE is a product development concept. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009, pp. 17–18).



Jurnal Pendidikan Matematika Indonesia
Volum 5 Nomor 1 bulan Maret 2020 Page 10 - 15
p-ISSN: 2477-5967 e-ISSN: 2477-8443

Fig. 1 ADDIE model

b. Development Procedure

The first stage is the analysis phase which includes needs analysis and material analysis. Needs analysis aims to bring up and determine the basic problems faced in calculus learning so that the development of learning media is needed. Material analysis is used to determine the content in lecture units. Material analysis is carried out to detail the content of teaching material in the form of an outline in accordance with the applicable curriculum. The second stage is the design stage namely the formation of the RKPS (Semester Learning Activities Plan) and calculus-based ICT modules, as well as evaluation instruments. The third stage is the development stage, namely the development of e-modules (Android-based modules) in calculus 2 based on expert validation and product revision I. Furthermore, the implementation stage, which is product development, is tested in class and revised stage 2, if it is necessary. The last step is the evaluation stage, which is carried out in an analysis of the practicality and effectiveness of the learning media developed.

c. Test Subjects, Time, and Place of Research

The subjects of the trial in this study were students of Informatics Engineering University of Pamulang semester 2 of 2018/2019 Academic Year. This research was conducted in August-September 2019.

d. Data, Techniques, and Data Collection Instruments

The type of data in this study consists of quantitative and qualitative data. Quantitative data were obtained from the results of expert validation, lecturer ratings, student assessments, observations of learning accomplishments, and achievement tests. Qualitative data were obtained from comments and suggestions on product development, as well as the results of quantitative data conversion. Data collection technique is a test. Data collection ts in this study consisted of (1) validation sheets, (2) lecturer evaluation sheets, (3) student response sheets, (4) observation sheets, and (5) learning achievement tests. The data obtained is used to determine the validity, practicality, effectiveness of the product developed. This is in accordance with the criteria for product quality stated by Niev

e. Data analysis technique

Data analysis techniques used in this study are as follows. Qualitative data in the form of comments and suggestions were analyzed qualitatively, and then it would be used as input to revise the product being developed. Quantitative data in the form of a Likert scale with 5 assessment categories are converted into qualitative data by referring to the formula adapted from Widoyoko (2009, p. 238) in Table 1.

TABLE I
Data Conversion Criteria

Interval Score	Category
$X > \bar{x}_i + 1{,}8SBi$	Very Good
$\bar{x}_i + 0{,}6SBi < X \leq \bar{x}_i + 1{,}8SBi$	Good
$\bar{x}_i - 0{,}6SBi < X \leq \bar{x}_i + 0{,}6SBi$	Pretty Good
$\bar{x}_i - 1{,}8SBi < X \leq \bar{x}_i - 0{,}6SBi$	Enough
$X \leq \bar{x}_i - 1{,}8SBi$	Not Good

Information:

$\bar{x}_i$ = average ideal score = $\frac{1}{2}$ (ideal maximum score + ideal minimum score)

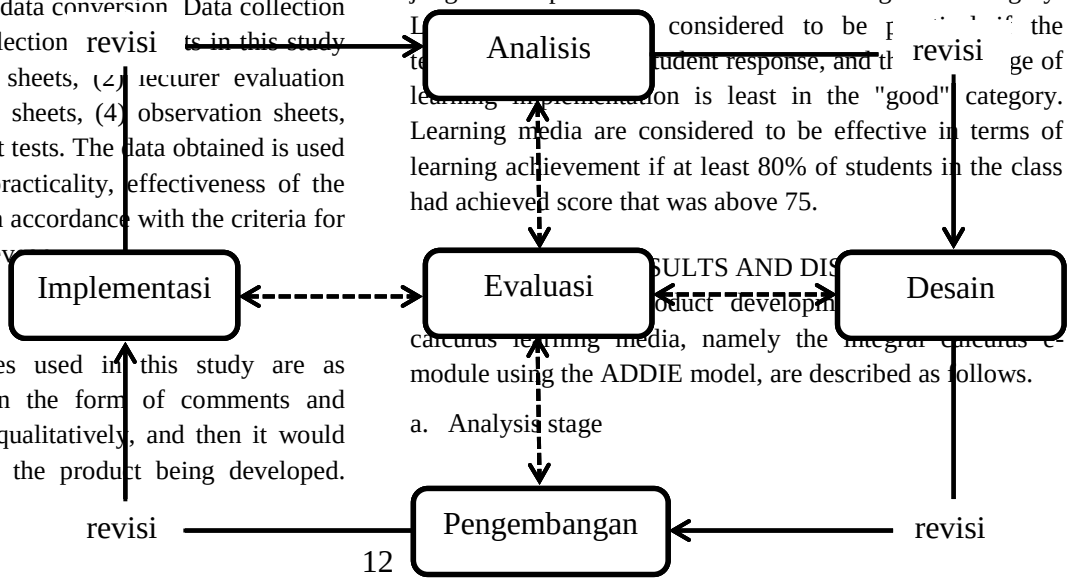
SBi = ideal standard deviation = $\frac{1}{6}$ (ideal maximum score - ideal minimum score)

X = empirical score

Ideal maximum score = number of items criteria x highest score

Ideal minimum score = number of items criteria x lowest score

Data conversion criteria above would be used to determine the categories within validity, practicality and affectivity. The technique of analyzing the effectiveness was reviewed by learning achievement. The effectiveness was determined by the percentage of students' mastery. Learning media was said to be valid if the average of expert judgment/response was least in the "good" category. I considered to be p if the tudent response, and th ge of l ion is least in the "good" category. Learning media are considered to be effective in terms of learning achievement if at least 80% of students in the class had achieved score that was above 75.



SULTS AND DIS
oduct developm
calculus learning media, namely the integral calculus e-module using the ADDIE model, are described as follows.

a. Analysis stage

Jurnal Pendidikan Matematika Indonesia
Volum 5 Nomor 1 bulan Maret 2020 Page 10 - 15
p-ISSN: 2477-5967 e-ISSN: 2477-8443

In terms of the learning process in the classroom, methods, learning resources and ways of teaching need to be renewed. Learning activities are dominated by the lecture method and work on assignments or questions from the lecturer. After students heard and took note the explanations from the lecturer, then the lecturer gave questions to students to reveal students' understanding of the material taught. The existence of technological advances that are so rapid has not been matched by the use of maximum technology in supporting the lecture process. Although every student had used a smartphone, students had not been able to maximize their smartphone to support on-going learning activities. Based on the needs analysis above, it is necessary to develop learning media in the form of modules that can actively involve lecturers as well as students in learning activities. Teaching materials that utilize current technology and that is relevant to students of the Informatics Engineering Department and in accordance with student needs. Based on this analysis, it is necessary to develop an e-module so that students can be more interested in learning calculus while giving opportunity to student to study easily and ubiquitously.

b. Design Stage

The results obtained from the analysis stage both the needs analysis and student analysis were used as the basis for developing learning media. The media developed were initially in the form of printed modules and then validated by 3 expert validators, namely material experts, media experts, and practitioners. The first validation was done by a material expert. Then the module was converted to an e-module then it was validated by media experts and practitioners. Module components compiled include the contents of the material, examples of questions and their solutions, as well as questions for evaluating and testing students' understanding of the calculus 2 lessons.

c. Development Stage

The results of the development stage were an e-module (android applications) that had been validated by experts and had been revised according to input from the validator. The results of the e-module assessment of each validator were presented in Table 2.

TABLE II
The Result of Learning Media Validation

No	Validator	E-Modul	
		Sum of empirical score	**Category**
1	I	56	Very good
2	II	57	Very good
3	III	58	Very good
Summation		**168**	**Very good**
Average		**57**	

Based on these results it is known that the developed e-module meets the valid criteria with excellent categories.

d. Implementation Stage

The results of the implementation stage are the outcomes of the teacher's assessment, the results of student responses, data of the implementation of learning observations, and the results of the learning achievement test.

e. Evaluation Stage

The results of the evaluation stage are the results of an analysis of the practicality and effectiveness of the learning media developed. Lecturer assessment is done by asking lecturers to provide an assessment of e-modules used in learning trials. Assessment is done by filling out a questionnaire that has been made. From the lecturer evaluation, it was obtained an empirical score of 69. This data shows that the practicality of e-modules based on the assessment of lecturers is classified in the excellent category.

The average response of students to e-modules is 77.77 from a maximum score of 90. Based on the results of student assessments, it can be seen that e-modules is considered in excellent category. The results of student assessment for each aspect can be seen in Table III.

TABLE III
The Result of Analysis on Students' Respond on E-module

No	Examination Aspect	Empirical Score	Category
1	Easiness	21,11	Very Good
2	Attractiveness	13,11	Very Good
3	Usefulness	43,54	Very Good
	Total	**77,77**	**Very Good**

The results of observations of the implementation of learning conducted by two observers are presented in Table IV.

TABLE IV
The result of practicality Analysis based on Learning Implementation

Meeting	Learning Process		
	Score	**%**	**Category**
1	28	93,33	Very Good
2	30	100	Very Good
3	30	100	Very Good
4	30	100	Very Good
Sum	**118**	**98,33**	**Very Good**

Jurnal Pendidikan Matematika Indonesia
Volum 5 Nomor 1 bulan Maret 2020 Page 10 - 15
p-ISSN: 2477-5967 e-ISSN: 2477-8443

Based on Table IV, it is known that the average percentage of the implementation of learning is in the very good category with a percentage of 98.33%.

Based on the results of the lecturer assessment analysis, student responses and observational data of learning implementation can be concluded that the learning media developed meet practical criteria for use.

The effectiveness of learning media based on the results of the learning motivation questionnaire is presented in Table V.

TABLE V
Effectiveness Analysis Result Based on Students' Learning Achievement

Respondent	Score	Category	Respondent	Score	Category
1	97	Pass	19	92	Pass
2	90	Pass	20	93	Pass
3	79	Pass	21	94	Pass
4	85	Pass	22	94	Pass
5	97	Pass	23	94	Pass
6	97	Pass	24	80	Pass
7	95	Pass	25	82	Pass
8	94	Pass	26	98	Pass
9	98	Pass	27	50	Not Pass
10	84	Pass	28	90	Pass
11	92	Pass	29	82	Pass
12	89	Pass	30	94	Pass
13	97	Pass	31	88	Pass
14	96	Pass	32	80	Pass
15	83	Pass	33	93	Pass
16	65	Not Pass	34	76	Pass
17	82	Pass	35	84	Pass
18	70	Not Pass			
Average Score					**87,26**
The Number of Students who pass					**32**
classical mastery percentage					**91,43**

Based on Table V, the developed media is considered as effective because the percentage of students' mastery is more than 80%, which is 91.43%. It means that ICT-based calculus learning media is effective in terms of student achievement.

Product Validity

Based on the assessment of experts, ICT-based calculus learning media in the form of e-modules each has fulfilled valid criteria, with very good categories. The e-module has also been revised based on expert suggestions so it is appropriate to use. Learning media set is valid because it was based on relevant theories, in its development

Product Practicality

Based on the field test results, it is known that e-modules have reached the practical category. It can be seen from the results of the lecturer assessment, student responses, and observations of the learning implementation. Based on the results of the lecturer's assessment of the e-module, it can be concluded that the e-module has been considered as practical with very good categories.

Based on the results of student responses, it can be concluded that the e-module is practical with very good categories. Based on observations of the feasibility of learning it can be concluded that e-module is practical with the implementation of learning reaching 98.33%.

Product Effectiveness

Based on field tests that have been carried out, this shows that the ICT-based learning media produced have fulfilled the effective criteria. This can be seen from the student achievement test which shows that more than 80% of students get scores above 75. The percentage of studying mastery is more than 80%. Therefore, it means that the learning objectives have been achieved and products developed are generally considered as effective and it is suitable for use

The use of ICT (information and communication technology), in mathematics, adjusts to the characteristics of mathematics itself, in which mathematics has characteristics of abstract study objects and requires logical thinking. ICT (information and communication technology) has enormous potential as a means or tool for developing learning process skills. Mac Kinnon (in Muderawan, 2011) states that technology will help develop all types of thinking skills ranging from the most basic to the level of critical thinking skills. Therefore, in modern education, lecturers are required to be able to integrate ICT in the learning process.

Mac Kinnon (in Muderawan, 2011) in his book stated that technology would help develop all types of thinking skills ranging from the most basic level to the level of critical thinking skills. Therefore, in modern education, lecturers are required to be able to integrate ICT in the learning process

IV. CONCLUTION

Based on the results of field trials on ICT-based calculus learning media for Informatics Engineering Study Program students, it was concluded that the e-module is considered valid, practical and effective with all of them in the very good category. In further research, it is recommended to utilize ICT as a learning medium in various subjects. Hence, it will not only be implemented in integral calculus courses but also for other subjects.

REFERENCES

Abdulhak, I., & Darmawan, D. (2005). *Teknologi Pendidikan*. Bandung: Remaja Rosda Karya.

Arhami, M., Si, S., & Kom, M. *Kalkulus Untuk Politeknik*. Yogyakarta: Penerbit Andi.

Branch, R. M. (2009). *Instructional design: The ADDIE approach* (Vol. 722). Springer Science & Business Media.

Cicih Juarsih, D. (2014). *Karakteristik Peserta Didik Dalam Rangka Implementasi Standar Proses Pendidian Siswa*. Jakarta: Rineka Cipta.

Hamalik, O. (2003). *Perencanaan pengajaran berdasarkan pendekatan sistem*. Bumi Aksara.

Harasim, L. (2017). *Learning theory and online technologies*. New York: Taylor & Francis.

Hasnida. (2014). *Media Pembelajaran Kreatif*. Jakarta: PT Luxima Metro Media.

Hidayati, T., & Widjajanti, D. B. (2015). Pengembangan Perangkat Pembelajaran Lingkaran SMP Kelas VIII dengan Suplemen Materi History of Mathematics (HOM). *Pythagoras: Jurnal Pendidikan Matematika*, *10*(2), 211-221.

Muderawan, I. W. (2011). Perkembangan Teknologi Informasi dan Komunikasidan Aplikasinya dalam Pembelajaran. *Makalah Disajikan Dalam Seminar Nasional Optimalisasi Pemanfaatan Aplikasi TIdalam Dunia Pendidikan. Jurusan Pendidikan Teknik Informasika. Singaraja*, *20*.

Nurchaili, N. (2011). Pengaruh Media Pembelajaran Berbasis Teknologi Informasi dalam Proses Pembelajaran Kimia terhadap Peningkatan Hasil Belajar Siswa. *Jurnal Pendidikan Dan Kebudayaan*, *16*(6), 648–658.

Pritchard, A. (2017). *Ways of learning: Learning theories for the classroom*. London: Routledge

Pribadi, B. A. (2009). Model desain sistem pembelajaran. *Jakarta: Dian Rakyat*, *35*.

Warsita, B. (2008). Teknologi pembelajaran landasan dan aplikasinya. *Jakarta: Rineka Cipta*, *135*.

Widoyoko, E. P. (2009). *Evaluasi program pembelajaran* (Vol. 91). Yogyakarta: Pustaka Pelajar.