

# ABS 47

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## E-Calculus: Development of Online-Based Calculus Teaching Material

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### ABSTRACT

At the time of the Covid-19 pandemic, online learning became the only alternative learning model that was relevant and safe to implement. Previously, the Indonesian government has also start to direct learning towards an online model. However, one of the problems in the online learning process is the lack of teaching materials availability that can be accessed online, especially quality teaching materials. The shortage of teaching materials is one of the reasons for not optimal online learning in Indonesia at this time. The purpose of this paper is to develop calculus teaching materials based on online learning (e-calculus) to optimize online mathematics learning in calculus material. The e-calculus process of developing uses research and development (R&D) method with stages: 1). data collection; 2). teaching material design; 3). development of teaching materials; 4). tests, evaluations, and revisions; 5). implementation. The results indicate that e-calculus teaching materials are valid, effective and practical so that it can be used as an alternative to online learning teaching materials in Calculus courses.

**Keywords:** Calculus- Online learning, Teaching material

### Introduction

Online learning in Indonesia begin with the Indonesia open and integrated online learning program (PDITT) in 2014 by Budiono, the vice president of the Republic of Indonesia at that time. After that, on September 18 2018 the program changed its name to the online learning system (SPADA) with the aim of improving the quality of online learning and as a means of equitable quality education throughout Indonesia ([www.spada.kemdikbud.go.id](http://www.spada.kemdikbud.go.id), 2019).

SPADA is a program of the Indonesian government through the ministry of education and culture (Kemendikbud) to face the era of the industrial revolution 4.0 in the field of higher education. One of the factors that can optimize the program is by providing teaching materials that can be accessed and used online. Teaching materials are a collection of learning resources that support the learning process in the form of printed or audio-visual

materials. Teaching materials include modules, student worksheets, brochures, videos, pictures, interactive CD, or internet-based teaching materials (Hamdani in Maulidya, et al., 2017).

Technology-based teaching materials reflect the progress of education and bring benefits to the learning process. The use of teaching materials also has a direct effect on the realization of educational goals in the learning process, including making students more interested in the material, more active, can do a lot of exercises according to the quality of individual students, improve learning outcomes, experience contextual learning, provide opportunities to collaborate, critical thinking, and improve problem-solving abilities (Koparan, 2017). Furthermore, internet-based teaching materials can improve students' additional skills including analysis, technology, presentation, and communication (Busljeta, 2013). Based on Lestari (2012), one of the positive effects of <sup>15</sup> the use of teaching materials is that teachers will have <sup>more</sup> time to be able to guide students during the learning process and help students to improve their independent learning skills by acquiring new knowledge from various sources or references on the teaching materials used. As a result, learning will focus on students not only on teachers.

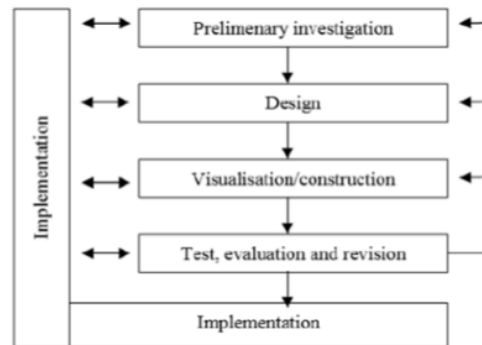
The development of an era that develops internet-based and robotic information technology with the theme of industrial revolution 4.0, the learning process should be carried out anywhere and anytime via the internet (Maskar & Anderha, 2019). Internet users at the youth level currently reach 98 percent, meaning that almost all teenagers in Indonesia can use the internet (Panji dalam Dewi & Sintaro, 2019). The development of electronic-based teaching materials has been carried out before by several researchers, <sup>12</sup> one of which is the development of GeoGebra-based electronic <sup>teaching materials</sup> by Amri (2018) with test results showing

that the teaching material can effectively improve student learning outcomes on integer material compared to conventional models with comparisons mean 70 and 61.43. In addition, teaching materials with the help of flipbooks can also improve problem solving skills with an increase of up to 92.9%. Teaching materials with the help of flipbooks also get good responses based on students' perceptions with a percentage of 74.05% for very good and good statements using the Likert Scale (Rusnilawati & Gustiana, 2017). In addition, electronic teaching materials can also help students with disabilities to learn numbers as is done by Saputra and Febriyanto (2019) by developing multimedia-based teaching materials through an Android application for mentally retarded people about recognizing numbers from 1 to 100 and calculating 1 to 20. The test results showed that students with mental retardation became more enthusiastic and active in learning numbers.

In this paper, the author tries to explain the development of calculus teaching materials that can be accessed online. The teaching material is made using blog media via [www.math-tekno.blogspot.com](http://www.math-tekno.blogspot.com) page. The advantages of this teaching material apart from being accessible online can also be integrated with other relevant media such as links that link material with other relevant sources, videos that can be accessed directly while reading material, simulations on interactive functions using GeoGebra's help, and evaluation interactive online.

### **Materials and Methods**

The method in this study uses a type of <sup>7</sup> research and development (R&D). The R&D research method is used to produce a product by testing the validity, practicality, and effectiveness of the product (Hanafi dalam Hikmah dan Maskar, 2020). <sup>15</sup> The development of teaching materials in this study was carried out by adopting the development of the Plomp model in Ahmar and Rahman (2017) as follows:



*Figure 1. Plomp R&D Research Design*

The following is an explanation of the Plomp R&D research design:

**1. Data collection (case study)**

The first step in developing online teaching materials starts from collecting data about problems in online learning and choosing relevant solutions to overcome these problems so that online learning can run optimally.

**2. Design of Teaching Materials**

The next step is designing teaching materials.. The product standards used to ensure that this teaching material is suitable for use refer to Nieveen's standards in Rusnilawati & Gustiana (2017) which are valid, practical, and effective.

**3. Development of Teaching Materials**

This online calculus teaching material is equipped with interactive media to make it easier for users to simulate calculus material. The material will also be complemented by GeoGebra software, a video linked to YouTube, and online evaluations via online quizzes.

**4. Test, Evaluation, and Revision**

The last stage is content testing. Content testing was carried out by several expert validators including content experts and experts in the field of online learning medi.

Decisions on the feasibility of teaching materials can be implemented according to Widoyoko's standards in Rusnilwati & Gustiana (2017) as follows:

Table 1. Criteria for Feasibility Testing of Teaching Materials

Score	Score Interval	Category
A	$X > \bar{X}_i + 1.8 sb_i$	Very Good
B	$\bar{X}_i + 0.6 sb_i < X \leq \bar{X}_i + 1.8 sb_i$	Good
C	$\bar{X}_i - 0.6 sb_i < X \leq \bar{X}_i + 0.6 sb_i$	Enough
D	$\bar{X}_i - 1.8 sb_i < X \leq \bar{X}_i - 0.6 sb_i$	Less
E	$X \leq \bar{X}_i - 1.8 sb_i$	Very Less

Information:  $\bar{X}_i$  = average ideal score =  $\frac{1}{2}$  (maximum score + minimum score),  $sb_i$  = ideal standard deviation =  $\frac{1}{6}$  (skkor maksimum – skor minimum),  $X$  = actual score. Teaching materials are categorized as feasible if they meet the valid criteria with a minimum category of good quality score.

## Result and Discussion

### Result

There are two research results in this paper including: 1) an overview of e-calculus as an online-based calculus teaching material with the help of GeoGebra; 2) the results of the validity test were carried out by two experts, material experts and online learning media experts

### Overview of E-Calculus

*The beginning of E-Calculus.* This teaching material is developed with online learning standards and contains material descriptions, general objectives (graduate learning outcomes), and specific goals (course learning outcomes). In addition, e-calculus teaching materials also contain a list of references that can be used by students to study Calculus material in depth. The following is the initial view of e-calculus teaching materials:

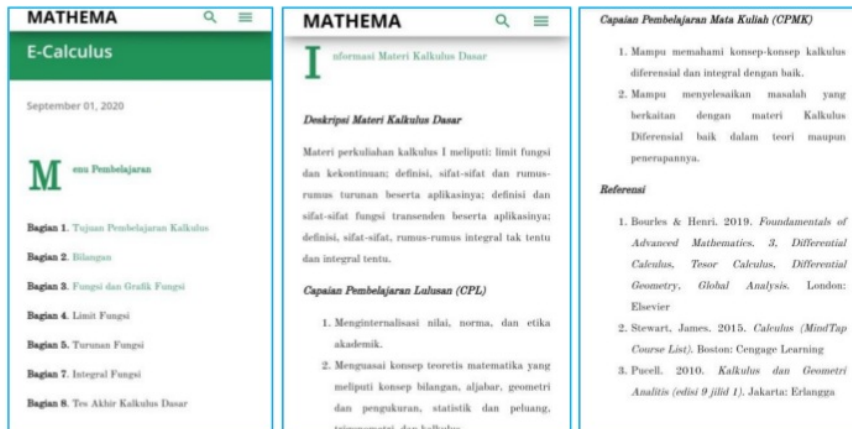


Figure 2. Initial view of E-Calculus

*E-Calculus Content Section.* The content on e-calculus consists of basic calculus materials including; numbers, functions and their graphs, function limits, function derivatives, and function integrals. The delivery of this material on e-calculus, apart from being explained in a descriptive narrative, is also assisted by several interactive media including GeoGebra software in order to describe functions in real time, besides that there are also videos embedded from YouTube so that they can be accessed directly on teaching materials. The video serves to help the narrative explanation so that it is easier for users to understand.

Figure 3 is an overview of how content or content displays on e-calculus.

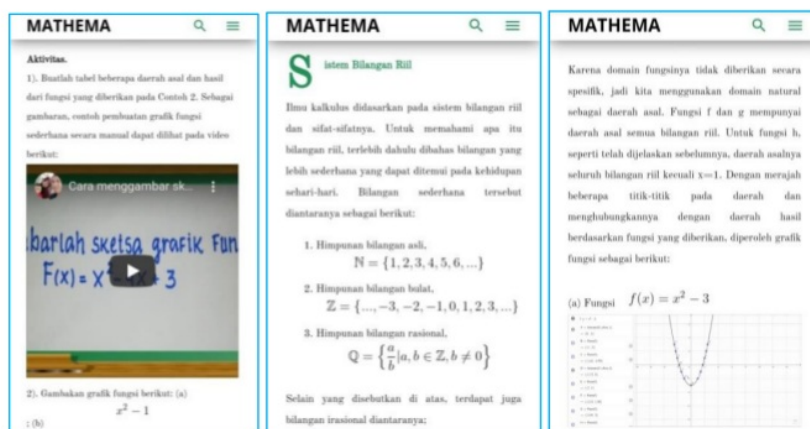


Figure 3. Display of E-Calculus Content

*E-Calculus Evaluation Section.* The last part of this calculus online teaching material is evaluation with the aim of increasing students' understanding and adding experience in solving basic calculus problems. In general, evaluation on e-calculus consists of activities contained in the sub-material to provide experience to students, and exercises per material to test and improve readers' understanding. The following is an overview of the evaluation section on the e-calculus material.

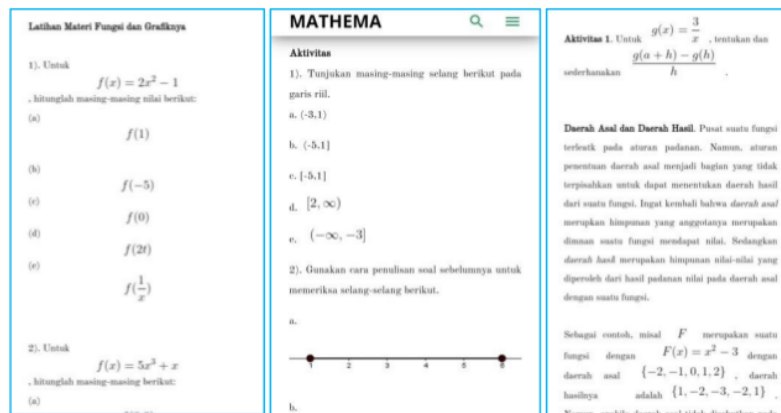


Figure 4. Display of E-Calculus Evaluation

### Validity of E-Calculus

E-Calculus has been tested on material experts and online learning media experts. The test aims to check the validity of e-calculus as a teaching material before it can be implemented in practitioners or students as online-based calculus teaching materials. The validity questionnaire instrument consisted of 18 statements with four assessment indicators among them; material substance, learning design, visual communication display, and media utilization. In addition, there are also two open questions regarding strengths and weaknesses as well as suggestions for improvement or development of e-calculus in the future.

The following is a table of criteria for testing the validity test based on an assessment made by two experts regarding online-based calculus teaching materials:



Table 2. Criteria for Feasibility Testing of E-Calculus Teaching Materials

Score	Score Interval	Category
A	$X > 4.6$	Very Good
B	$4.2 < X \leq 4.6$	Good
C	$3.8 < X \leq 4.2$	Enough
D	$3.4 < X \leq \bar{X}_i - 0.6 sb_i$	Less
E	$X \leq 3.4$	Very Less

The results of the e-calculus validity test based on the results of the two packets test got the actual value =  $X = 4.7$ . This means that based on table 2, the validity of the online-based calculus teaching materials has a very good quality result value. Based on Widoyoko's assessment standards in Rusnilwati & Gustiana (2017), e-calculus teaching materials or online-based calculus teaching materials are considered feasible to be implemented in students to measure their practicality and effectiveness.

Table 3 shows the distribution of e-calculus validity assessments per indicator:

Table 3. Distribution of E-Calculus Validity Scores per Indicator

No	Indicator	Average Score
1	Learning Substance	4.63
2	Learning Design	4.90
3	Visual Communication Display	4.67
4	Media Utilization	4.50
	Average	4.70

Based on table 3, the highest mean lies in the learning design indicator with a mean score of 4.90 and the lowest is on the media utilization indicator with an average score of 4.50. This is the author's attention to make improvements to e-calculus in order to produce a significant effect on improving students' understanding and learning outcomes of calculus. In addition, this revision is also expected to increase the mean score of e-calculus validity.

## Discussion

<sup>20</sup> Based on the results of the validity test, it shows that e-calculus is valid and feasible to be implemented and further testing its practicality and effectiveness. But before that, there are several things that need to be improved in e-calculus based on the assessment of the validation questionnaire that has been filled in by material experts and online learning media. The assessment on the questionnaire with closed statements on the four indicators resulted in several notes, including: 1). e-calculus gets the lowest score on the media utilization indicator. Therefore, it is necessary to improve the use of media by optimizing some parts of the teaching material so that the media can be inserted as a tool to explain the material <sup>14</sup> so that students understand the material more easily. One of the tools that can be optimized is GeoGebra, with the GeoGebra program, abstract geometric objects can be visualized and manipulated quickly, accurately, and efficiently (Mahmudi dalam Japa et al., 2017). In addition, according to Machromah et al. (2018) stated in the results of their research that learning calculus with GeoGebra can make students focus on material, namely integral; 2). an assessment of the material substance indicators also needs to be considered, so there needs to be a deepening of the material on e-calculus. The depth of the material becomes an important element so that the benefits of the material can be felt by students and can be applied in real life. Even though the learning process is carried out online or with blended learning, learning outcomes can still be optimized. Based on research by Ulfa & Puspaningtyas (2019) that the online learning process using the blended learning method is effective in improving concept understanding and can improve student learning outcomes.

Furthermore, based on the results of open-ended questions given by experts who assess e-calculus regarding the strengths, weaknesses, and suggestions of this online-based calculus teaching material, it produces some important notes. Based on calculus material experts, e-calculus teaching materials need improvement in adding content regarding the application of

calculus material in everyday life and its benefits. This is considered very important, considering that the content on e-calculus is a basic calculus that can be used by practitioners of all majors, so it is hoped that this e-calculus can be of great use to practitioners or students in engineering and economics majors. In addition, based on the assessment of online learning media experts, e-calculus needs to experience improvements in terms of online learning design. Media experts suggest that e-calculus can improve the layout of teaching materials to make them simpler and more attractive to practitioners. Considering that e-calculus is an online-based teaching material, media experts suggest giving more media space to the teaching material.

### **Conclusion**

Based on the assessment of two experts, namely calculus material experts and learning media experts, online calculus teaching materials (e-calculus) have very good quality standards with a validity value of 4.67. Based on the results of the questionnaire scores and input from experts, it can be concluded that e-calculus can be further optimized in terms of using interactive media, deepening calculus material, and in learning design.

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