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Development of Derivative and Integral Module as Calculus Lecture Support

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Abstrak

Penelitian ini bertujuan untuk mengetahui pengembangan *modul materi Turunan dan Integral* ditinjau dari tingkat validitas, kepraktisan, efektivitas modul sebagai penunjang perkuliahan mahasiswa prodi Pendidikan Matematika yang dinilai oleh ahli materi dan ahli media serta perbedaan peningkatan kemampuan pemecahan masalah matematis antara kelas yang menggunakan modul Turunan dan Integral dengan kelas yang tidak menggunakan modul Turunan dan Integral. Pengembangan modul Turunan dan Integral yang diperuntukkan untuk mahasiswa prodi Pendidikan Matematika dilakukan melalui beberapa tahap dalam model *Research and Development* (RnD) yang meliputi *research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination and implementation.* Hasil pengembangan modul Turunan dan Integral menunjukkan valid, praktis dan efektif sehingga layak digunakan pada pembelajaran Kalkulus.

Kata kunci: Pengembangan Modul, Kevalidan, Kepraktisan, Keefektifan

Abstract

The purpose of this study was determine the development of the Derivative and Integral material module in terms of the level of validity, practicality, and effectiveness of the module as a lecture support for students of the Mathematics Education study program assessed by material experts and media experts as well as differences in increasing mathematical problem solving abilities between classes using module Derivatives and Integrals with classes that do not use the Derivatives and Integral modules. The development of the Derivative and Integral module which is intended for students of the Mathematics Education study program is carried out through several stages in the Research and Development (RnD) model which includes research and information collecting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revision, operational field testing, final product revision, dissemination and implementation. The results of the development of the Derivative and Integral module show that this module is valid, practical and effective so that it is suitable for use in Calculus learning.

Keywords: Module Development, Validity, Practicality, Effectiveness

1. INTRODUCTION

Many disciplines that rely on calculus especially in science and technology (Hitier, M., & González-Martín, A. S., 2022). Derivative and integral are materials that are given to mathematics prospective teachers in one of university in Bandung. Derivative and integral are divided into several subjects, which are Differential Calculus, Integral Calculus, Multivariable Calculus, Derivative, and Intergral materials given in several courses are Integral Calculus, Multivariable Calculus, Differential Calculus, Highschool Mathematics Selected Topics, and the other subjects that also discuss about derivative and integral with their applications. By giving derivative and integral materials, mathematics prospective teachers are expected to be able to solve problems related to derivative rules to a function, derivative of trigonometric function, and derivative application. Mathematics prospective teachers are also expected to be able to solve problems related to integral, like indefinite integral, definite integral, partial integral, substitution integral, trigonometric function integral, and integral application.

Based on the interview that conducted to several mathematics prospective teachers that had been through the calculus lecture shown that they were facing some difficulties about learning the concept of derivative and integral, specifically about the ability of problem solving, whereas this ability is the basic ability to be able to comprehend mathematics Hence, mathematics prospective teachers should be able to master problem solving ability since it is: (a) general aim of mathematics learning, (b) occupy method, strategy, and procedure which are the core of mathematics curriculum, and (c) basic competency in mathematics learning (Branca, 1980). Anderson (2009) defined problem solving ability as a proficiency of a person in doing interpretation, analysis, prediction, reasoning, evaluating, and output reflection. Moreover, Ulya & Hidayah (2016) defined problem solving ability as an ability to use the known knowledge in a new condition to solve the faced problem. Student that having a good problem solving ability will try to find the most effective way to solve the problem on his/her own (Nengsih et al., 2019).

Difficulties during learning the concept of Derivative and Integral also shown by the Calculus lecture score of 114 3rd semester students in 2021-2022 academic year. There are 68% or more that got grade below 70, which in the category of C and D. C and D grade that most of the students got shown that they were not succeed yet in the learning and had to be improved. The COVID-19 Pandemic also affected learning in Indonesia that forced us to apply online learning. This effect made students face some difficulties, which also stated by Turmuzi (2021), which are unstable internet connection, high consumption of internet quota, and low interaction with the environment. Since learning via virtual meeting has some limits compared to direct learning caused students to do learning activities independently.

Independent learning also has to be supported by module. This argument is also strengthened by Direktorat Jendral Penjaminan Mutu Pendidikan dan Tenaga kependidikan (2008) that said module has to be arranged so learning participant could learn a subject independently. Thus, the use of learning module is expected to support mathematics prospective teachers in independent learning. A learning module should have some characteristics, like it is formed in smallest and complete learning unit, the learning aims that formed are clear and specific so it is possible for mathematics prospective teachers to learn independently, and also contained learning activity channel that arranged systematically (Walid, Ahmad, 2019).

Learning that used module is urgently needed by mathematics prospective teachers in online learning, unexceptionally in derivative and integral materials. Learning supported by module gives a chance for mathematics prospective teachers to learn independently and to improve effectiveness and efficiency in learning activities (Chandra, 2018). Hence, it will be interesting to do a development of module in derivative and integral materials through research method of *Research and Development* (RnD) that adopted from Borg & Gall (1983). To produce a module that gives good

effect, there are several things to be looked after when doing development, such as clear instruction of the use of the module that can be understood by the user, independent, and easy to use (Depdiknas, 2008).

The module will be divided into two types that had been adjusted by the competency aims that will be achieved and also adjustment to mathematics prospective teachers, which are in electronic and printed modules. The advantages of electronic module are could be applied to gadget so it is accessible by mathematics prospective teachers anywhere independently, while one of the advantage of printed module is could be worked out and read directly in the sheets that available in the module (Puspitasari, 2019). Besides of that, the advantage of this derivative and integral module that will be developed is shown on the adjustment of basic ability and competency that will be achieved by mathematics prospective teachers in a university in Bandung. This product is expected to help mathematics prospective teachers in mastering whole derivative and integral materials since derivative and integral materials are the basic for further subjects in mathematics education department. Generally, this module development is expected to give positive effect as a mathematics learning process support, specifically in mathematics education department in one of university in Bandung.

2. METHOD

The method used in this study is *Research and Development* (RnD) with *mixed method embedded design*. The instruments that will be used are judgment expert sheet to identify the module's quality that has been through development process, test to identify the achievement difference of mathematics prospective teachers after using the module, and also mathematics prospective teachers response questionnaire for the module that has been distributed in experiment class.

Development of derivative and integral materials module will be done and produce printed and electronic modules. This method is used to produce and test the quality of the product. This means that the module's quality will be tested through validity, practicality, and effectiveness of the module's usage. To identify validity and practicality, descriptive statistics analysis will be done through the sheet result of judgment expert and also mathematics prospective teachers questionnaire response. Practicality will be tested through *cognitive load theory* data analysis test that will be exposed in the form of descriptive statistics. To identify the achievement difference of mathematics prospective teachers, *control group pretest-posttest design* will be used and the data of N-Gain score will be tested its pre-condition and also through Mann Whitney Test.

This RnD is a necessity analysis that used to produce and to test the quality of the product so it could be used by society. Hence, it is needed to identify the quality of the developed product (Sugiyono, 2010). There are many literatures that written the steps to do RnD. This study will adopt Borg & Gall (1983), where they developed ten steps of model development, which are:

1.1. *Research and information collecting*. This is the preliminary step. This step is done by doing literature study about the problem that will be discussed, preliminary study, necessity measurement, and forming plan to formulate the research framework;

1.2. *Planning*. This step contains research plan arrangement that involves formulation of skill and ability that related to the problem, decides the goal that will be achieved for each step, steps or research design, and if needed, there will be a limited validity test;

1.3. *Develop preliminary form of product*, which is a step to develop the first design of the product that will be developed, which includes support component planning step, make guide and guidebook, and assessment for the supporting instrument validity, e.g.: teaching materials development, learning process, and assessment instrument;

1.4. *Preliminary field testing*, which is preliminary field trial test that will be done in limited scale that only involves one experiment class. Collecting and analyzing data will be done through test of problem solving ability;

1.5. *Main product revision*, is doing a revision based on the preliminary trial test result for the early product or plan that resulted. The revision process is based on the result shown in the limited trial test so the main product draft is ready to be tested through larger scale test obtained;

1.6. *Main field testing*, involves more larger subjects, with 65 mathematics prospective teachers as subjects. The data is collected quantitatively, mainly in the before and after trial test applied. This trial test is resulted as an evaluation through the achievement of trial test result which will be compared with the control group. Hence, experiment research plan is used in this step;

1.7. *Operational product revision*, is perfecting or fixing the product based on the large scale trial test result so the product that developed into operational model design is ready to be tested its validity;

1.8. *Operational field testing*, is a validity test step for the operational model that has been produced. The test will be done through questionnaire for subjects that used the product;

1.9. *Final product revision*, is perfecting the final model that has been developed so the final product can be obtained;

1.10. *Dissemination and implementation*, is a step to distribute the model/product that has been developed to the society, specifically academic civic. The key step is to communicate and to socialize this product in a result research seminar, journal publication, or presentation in a conference.

3. RESULT AND DISCUSSION

Research Result

This study result will discuss about the process and the result of the derivative and integral module development in each development step, which is validity, practicality, and effectiveness, and also the achievement difference of mathematics prospective teachers problem solving ability between the class that used the module and the one that not used.

A. Development Result of Derivative and Integral Module

The development of Derivative and Integral module in this study was through ten steps adopted from Borg & Gall (1983). The earliest step, r*esearch and information collecting*, was done by collecting information through interview and observation on mathematics prospective teachers in one of university in Bandung. The interview and observation results shown that mathematics prospective teachers are facing difficulties in learning derivative and integral concept, that also affected by online learning through virtual meeting. The preliminary study was also conducted that to find and measure mathematics prospective teachers necessity in Calculus lecture support and shown that 85% of mathematics prospective teachers that has obtained Calculus material was really needed a Derivative and Integral module as Calculus lecture support. Literature study was also conducted to complete and to strengthen the preliminary, specifically as a source for the module that will be arranged.

Planning step involved research plan arrangement that included Derivative and Integral module arrangement that has been adjusted for skill and ability of mathematics prospective teachers,

decided achievement in each step, steps or research design, and also limited validity study. The plan that has been made in this study was made a Derivative and Integral module with mathematics prospective teachers that took Calculus lecture as a target based on the preliminary study on mathematics prospective teachers that had done Calculus lecture.

Develop preliminary form of product, was a step to do the early developement of the module based on the data that had been collected, which are materials that will be taught or given to students and also questions about Derivative and Integral material. The module was also arranged and developed through the principles that applied to the module, which in this step is called as draft. The complete module draft that has been created and ready to be tested by the expert was done in this step. This validity test involved 2 experts, which are material and media experts.

Preliminary field testing was done by doing early draft trial test after the draft that has been revised by recommendation of the experts. The test was done in a limited scale that involved 41 students in one experiment class in this study. Data collecting and analysis were done by giving 5 items of problem solving ability test questions.

Main product revision was done based on the early trial test that has been done with 41 students through the early product that has been produced. The revision was done more than once. The revision should be based on the result of the limited trial test so the main Derivative and Integral module product draft was ready and has been adjusted by the recommendation obtained for larger scale test.

Main field testing involved more students, which were 65 students that divided into 2 class which soon will be mentioned as experiment and control class. The data collecting in this step was done by giving pretest and posttest on experiment and control class that differentiated only by the treatment. The experiment class was given treatment through learning supported by Derivative and Integral module, while the control class did not given this treatment. The result that obtained in this trial test was in the form of evaluation of the trial test achievement from the experiment class was better than in control class.

O*perational product revision* was done by doing revision or recompletion of the module trial test result that has been done in the previous step so the developed product was in the form of operational model which ready to be validated.

Operational field testing was a step to do validity test for the developed module of Derivative and Integral. The test was done through questionnaire on experiment class and analysis of the result. This has to be done to determine whether the developed model was ready to be used without the guidance of the module developer.

Final product revision was a final revision process for the developed model that expected to produce the final product. *Dissemination and implementation* was the last step in developing the module by distributing the developed product/model to user widely, mainly to those are in academic civic. This step also concluded the result of the module development which followed by communicating and socializing the development module result of Derivative and Integral in scientific publication on journal publisher.

B. Result of Module's Validity, Practicality, and Effectiveness

1) Validity Result

To determine the validity of the developed module, the details of judgment expert result is shown by Table 1.

Table 1. Validity Result Summary by Media Expert and Material Expert

Validator	Validator Notes	Result
Validator I	• Fix typos • Fix wrong discussion • Adjust the order systematically • There should be challenging question in each chapter • Problem based question should be added more	71,8% (Good/Valid)
Validator II	• Recheck the writings to avoid typo, cite the main source for definition/theorem. • Write down the source for figure that has copyright • Use consistent reference style, such as APA, etc. • Adjust the module with the choosen module structure such as according to Surahman that divided into 4 parts.	87,5% (Very Good/Very Valid)
Validator III	Give number and caption to figures given	92,5% (Very Good/Very Valid)

Revision was done based on notes and recommendations that come from validators. The Derivative and Integral module is ready to be used after the revision was done.

2) Practicality Result

Practicality questionnaire was given to students in experiment class, which were 41 students that had used the Derivative and Integral module in learning process. Table 2 shown the results obtained.

Table 2. Percentage Result of Practicality Questionnaire

No	Aspect	Indicator	Result
1	Attractiveness	User Interface of Derivative and Integral module	79,5% (Good)
		Benefits of of Derivative and Integral module	78% (Good)
		The illustration and writings are attractive, Illustration is fitted with the content of of Derivative and Integral module	82%(Very Good)
2	Material	Clear learning aims of of Derivative and Integral material	78% (Good)
		Question and Material Presentation of Derivative and Integral	77% (Good)
3.	Ease	Derivative and Integral module useful ease	78% (Good)

Table 2. shown that practicality of Derivative and Integral module was on good and very good category which could be implied that Derivative and Integral module has gone through development process that has good and very good practicality.

3) Effectiveness Result

To identify the usage effectiveness of Derivative and Integral module that has been developed was through *Cognitive Load Theory* test. Based on the students result data test that has been distributed on experiment class that involved 41 students shown on Table 3.

Table 3. *Cognitive Load Theory Test Data Analysis*

Type of Test	Completed Students	Percentage of Completed Students
Cognitive Load Theory	36	83%

Table 3. shown that there were 83% of completed students. This indicated that completeness that has been obtained by each student was exceeding the minimum completeness level, which is 75%. It can be inferred that the module that has been developed based on *Cognitive Load Theory* was effective.

C. Mean Difference Test Result

Mean difference test result that was obtained from N-gain of mathematics problem solving ability test of experiment and control class, tested its pre-condition test, and then its mean difference will be analyzed.

1) Normality Test through SPSS 26

Table 4. Normality Data Test Result

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
exp	,158	81	,000	,804	81	,000
ctrl	,343	81	,000	,636	81	,000

1.3.1.1. Lilliefors Significance Correction

Table 4. shown that all of the Sig. value = 0,000 < 0,05 which can be interpreted that those data are not normally distributed.

2) Variance Homogeneity Test through SPSS 26

Table 5. Variance Homogeneity Test Result

	Levene Statistic		df1	df2	Sig.
exp	Based on Mean	1,485	1	79	,227
	Based on Median	,575	1	79	,450
	Based on Median and with adjusted df	,575	1	53,079	,451
	Based on trimmed mean	,802	1	79	,373

Table 5. shown the Test of Homogeneity of Variance through Levene test. The output shown that the value of Sig Based on Mean = 0,227 > 0,05. It can be inferred that both of the data come from the homogent variance.

3) Mean Difference Test through SPSS 26 by Mann Whitney Test since the data were not normally distributed.

Table 6. Mean Difference Test Result

Ranks

	Value	N	Mean Rank	Sum of Ranks
exp_ctrl	exp	41	43,83	1797,00
	kntrl	40	38,10	1524,00
	Total	81		

Test Statistics[a]

	exp_cttrl
Mann-Whitney U	704,000
Wilcoxon W	1524,000
Z	-1,096
Asymp. Sig. (2-tailed)	,273

Rank output shown that the mean rank for control class was 38,10, lesser than mean rank of experiment which was 43,83 (**38,10 < 43,83**). To prove whether there was a mean rank difference between both groups could be done by looking at Table **Test Statistics**.

The output of **Test Statistic** shown that the value of **Sig.2-tailed = 0,273 > 0,05.** which means that **Ho is accepted** and **H_1 is rejected**. It concluded that there were no significant difference of mathematical solving ability between the class that used the Derivative and Integral module and the class that was not using the module.

Research Discussion

Based on research result that has been explained previously, there are several things that need to be discussed, which are development process of Derivative and Integral module, module's validity, module's practicality, module's effectiveness, and the achievement difference of mathematics prospective teachers' problem solving ability after using the module.

1) The development process was going through *Research and Development* (RnD) model steps which involved *research and information collecting, planning, develop preliminary form of product*, *preliminary field testing*, *main product revision*, *main field testing*, *operational product revision*, *operational field testing*, *final product revision*, *dissemination and implementation*. All of the steps were passed so it produced Derivative and Integral module that fitted with competency that will be achieved and also it was fitted to the needs and understanding ability of mathematics prospective teachers as feasible Calculus lecture support.

2) The Derivative and Integral module has very valid level of validity with the whole percentage in 84%. This module is having a high practical value to be used as Calculus lecture support with the whole percentage in 78,75% on practice category, which supported by Firmansyah, R.S, et. al. (2020) that stated by using learning module as teaching materials, learning participants could learn independently, thinking critically for formulating problems in practicum, giving conclusion, and also doing teamwork in group. Also, the Derivative and Integral module was very effective to be used in learning activity that could be shown through percentage of completeness in 83%. This also indicated that students has exceeded the minimum completeness, which was 75%. Hence, it can be inferred that the developed Derivative and Integral module based on *Cognitive Load Theory* was categorized as effective. This also stated by Nuryadi (2017) which said that the development result of mathematics learning media was categorized as effective based on Cognitive Load Theory test.

3) The achievement difference of mathematics problem solving ability based on pretest and posttest data that transformed into N-Gain, it was obtained that the N-Gain Mean Value of the class that

4) used the Derivative and Integral module was 0,65, better than the class that was not using the module which was 0,56. Hence, it can be concluded that the achievement difference of mathematical problem solving ability in experiment class was better than in control class

5) The Mann Whitney test shown that there was insignificant achieved difference of mathematical problem solving ability between mathematics prospective teachers that used Derivative and Integral module and those who were not. It was because of, even though the control class was not given the module, but they were already used Calculus book that greatly helped them in learning Calculus.

4. CONCLUSION

This study concluded that based on the analysis and discussion that have been explained, it shown that the process of developing Derivative and Integral module that has been done through *Research and Development* (RnD) model that involves *research and information collecting, planning, develop preliminary form of product*, *preliminary field testing*, *main product revision*, *main field testing*, *operational product revision*, *operational field testing*, *final product revision*, *dissemination and implementation*. All of the step have been passed well and produce a valid Derivative and Integral module for Calculus lecture. The development of Derivative and Integral module could be stated as valid in very good category, practical value in good category in the aspect of interesting value, good category in material aspect, and also good category in easy access and effective material teaching based on *Cognitive Load Theory*. The achievement difference of mathematics prospective teachers problem solving ability for those who used the Derivative and Integral module and those who are not shown insignificant differenece. However, the achievement difference of mathematics prospective teachers' problem solving ability from the class that used the module is better than the class that is not used it.

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