



Development of Integral Calculus Teaching Materials to Improve Mathematical Reasoning Ability of Mathematics Education Students at HKBP Nommensen Pematangsiantar University

Theresia Monika Siahaan¹; Eva Pratiwi Pane²; Ropinus Sidabutar³;
Golda Novatrasio Sauduran⁴

^{1,2,3}Faculty of Teacher Training and Education, University HKBP Nommensen Pematangsiantar, Indonesia

⁴Faculty of Teacher Training and Education, University HKBP Nommensen Medan, Indonesia

¹Corresponding Email: teresiahaan72@gmail.com, Phone Number: 0853 xxxx xxxx

Article History:

Received: Nov 22, 2022

Revised: Dec 23, 2022

Accepted: Dec 26, 2022

Online First: Jan 02, 2023

Keywords:

Teaching Materials,
Mathematical Reasoning,
Integral Calculus

Kata Kunci:

Bahan Ajar,
Penalaran Matematis,
Kalkulus Integral.

How to cite:

Siahaan, T. M., Pane, E. P., Sidabutar, R., & Sauduran, G. N. (2023). Development of Integral Calculus Teaching Materials to Improve Mathematical Reasoning Ability of Mathematics Education Students at HKBP Nommensen Pematangsiantar University. *Edunesia: Jurnal Ilmiah Pendidikan*, 4(1), 133-145.

This is an open-access article
under the CC-BY-NC-ND license



Abstract: Integral is one of the main subjects in the school mathematics curriculum and is the compulsory subject in the Mathematics Education Study Program at HKBP Nommensen Pematangsiantar University, namely the Integral calculus course. Therefore the status of this material is the subject matter for SMA/MK students and students in mathematics education study programs. This study aims to discover how to develop integral calculus to improve the mathematical reasoning abilities of mathematics education students at HKBP Nommensen Pematangsiantar University. Research on the development of integral calculus teaching materials uses the analysis, design, development, implementation, and evaluation stages. Initial and limited field trials were conducted at the Teaching and Education Faculty (FKIP) HKBP University Nommensen Pematangsiantar. The normality analysis of gain (n-gain) in the experimental student class has increased with an average n-gain value of 0.87. Feasibility of Integral Calculus Teaching Materials Integral Calculus obtained percentage values from experts and subjects studied as follows: (1) Post-test scores reached an average of 83 compared to pretest average scores of 48, there was a significant increase. This shows an increase in learning outcomes after using the results of the product development of Integral Calculus teaching materials. Acquisition of the development value of Integral Calculus Teaching Materials has a high level of attractiveness based on the assessment of material/content experts reaching 93.75%; (2) The acquisition of the value of developing Integral Calculus has a high level of attractiveness based on the assessment of design experts getting 86.53%. Also, the importance of developing Integral Calculus has a high level of beauty based on field test assessments reaching 91%.

Abstrak: Integral merupakan salah satu materi pokok dalam kurikulum matematika sekolah dan sesuai dengan mata kuliah wajib di Program Studi Pendidikan Matematika Universitas HKBP Nommensen Pematangsiantar yaitu mata kuliah kalkulus Integral. Oleh karena itu status materi ini adalah mata pelajaran bagi siswa SMA/MK dan mahasiswa program studi pendidikan matematika. Penelitian ini bertujuan untuk: Untuk mengetahui bagaimana pengembangan kalkulus integral untuk meningkatkan kemampuan penalaran matematis mahasiswa pendidikan matematika di Universitas HKBP Nommensen Pematangsiantar. Penelitian pengembangan bahan ajar kalkulus integral menggunakan tahapan menganalisis, merancang, mengembangkan, menerapkan dan mengevaluasi. Uji coba lapangan awal dan uji coba lapangan terbatas dilakukan di Fakultas Keguruan dan Ilmu Pendidikan (FKIP) Universitas HKBP Nommensen Pematangsiantar. Analisis normalitas gain (n-gain) pada kelas eksperimen siswa mengalami peningkatan dengan rata-rata nilai n-gain sebesar 0,87. Kelayakan Bahan Ajar Kalkulus Integral Kalkulus Integral memperoleh nilai persentase dari ahli dan subjek yang diteliti sebagai berikut: (1) Perolehan skor postes mencapai rata-rata 83 dibandingkan dengan perolehan skor pretes rata-rata 48, ada peningkatan yang signifikan. Hal ini menunjukkan adanya peningkatan hasil belajar setelah menggunakan produk hasil pengembangan bahan ajar Kalkulus Integral. Perolehan nilai pengembangan bahan ajar Kalkulus Integral memiliki tingkat kemenarikan yang tinggi berdasarkan penilaian ahli materi/isi mencapai 93,75%; (2) Perolehan nilai pengembangan Kalkulus Integral memiliki tingkat kemenarikan yang tinggi berdasarkan penilaian ahli desain mencapai 86,53%. Perolehan nilai pengembangan Kalkulus Integral memiliki tingkat kemenarikan yang tinggi berdasarkan penilaian uji lapangan mencapai 91%.

A. Introduction

Mathematics is an essential branch of science taught from elementary school to tertiary level, and it is expected to shape one's personality to become a quality human being (Rosyidah & Ayuwanti, 2019). Education is a process of forming a human mindset that allows it to grow and develop according to its abilities. For educated people in the future to have the capabilities, as stated earlier, an education system oriented towards problem-solving, reasoning, critical thinking, and creative, systematic, and logical thinking is needed. Aminu (in Bien et al., 2019) states that mathematics is the basis of all science and technology. From its simplest to complex forms, mathematics contributes to the development of other sciences and everyday life. This means that learning mathematics must facilitate students to be the ability to connect the material they are studying with problems related to everyday life so that students can apply mathematics in their lives both now and in the future (Siregar et al., 2022). Mathematics is an essential branch of science taught from elementary school to tertiary level, and it is expected to shape one's personality to become a quality human being (Nuraeni, 2018). Education is a process of forming a human mindset that allows it to grow and develop according to its abilities. For educated people in the future to have the capabilities stated earlier, an education system oriented toward problem-solving and the ability to think critically, creatively, systematically, and logically is needed (Bernard & Novtiar, 2022).

Integral is one of the primary materials in the school mathematics curriculum and is the compulsory subject in the Mathematics Education Study Program at HKBP Nommensen Pematangsiantar University, namely the Integral calculus course. Therefore the status of this material is the subject matter for SMA/MK students and students in mathematics education study programs (Maskar & Dewi, 2020). The topic of integrals is the primary material to support other courses and will impact mastery or understanding of the material in other classes, such as numerical methods, fundamental analysis, differential equations, analytical geometry, and others. For students, mastering this material also helps make it easier to understand other materials, such as proving the area of a plane and the volume of a rotating object and its application in the fields of physics and economics (Listiana et al., 2020). Thus the mastery of concepts, reasoning, and problem-solving must be sought as early as possible. But the reality in the field so far is that researchers have observed that as lecturers in integral calculus courses, students are passive in solving the questions given. Students must be more optimal in developing their reasoning abilities (Listiana et al., 2020). Many students need to remember the primary material related to basic mathematics. As an initial test for previous students, the researcher gave an initial ability test regarding mathematical knowledge (Meilasari, 2020).

The results obtained were still far from expectations. Researchers suspect that this happens because students are not used to the processes carried out in class. So far, many students have been spoiled by material intake from lecturers (Rosyadi, 2018). Once they arrive at concepts that must link with other materials, students need to be used to recalling the basic principles that build understanding (Harahap et al., 2022). Therefore researchers try to familiarize students from an early age to be able to develop and connect old knowledge with related material.

One of the processes that researchers carry out is to train students to understand theoretical concepts with real applications in real-life contexts. Mathematical objects in integral material, especially area, are a collection of facts, ideas, operations, and principles

that students must master (Franita et al., 2020). Mastery of integral material with a high level of reasoning will make it easier for students to apply the concepts in calculus courses. The goal to be achieved after students study integrals is to organize a critical, logical, and systematic scientific mindset. Trained reasoning abilities will assist in designing mathematical models (Rosyidah et al., 2021). Mathematical reasoning is essential for doing program verification or checking and inference in an artificial intelligence system. Solving every math problem requires reasoning skills (Alam, 2020). Through reasoning, students are expected to be able to see that mathematics is a reasonable or logical study. Thus students feel confident that mathematics can be understood, thought about, proven, and can be evaluated. Based on the description previously explained, it can be concluded that students' mathematical reasoning ability is the ability or ability of students to solve the problems given (Zetriuslita & Ariawan, 2020).

The cause of students' low mathematical reasoning abilities in integral calculus courses is the need for more reading material in preparing themselves to attend lectures (Bigotte de Almeida et al., 2020). At the same time, there is no material as suitable teaching material from lecturers as a guide for students in lectures. The teaching materials used are only materials in the library; even then, the number is limited (Pramuditya et al., 2019). Limited reading materials result in low mathematical reasoning abilities of students in integral calculus courses; so that students experience ease in understanding various concepts in lectures, it is necessary to develop and develop teaching materials that can direct and stimulate students' thinking processes in maximizing students' mathematical reasoning abilities (Kidron, 2020). Learning will become more meaningful and passionate and able to improve students' mathematical reasoning abilities, assisted by the existence of printed teaching materials in the form of integral calculus teaching materials (Septian et al., 2020).

Research on the effectiveness of using online platforms has been revealed by many researchers (Jacinto & Carreira, 2021; Pischetola et al., 2021; Setyawan et al., 2020). Therefore the development of teaching materials should not only be about changing from physical form to digital form, but the changes lead to adjusting the patterns of interactivity offered in the developed teaching materials.

In addition, the teaching materials developed are expected to accommodate abstract ideas that occur during the lecture process through learning approaches that can be relevant and stimulate students' problem-solving abilities (Awaludin et al., 2020). Through activities that involve these reasoning abilities, lecturers can facilitate students.

B. Method

This type of research is research and development (research and development). The development model in this study uses the ADDIE model to analyze, design, develop, implement and evaluate stages (Branch, 2009).

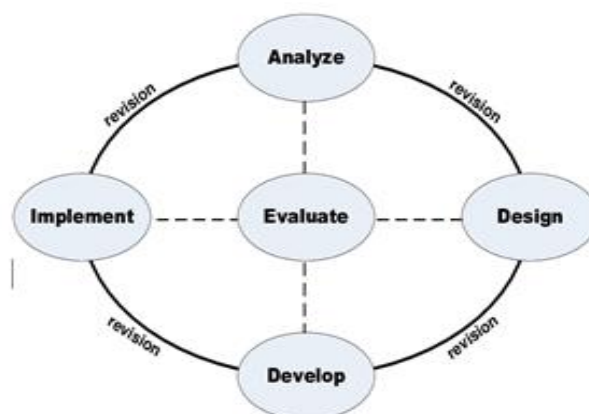


Figure 1. ADDIE Development Model Design

The research location is at the Faculty of Teacher Training and Education, Mathematics Education Study Program, University of HKBP Nommensen Pematang Siantar Semester 1 Academic Year 2021/2022. The procedure for developing this research is as follows:

1. Analysis

At this stage, several activities were carried out: (a) Validating performance gaps. The purpose of validating performance gaps is to produce a statement of primary objectives to address performance gaps or related problems and find their causes and solutions to these gaps. To find out what problems occur, it can be done either by interviews or observation sheets in the form of questionnaires that are shown to lecturers and students; (b) Setting instructional goals. Instructional goals are needed to produce plans that respond to implementation gaps caused by a lack of knowledge and skills. This instructional goal can only be determined after identifying the gap between actual (natural) and expected conditions.

After obtaining the instructional objectives, selecting or setting priorities for action is followed. In this case, the researcher determines the focus of the activity is to develop teaching materials in the form of practicum modules; (3) Analyze student characteristics. Learning analysis is carried out to identify the learner's initial abilities, experiences, preferences, and motivations. Student analysis was conducted using interviews or observation sheets shown to students; (4) Identify available resources. This stage aims to identify all the types of resources that will be needed. Four resources must be audited: content resources, technological resources, instructional facilities, and human resources; and (5) Prepare a work plan. A work plan is made (Fitriawan et al., 2022). Where will confirm the product description that researchers in the final stages of development will produce.

2. Design

The stages are as follows: (a) Task inventory. A task inventory aims to identify the essential tasks required to achieve instructional goals. Instructional objectives can be analyzed according to the knowledge, skills, attitudes, and procedures one must perform

to accomplish a purpose; (b) Setting work goals. Develop objectives that include condition components, performance components, and criteria components. There are three components of the plan: What performance will students do, Important circumstances under which the version is expected to occur, and. Quality criteria or performance standards deemed acceptable; (c) Generate a test strategy. The goal is to create items to test student performance. What must be known is that the objective performance criteria component provides a standard measure for determining the success of performance tasks, basically tests; and (d) Calculates the return on investment. The goal is to estimate the cost of completing the entire ADDIE process.

3. Development

The stages of the procedure are explained as follows: (a) Produce content. The purpose of producing content at the development stage is to make lesson plans; (b) Develop a student manual. At this stage, create the module you want to develop: Integral Calculus Textbook; (c) Develop teacher guides. Materials made for students differ from those intended for teachers/lecturers; (4) Designing a Formative Evaluation. Designing a formative evaluation aims to evaluate and revise Materials that have been created to better close gaps. Evaluation is carried out by material expert evaluators, pedagogic experts, presentation experts, and language experts.

4. Evaluation

The general procedures for the evaluation stage are as follows: (a) Determine the evaluation criteria. Identify perception, learning, and performance as the three primary levels of evaluation related to instructional design; (b) Choose an evaluation tool. Identify the main attributes for each evaluation tool for the selected instructional design in the ADDIE approach; (c) Conduct evaluation. After choosing the evaluation tool, the researcher immediately distributed the perception questionnaire to HKBP Nommensen Pematangsiantar University Mathematics education students class of 2019 to determine their perceptions of the teaching materials being developed.

The normalization gain test (g) is used to determine the magnitude of the increase in students' reasoning abilities before treatment and after treatment in the experimental class, which is calculated using the normalization formula as follows:

$$N \text{ gain} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maks}} - S_{\text{pretest}}}$$

C. Results and Discussion

The teaching materials produced in this development contain three parts: introduction, content, and closing. There are two types of data obtained in this study: quantitative data and qualitative data. The data was obtained through two assessment stages, expert validation and field trials. Validation data for teaching materials were obtained from evaluations carried out by content/material expert validators,

design/media expert validators, and lecturer validators who delivered Basic Integral Calculus courses. The following is a presentation of data and analysis of questionnaire assessment data by material/content experts, media/design experts, and supporting lecturers, along with their criticisms and suggestions.

Table 1. Teaching Material Validation Results

No	Rated aspect	Score	%	Category
I	FORMAT			
	1. Clarity of material distribution	3	75	Valid
	2. Has traction	4	100	Valid
	3. The numbering system is clear	4	100	Valid
	4. Room arrangement/layout	4	100	Valid
	5. Conformity between text and illustration	3	75	Valid
	6. Appropriate font type and size	3	75	Valid
II	LANGUAGE			Valid
	1. Grammatical correctness	3	75	Valid
	2. Clarity of instructions/ instruction, comments, and problem solving	3	75	Valid
	3. The simplicity of sentence structure	3	75	Valid
	4. Communicative nature - the language used	3	75	Valid
III	ILLUSTRATION			
	1. Illustration support	3	75	Valid
	2. Have a clear view	4	100	Valid
	3. Easy to understand	3	75	Valid
IV	CONTENT			
	1. Truth content/material	4	100	Valid
	2. Grouped into different sections, logical	3	75	Valid
	3. Appropriateness of the order of the material	4	100	Valid
	4. Feasibility as a learning tool - ran	4	100	Valid
	Average	3,41	85,29	Valid

Table 1 shows that the overall average score for the assessment of teaching materials is in the valid criteria, equal to 85,29 %. The three validators concluded that teaching materials could be used with minor revisions. From the assessment of the validators, corrections, criticisms, and suggestions were obtained, which were used as material for consideration in revising the teacher's materials. For requests for improvement, some writing/spelling errors in the manuscript have been corrected according to the validator's streaks, while the other revisions are listed in table 2 below:

Table 2. Revision of Teaching Materials based on Validation Results

No	Validators	Error	Revision Suggestions
1	Validators 1 Content/Material Expert	Important terms _	Correct important terms
2	Validators 2 Media Expert	That is the wrong typing, and please fix it.	Typing is corrected, and teaching materials can be used with minor revisions
3	Validators 3 Supporting lecturer	➤ Typing symbols ➤ Erroneous typing fixed	➤ Improved typing of symbols ➤ Typing is corrected, and teaching materials can be used with minor revisions.

The average value of N-gain illustrates the increase in students' mathematical problem-solving abilities based on students' initial mathematical abilities (high, medium, low) in problem-based learning and conventional learning. More details are described below:

Table 3. Average Gain of Mathematical Reasoning Ability

Ability Learning	Students' Initial Mathematical Abilities	Automatic Reasoning Abilities	
		Average	SSD
K P A	High (5)	0.7048	0.1451
	Intermediate (15)	0.4572	0.1673
	Low (5)	0.2873	0.2081
	Total (30)	1.4493	0.5206
K P B	High (4)	0.4916	0.1023
	Intermediate (15)	0.2354	0.1469
	Low (6)	0.1492	0.0644
	Total (30)	0.876	0.3137

Normality Test on N- Gain Mathematical Reasoning Ability is shown in Table 4 below:

Table 4.

Experimental Class N-Gain Normality Test Results Class Control (*Tests of Normality*)

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Gains	.123	30	.200	.970	30	.549
	.139	30	.145	.931	30	.051

From the results of the *Kolmogorov-Smirnov test*, it is known that the significance value of the experimental class is 0.200 while that of the control class is 0.145 because the significance value of the practical course is 0.200 then $0.200 > \alpha : 0.05$ so that the N-gain data for the experimental type is usually distributed, and for the control class, a significance value of $0.145 > 0.05$, meaning that the N-gain data for the control class is standard. So the N-gain information for the experimental and control courses comes from normally distributed data. Thus the data N-gain reasoning ability mathematically shows that the distribution is normal.

Analysis of the Development of Teaching Materials to Improve Students' Mathematical Reasoning Ability

Teaching materials made by this researcher are arranged systematically, motivating students to study harder, providing concepts for student understanding, providing competency tests to anticipate students' difficulties in learning, and providing instructions in doing Integral Calculus.

Learning materials (*instructional materials*) are knowledge, skills, and attitudes that students must master to fulfill learning outcomes in the learning outcomes of study programs. Material analysis was carried out to develop Integral Calculus teaching materials for mathematics education students: Indefinite Integral, Sigma Notation, Definite Integral, Fundamental Theorem of Calculus, Area of Plane, Length of Arc of a Curve, and Surface Area of Rotating Objects.

Feasibility Analysis for Developing Teaching Materials to Improve Students' Mathematical Reasoning Ability

The criteria for obtaining the eligibility value of image-based teaching materials are as follows:

Table 5. Eligibility Criteria for Teaching Materials

Percentage (%)	Validity Level	Information
80-100	Valid	No Revision
60-79	Valid Enough	No Revision
40-59	Invalid	Some Revisions
0-39	Invalid	Total Revision

1. Data Analysis Results of Content Expert Validation Teaching Materials

The assessment results given by the content validation expert in Integral Calculus teaching materials are valid. This is based on the development of teaching materials produced by researchers that are relevant to the Mathematics education curriculum. The overall value of the questionnaire assessment is presented as follows:

$$P = \frac{\sum X}{\sum Xi} \times 100\% = \frac{15}{16} \times 100\% = 93,75\%$$

The validation results from material/content experts in Integral Calculus Teaching Materials reached 93.75%, were in very valid criteria, and did not need further revision. Teaching materials are appropriate for the learning process.

2. Data analysis of Integral Calculus Teaching Material Design Expert Validation Results

The assessment results given by the teaching material design validation expert were sufficient. This is based on the development of Basic Integral Calculus Teaching Materials. The appearance of teaching materials is quite exciting and suitable for learning. The overall value of the questionnaire assessment is presented as follows:

$$P = \frac{\sum X}{\sum Xi} \times 100\% = \frac{45}{52} \times 100\% = 86,53 \%$$

The validation results from the Integral Calculus Teaching Material design expert reached 86,53 %, were in very valid criteria and did not need further revision. Teaching materials are appropriate for the learning process.

3. Development Stage

In the development stage of this teaching material, the executor of the activity carried out several activities, namely drafting teaching materials, reviewed by experts, revising the draft teaching materials, small-scale trials on several students, changing teaching material products and practices using the product in the classroom (Yuliana M., 2022).

a. Results of Drafting Teaching Materials

The draft of Calculus II teaching materials is prepared based on the structure of Calculus II teaching materials. The draft teaching materials are arranged using a systematic cover page, preface page, table of contents page, student activity sheets, practice questions, and bibliography. The draft teaching materials are validated and reviewed by experts.

b. Expert Assessment Results

After the teaching materials were compiled, the next step was validated by 3 experts. Validation is done by filling in the teaching material validation sheet. Analysis of validation results is presented in table 6 below:

Table 6.
Expert Validation Results of Draft Integral Calculus Teaching Materials

Aspect Textbook Validation	Amount	Average	Category
Appropriateness	9	32,33	Well
Eligibility of Presentation	13	46	Well
Language Eligibility	4	13.5	Well
Amount	26	91.83	Well

The validation results of textbooks on content feasibility obtained an average validation result of 32.33 from a maximum score of 45 in the Good category. Scores were

obtained from 3 aspects of content feasibility, including (1) the aspect of material coverage consisting of 3 points, (2) the aspect of the accuracy of the material consisting of 2 points, (3) the aspect of relevance consisting of 4 points.

Discussion

Inductive and deductive reasoning are two main categories into which reasoning can be divided. General principles or rules are deduced using inductive reasoning using examples from real-world situations or observing objects (Mahmuzah et al., 2020) ; (Amelia & Ulfah, 2022). Deductive reasoning, on the other hand, is a reasoning process from general knowledge or experience that helps us arrive at certain conclusions. Wilson (2020) states that in grades 5-8, the mathematics curriculum should include many experiences that diversity can strengthen and broaden logical reasoning abilities so that students can: (1) learn to apply deductive and inductive reasoning; (2) understand and apply reasoning processes with a focus on reasoning with proportions and graphics; (3) develop and evaluate conjectures and logical arguments; and (4) the rate of absorption of power and reasoning power from mathematics. Based on the summary above, the indicators of mathematical reasoning ability used in this study are the ability to follow logical arguments, draw conclusions, and explain existing models, pictures, facts, qualities, relationships, or patterns. Table 1 shows that the overall average score for the assessment of teaching materials is in the valid criteria, equal to 8.5, 29 %. The three validators concluded that teaching materials could be used with minor revisions. From the results of the *Kolmogorov-Smirnov test*, it is known that the significance value of the experimental class is 0.200 while that of the control class is 0.145 because the significance value of the experimental class is 0.200 then $0.200 > \alpha : 0.05$ so that the N-gain data for the experimental class is usually distributed, and for the control class, a significance value of $0.145 > 0.05$, meaning that the N-gain data for the control class is normal. In line with research conducted by (Siregar et al., 2022) in his study it was stated that students need an e-LKM that contains instructions, assignments, or work steps, can be used independently anywhere and anytime, and can increase learning engagement while increasing students' capacity to think innovatively mathematically. In line with the results of relevant research conducted by Ramdani et al (2018), which stated that the findings of the instrument trial yielded a significance value of 0.42, indicating that the item's validity has been considered equally by experts. Inquiry validity has a significance value of 0.82, meaning an advanced language and visuals category. Reliability has a significance value of 0.87 and is included in the advanced class. Analysis of the difficulty level shows that question number 7 is included in the difficult category, while questions number 1, 2, 4, and 6 are included in the moderate category, and questions number 3 and 5 are included in the easy category. Questions 1, 2, and 3 are pretty good, questions 4, 6, and 7 are good, and questions 8, 9, and 10 are perfect puzzles with the inclusion of the number 5. From relevant research conducted by experts, the validation results textbooks on content feasibility obtained an average validation result of 32.33 from a maximum score of 45 in the Good category.

Scores were obtained from 3 aspects of content feasibility, including (1) the aspect of material coverage consisting of 3 points, (2) the aspect of the accuracy of the material consisting of 2 points, (3) the aspect of relevance consisting of 4 points.

D. Conclusion

The results of product development which have been revised, are based on the validation results that the Development of Integral Calculus Teaching Materials produces products in the form of Integral Calculus teaching materials. The product developed has fulfilled the components as good teaching material and can be used in the learning process. The feasibility of Integral Calculus teaching materials obtained percentage values from the experts and subjects studied as follows: (a) The acquisition of post-test scores reached an average of 83 compared to the addition of an average pretest score of 48, there is a significant increase. This shows an increase in learning outcomes after using the product development results of Integral Calculus teaching materials. Acquisition of value for the development of Calculus teaching materials Integral has a high level of attractiveness based on the assessment of material/content experts reaching 93.75% ; (b) Earn mark the development of Integral Calculus has a high level of beauty based on the evaluation of design experts getting 8.6, 53 % ; (c) Acquiring the value of the development of Integral Calculus has a high level of attractiveness based on field test assessments reaching 91%. Thus the development of Integral Calculus teaching materials is of good quality. This is because the use of these teaching materials can increase effectiveness and feasibility and provide a positive influence in improving student learning outcomes.

References

- Alam, A. (2020). Challenges and Possibilities in Teaching and Learning of Calculus : A Case Study of India. *Journal for the Education of Gifted Young Scientists*, 8(1), 407–433. <https://doi.org/10.17478/jegys.660201>
- Amelia, T., & Ulfah, S. (2022). Pengaruh Kecemasan Matematika Siswa Terhadap Kemampuan Penalaran Matematis Pada Pembelajaran Daring. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, 11(1), 81–92. <http://doi.org/10.25273/jipm.v11i1.13215>
- Awaludin, A., Wibawa, B., & Winarsih, M. (2020). Integral Calculus Learning Using Problem Based Learning Model Assisted by Hypermedia-Based E-Book. *JPI (Jurnal Pendidikan Indonesia)*, 9(2), 224. <https://doi.org/10.23887/jpi-undiksha.v9i2.23106>
- Bernard, M., & Novtiar, C. (2022). Pengembangan Media Kalkulus Menggunakan Javascript Geogebra untuk Meningkatkan Kemampuan Penalaran Terhadap Calon Guru pada Pandemi COVID 19. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 5(1), 159–168. <http://dx.doi.org/10.22460/jpmi.v5i1.p159-168>
- Bien, Y. I., Daniel, F., & Taneo, P. N. L. (2019). Pengembangan Buku Ajar Kalkulus Integral Berbasis Maple untuk Meningkatkan Pemahaman Konsep Mahasiswa. *ANARGYA: Jurnal Ilmiah Pendidikan Matematika*, 2(1), 39–45. <https://doi.org/10.24176/anargya.v2i1.3404>

- Bigotte de Almeida, M. E., Queiruga-Dios, A., & Cáceres, M. J. (2020). Differential and Integral Calculus in First-Year Engineering Students: A Diagnosis to Understand the Failure. *Mathematics*, 9(1), 61. <https://doi.org/10.3390/math9010061>
- Fitriawan, D., Ijuddin, R., & Sayu, S. (2022). Analisis Materi Sulit Dipahami Dan Miskonsepsi Mahasiswa Dalam Mata Kuliah Kalkulus Integral. *Numeracy*, 9(1), 27–38. <https://doi.org/10.46244/numeracy.v9i1.1682>
- Franita, Y., Hendrastuti, Z. R., Asna, K. N., & Nafisah, S. (2020). Pengembangan Lembar Kerja Mahasiswa Berbasis Problem Based Learning pada Mata Kuliah Kalkulus Integral. *MATH LOCUS: Jurnal Riset Dan Inovasi Pendidikan Matematika*, 1(2), 100–110. <https://doi.org/10.31002/mathlocus.v1i2.2605>
- Harahap, T. H., Mushlihuddin, R., & Afifah, N. (2022). Pengembangan Bahan Ajar Berbasis Masalah Terhadap Kemampuan Berpikir Kreatif Matematis. *EduTech: Jurnal Ilmu Pendidikan Dan Ilmu Sosial*, 8(1), 377003. <https://doi.org/10.30596/edutech.v7i2.7063>
- Kidron, I. (2020). Calculus Teaching and Learning. In *Encyclopedia of Mathematics Education* (pp. 87–94). Springer International Publishing. https://doi.org/10.1007/978-3-030-15789-0_18
- Listiana, Y., -, W., & Wirevenska, I. (2020). Pengembangan Bahan Ajar Kalkulus Berbantuan Software Autograph Untuk Meningkatkan Kemampuan Pemahaman Mahasiswa. *Jurnal Serunai Matematika*, 12(1), 32–43. <https://doi.org/10.37755/jsm.v12i1.265>
- Mahmuzah, R., Ainun, N., Suryawati, I., Sianturi, M. S., & Walil, K. (2020). Kemampuan Penalaran Matematis Melalui Pembelajaran Learning Cycle 5E Pada Materi Himpunan Siswa MTs Keutapang Dua Aceh Besar. *Jurnal Serambi Akademica*, 8(8), 1501–1510.
- Maskar, S., & Dewi, P. S. (2020). Praktikalitas dan Efektifitas Bahan Ajar Kalkulus Berbasis Daring Berbantuan Geogebra. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 4(2), 888–899. <https://doi.org/10.31004/cendekia.v4i2.326>
- Meilasari, V. (2020). Pengembangan Bahan Ajar Kalkulus Integral Dengan Pendekatan Aptitude Treatment Interaction (Ati) Berbantu Macromedia Flash. *Eksponen*, 10(1), 31–39. <https://doi.org/10.47637/eksponen.v10i1.173>
- Nuraeni, R. (2018). Perbandingan Kemampuan Komunikasi Matematis Mahasiswa Antara Yang Mendapatkan Pembelajaran Group Investigation Dengan Konvensional Pada Mata Kuliah Kalkulus Integral. *Mosharafa: Jurnal Pendidikan Matematika*, 7(2), 219–228. <https://doi.org/10.31980/mosharafa.v7i2.29>
- Pramuditya, S. A., Sulaiman, H., & Wahyudin. (2019). Development of instructional media game education on integral and differential calculus. *Journal of Physics: Conference Series*, 1280(4), 042049. <https://doi.org/10.1088/1742-6596/1280/4/042049>
- Ramdani, Y., Rohaeni, O., & Sumardi, S. (2018). Pengembangan Instrumen dan Bahan Ajar Kalkulus Integral Melalui Strategi Scientific Debate. *Ethos (Jurnal Penelitian Dan*

- Pengabdian Masyarakat*), 1, 10.
<https://doi.org/https://doi.org/10.29313/ethos.v6i1.3231>
- Rosyadi, A. A. P. (2018). Pengembangan modul berbasis riset pada mata kuliah kalkulus untuk meningkatkan kreativitas mahasiswa. *Math Didactic: Jurnal Pendidikan Matematika*, 4(2), 128-135. <https://doi.org/10.33654/math.v4i2.99>
- Rosyidah, U., & Ayuwanti, I. (2019). Pengembangan Bahan Ajar Kalkulus II dengan Scientific Approach Berbantuan Maple Untuk Meningkatkan Kemampuan Penalaran Mahasiswa Program Studi Pendidikan Matematika. *Jurnal Riset Interoensi Pendidikan (JRIP)*, 1(1), 49-54.
- Rosyidah, U., Setyawati, A., & Awaludin, A. A. R. (2021). Pengembangan Bahan Ajar Berbantuan Software Maple Untuk Meningkatkan Pemahaman Konsep Matematis Mahasiswa. *Jurnal THEOREMS (The Original Research of Mathematics)*, 5(2), 189. <https://doi.org/10.31949/th.v5i2.2617>
- Septian, A., Darhim, & Prabawanto, S. (2020). Geogebra in integral areas to improve mathematical representation ability. *Journal of Physics: Conference Series*, 1613(1), 012035. <https://doi.org/10.1088/1742-6596/1613/1/012035>
- Siregar, H. M., Solfitri, T., Siregar, S. N., Anggraini, R. D., & Aldresti, F. (2022). Analisis Kebutuhan E-LKM Kalkulus Integral Untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis. *RANGE: Jurnal Pendidikan Matematika*, 4(1), 55-70. <https://doi.org/https://doi.org/10.32938/jpm.v4i1.2664>
- Wilson, J. (2020). Reflections on Mathematics Education Research: 1970-1982. *Journal for Research in Mathematics Education*, 51(1), 3-11. <https://doi.org/10.5951/jresmetheduc.2019.0004>
- Yuliana M., R. (2022). Metakognisi Dalam Memecahkan Masalah Penerapan Integral Pada Mata Kuliah Kalkulus Ditinjau Dari Tipe Perilaku Disc. *Aksioma*, 11(1), 21-39. <https://doi.org/10.22487/aksioma.v11i1.1903>
- Zengin, Y. (2022). Construction of proof of the Fundamental Theorem of Calculus using dynamic mathematics software in the calculus classroom. *Education and Information Technologies*, 27(2), 2331-2366. <https://doi.org/10.1007/s10639-021-10666-1>
- Zetriuslita, Z., & Ariawan, R. (2020). Students' Mathematical Thinking Skill Viewed From Curiosity Through Problem-Based Learning Model On Integral Calculus. *Infinity Journal*, 10(1), 31-40. <https://doi.org/10.22460/infinity.v10i1.p31-40>