Jurnal Pendidikan Matematika (Kudus)
P-ISSN 2615-3939 | E-ISSN 2723-1186
https://journal.iainkudus.ac.id/index.php/jmtk
DOI: http://dx.doi.org/10.21043/jpmk.v7i1.26227
Volume 7, Number 1, June 2024, pp. 89-112

Analysis of Student Understanding Related to Indefinite Integral Concepts Through Cooperative Learning Assisted Media Interactive Animated PowerPoint Learning and Indefinite Integral Matter

Rizky Agassy Sihombing[1*], Muslim[2], Taufik Rahman[3], Aulia Eka Rahma[4], Jennie Febrina Hutagalung[4], Winanta Sitanggang[4], Amir Karimi[5]
[1]*Master Program on Science Education, Universitas Pendidikan Indonesia, Indonesia*
[2]*Department of Physics Education, Universitas Pendidikan Indonesia, Indonesia*
[3]*Department of Biology Education, Universitas Pendidikan Indonesia, Indonesia*
[4]*Department of Natural Science Education, Universitas Negeri Medan, Indonesia*
[5]*Research Lecturer at Farhangian, University of Albborz, Iran*
**Correspondence: rizkyagassy@upi.edu*

Abstract

This research aims to determine students' understanding of integral calculus. This qualitative study investigates students' responses and understanding of integral calculus, with a particular focus on indefinite integrals. The study employed cooperative learning and animated PowerPoint (PPT) media. Data were collected from 117 students across 37 educational institutions, representing various classes and majors. The study, conducted online, comprised nine questions addressing students' attitudes, perceptions, and behaviours towards learning integral calculus. The findings reveal that while a majority of students express interest in mathematics, 26.5% have a good understanding of integral calculus, 45.3% find it average, and 18.8% struggle. For indefinite integrals, 28.2% understand them well, 45.3% find them average, and 19.7% struggle. Regarding learning methodologies, 60.7% of students express a preference for learning models integrating various media over traditional teacher-centric approaches. Additionally, 59.8% find animated PPTs helpful in understanding Integral Calculus. Additionally, 51.3% prefer a combination of traditional teaching and animated PPTs. Furthermore, the study reveals a strong inclination towards group learning models over individual learning. Notably, the majority of students correctly solved the indefinite integral problems provided, indicating a satisfactory understanding of the subject matter. Students generally exhibit a positive attitude towards learning Integral Calculus, especially when utilizing cooperative learning methods and animated PPTs. These findings underscore the importance of incorporating diverse teaching strategies to enhance student engagement and comprehension in mathematics education.

Keywords: Analysis; Understanding; Indefinite integral; Cooperative learning; Interactive media

Abstrak

Penelitian ini bertujuan untuk menilai pemahaman siswa dan mahasiswa tentang kalkulus integral. Studi penelitian kualitatif ini menyelidiki respons dan pemahaman mahasiswa terhadap Kalkulus Integral, dengan fokus khusus pada topik integral tak tentu, dengan menggunakan pembelajaran kooperatif dan media PowerPoint animasi (PPT). Sebanyak 117 siswa dan mahasiswa dari 37 lembaga pendidikan di berbagai kelas dan jurusan berpartisipasi dalam penelitian ini. Data dikumpulkan melalui kuesioner online yang terdiri dari sembilan pertanyaan, yang membahas sikap, persepsi, dan perilaku mahasiswa terhadap pembelajaran Kalkulus Integral. Temuan menunjukkan bahwa sebagian besar mahasiswa (59,8%) menunjukkan minat dalam matematika. Namun, sementara 26,5% mengklaim pemahaman yang baik tentang kalkulus integral, 45,3% menganggapnya hanya biasa, dan 18,8% kesulitan memahami konsep tersebut dengan baik. Demikian pula, 28,2% memahami integral tak tentu dengan baik, sementara 45,3% menganggapnya biasa, dan 19,7% mengalami kesulitan dalam pemahaman. Mengenai metodologi pembelajaran, 60,7% mahasiswa menyatakan preferensi terhadap model pembelajaran yang mengintegrasikan berbagai media dibanding pendekatan tradisional yang berpusat pada guru. Selain itu, 59,8% menganggap PPT animasi bermanfaat dalam memahami Kalkulus Integral. Namun, 51,3% lebih memilih kombinasi pengajaran tradisional dan PPT animasi. Selain itu, penelitian ini mengungkap kecenderungan kuat terhadap model pembelajaran kelompok (70,1%) dibanding pembelajaran individual (13,7%). Secara mencolok, mayoritas mahasiswa (74,4%) berhasil menyelesaikan masalah integral tak tentu dengan benar, menunjukkan pemahaman materi yang memuaskan. Secara umum, mahasiswa menunjukkan sikap positif terhadap pembelajaran Kalkulus Integral, terutama saat menggunakan metode pembelajaran kooperatif dan PPT animasi. Temuan ini menekankan pentingnya menggabungkan beragam strategi pengajaran untuk meningkatkan keterlibatan dan pemahaman mahasiswa dalam pendidikan matematika.

Kata Kunci: Analisis; Pemahaman; Integral tak tentu; Pembelajaran kooperatif; Media interaktif

Introduction

Mathematics is essential in this process, acting as a flexible problem-solving tool for various real-life situations, helping them use their learning to tackle present and future challenges. As noted by Skemp (1971), mathematics is not only essential for scientific, technological, and commercial endeavors but also serves as a foundation for entry into many professions. In this learning process, students are expected to understand the concepts taught, not just memorize them (Sulthon, 2017; Manurung et al., 2021; Panggabean et al., 2022).

Hadi (2005) states that the mathematics learning process is still centred on the teacher, which has yet to happen as expected. Students take notes from the board, work through practice problems modelled after the teacher's, and quietly listen to the teacher throughout this period. Instead of encouraging students to

actively seek out knowledge and skills on their own, this teacher-centered approach turns them into passive learners who only interact to absorb information. Because of this, pupils rely significantly on their teachers to help them learn.

Calculus is one branch of mathematics and also the subjects studied in higher education. Calculus, often known as the entrance to advanced mathematics, has two primary branches: integral calculus and differential calculus. Integral is the concept of continuous addition in mathematics together with its inverse differential are developed following the development of internal problems differential where mathematicians have to think how to solve that problem in contrast to differentiation solutions, so integrals are also called anti-derivative (Varberg et al., 2010).

Integral calculus is a fundamental subject in mathematics subjects. Its objectives include imparting knowledge about integral concepts, integration techniques, transcendent functions, area, volume, and improper integrals. Expected competencies in integral calculus encompass understanding indefinite and definite integrals, proficiency in integration techniques, and adeptness in solving problems involving improper integrals (Sholihah & Mubarok, 2016; Susilo et al., 2019).

Research by Siregar and Solfitri (2019) shows that students frequently struggle with integral calculus, as reflected in their performance, with more than 50% scoring below 70. To address these issues, it is essential to identify common errors students make in mathematical problem-solving (Li et al., 2017). Understanding these errors enables instructors to focus teaching on areas where students struggle the most (Machromah & Purnomo., 2017; Nursyaidah & Albab, 2017). Moreover, recognizing factors influencing these errors, including gender differences, is crucial. Given these considerations, the research problem centres on exploring the types of mistakes students make when solving indefinite integrals, considering gender differences.

Research by Nursyaidah & Albab (2017) has highlighted several challenges encountered by students in calculus and integration. These challenges include grappling with the language of mathematics, understanding the complexities of limits beyond basic arithmetic or algebraic operations, and comprehending the concept of infinitesimally small variables (Nursyaidah & Albab, 2017; Joseph, 2020). Additionally, other researchers have identified other difficulties, such as misapplication of concepts, failure to provide justifications, and imprecise utilization of algorithms (Zetriuslita et al., 2016; Napfiah, 2021). Errors often manifest in the inability to select the appropriate integration method and the incorrect application of theorems.

Several methods are used to solve indefinite integral problems, of course, in general, namely using the fundamental theorem of calculus, the method of substitution, partial integrals, and some particular integral problems that are worked out using transcendent functions (Varberg et al., 2010). To determine the suitable method for solving integral calculus problems, course questions must be identified first (Saparwadi, 2015). Identify a problem, provide examples and not examples, and develop ideas so that a comprehensive understanding is built into one mathematical ability, namely understanding concepts (Depdiknas, 2006). When students already have a good understanding of the concept, they can determine which procedure or method is most appropriate to use in identifying problem-solving (Kesumawati, 2008).

In solving integral problems, students must still identify and justify concepts and analyze and evaluate an algorithm (Zetriuslita et al., 2016; Ario & Asra, 2018). Some mistakes made in solving integral calculus problems include: (a) on solving anti-derivative problems: do not add constant C to the steps integration and results of integration, (b) on solving integral problems, of course definition: the mistake of solving problems using the fundamental theorem of calculus combined with the use of a general rank and (c) after the question about the fundamental theorem of calculus, the error in solving the integral substitution problem, in assuming u (Rahimah, 2012). These mistakes can occur because students still need to understand that integral calculus is good. In contrast, understanding concepts is essential to identify Mathematical problem-solving and initial processes to achieve higher abilities (Kesumawati, 2008).

When teaching the concept of an indeterminate integral, educators must consider the varying abilities of students to grasp this concept. While some students can understand it quickly, others require more time to absorb the material.According to Djamarah & Zain (2002), there are differences in students' absorption, which requires appropriate teaching strategies. As a professional in the field of education, a teacher is required to have a deep understanding of the material being taught as well as skills in designing learning that suits the various conditions and needs of students (Azis et al., 2013; Hoesny & Darmayanti, 2021; Sihombing et al., 2021; Sihombing et al., 2022; Sihombing et al., 2023). Implementation in education always develops in accordance with the times because education is a provision that must be owned by humans in living an increasingly advanced and developing life (Octavia et al., 2022; Sihombing, 2023), one of which is the use of learning media.

Therefore, cooperative learning Student Team Achievement Division (STAD) type can be assisted by instructional media, Animated interactive

PowerPoint to increase students' understanding of integral concepts. The STAD cooperative learning technique prioritizes collaboration among students to achieve maximum performance. This technique not only allows students to learn independently, but it also encourages them to engage, motivate, and help one another understand the learning material In this context, combining the STAD approach with other teaching methods can enhance the effectiveness of learning (Suryana & Somadi, 2018; Akhmad, 2020). For example, integrating the STAD technique with project-based learning approaches allows students to work in well-organized teams while focusing on specific learning objectives. Furthermore, integrating technology into the implementation of the STAD technique is also an effective approach. Utilizing online learning platforms or specialized applications facilitates student collaboration, monitors individual progress, and provides real-time feedback. Additionally, combining the STAD approach with differentiated learning strategies addresses the individual needs of students. By offering tasks or activities tailored to students' abilities and interests, the STAD approach becomes more inclusive, providing equal opportunities for all students to achieve success. By combining the STAD technique with other teaching approaches, educators can create a dynamic, cooperative, and stimulating learning environment for students to achieve their maximum potential (Ariani & Agustini, 2018; Wulandari, 2022).

According to Sudjana and Rivai (Ngalimun, 2016), the benefit of using PowerPoint in learning is that it attracts students, fostering motivation and making the material more precise and understandable. This clarity helps students master the content and achieve learning goals. In their research, Getut and Maryono (2011) also concluded that interactive multimedia PowerPoint improves learning attitudes. With the application of this learning, students find together the formula's origin or how to apply the formula with interactive media point learning media assistance animate, ask for each other and give with the same purpose so that the formulas will be remembered and understood.

To address the aforementioned challenges, educators must adopt adaptable and efficient learning methodologies that empower students to think critically, comprehend the material, and actively participate in the teaching and learning process. This shift entails transitioning from teacher-centered to student-centered approaches, employing suitable teaching aids aligned with the chosen learning model. By utilizing appropriate learning models, educators can cultivate students' enjoyment of learning, enhance motivation for assignments, and facilitate comprehension, thus fostering favourable learning outcomes. Among these models, problem-based and cooperative learning stand out as effective strategies for

nurturing critical thinking and transforming students from passive recipients into proactive learners and problem solvers.

Based on the background described above, the researcher is interested in conducting research titled "Analysis of Student Understanding Related to Indefinite Integral Concepts Through Cooperative Learning Assisted Media Interactive Animated PowerPoint Learning and Indefinite Integral Matter." The research problem formulation in this study are how do students understand and respond to the calculus integral material, particularly the topic of indefinite integrals?, what are the students' preferences regarding learning models involving cooperative learning and animated PowerPoint (PPT) media in comprehending calculus integral material?, and how effective are the cooperative learning and animated PowerPoint (PPT) media learning models in enhancing students' understanding of indefinite integral concepts?

Method

This research employed a quantitative approach using a survey method. It aimed to describe the responses and understanding of students regarding the Integral Calculus course, specifically focusing on the topic of integrals. Additionally, it incorporated cooperative learning and animated PowerPoint media. The study explored students' attitudes, perceptions, and behaviors. Data were collected through an online test administered individually, accompanied by a questionnaire.

This research participant improved 117 students and students in 37 Educational Institutions with different classes and majors. The subjects of this study are shown in Table 1.

Table 1. Demographics of Research Participant

No.	Origin University/School	Class/Major	Total
1.	MAN 1 Medan	Eleventh-Grade Majoring in Science Education	6 Students
2.	SMA Brigjend Katamso 1 Medan	Eleventh-Grade Majoring in Science Education	1 Students
3.	SMA Harapan Mandiri	Twelfth-Grade and Alumnus Majoring in Science Education	2 Students
4.	SMA Negeri 7 Medan	Tenth-Grade Majoring in Science Education	2 Students
5.	SMA Harapan 3	Eleventh-Grade Majoring in Science Education	1 Students
6.	SMAS Budi Murni 1	Eleventh-Grade Majoring in Social	1 Students

No.	Origin University/School	Class/Major	Total
	Medan	Science	
7.	SMA Negeri 18 Medan	Eleventh-Grade Majoring in Social Science, and Alumnus in Science Education	6 Students
8.	SMK Telkom Medan 01	Eleventh-Grade Majoring in Multimedia	1 Students
9.	MAN Tanjung Morawa	Twelfth-Grade Majoring in Science Education	1 Students
10.	MAN 2 Medan	Twelfth-Grade Majoring in Science Education	1 Students
11.	SMAS Sultan Iskandar Muda Medan	Twelfth-Grade Majoring in Science Education	3 Students
12.	SMA Teladan Siantar	Eleventh-Grade Majoring in Science Education	1 Students
13.	SMK Negeri 1 Percut Sei Tuan	Eleventh-Grade Majoring in Computer and Network Engineering	1 Students
14.	SMK Negeri 6 Medan	Eleventh-Grade Majoring in Accounting, and Tenth-Grade Majoring in Office Department	3 Students
15.	SMK Sandy Putra 2 Medan	Twelfth-Grade Majoring in Social Science	1 Students
16.	SMK Dharma Analitika	Health Analytics	1 Students
17.	Universitas Muhammadiyah Sumatera Utara	Civil Engineering	1 Students
18.	Universitas Negeri Medan	Biology Education, Chemistry Education, Health and Recreation Physical Education, Physics Education, Accounting, Mathematics Education, History Education, Physics, Science Education, Civic Education, Mechanical Engineering	30 Students
19.	Universitas Sari MutiaraMedan	Pharmacy	1 Students
20.	Institut Teknologi PLN	Civil Engineering	1 Students
21.	Sekolah Tinggi Ilmu Kelautan	Maritime Law	4 Students

No.	Origin University/School	Class/Major	Total
22.	Universitas Sumatera Utara	Management, Psychology, Food Technology, Tax Administration, Industrial Engineering, Public Health, Systems Information	13 Students
23.	Institut Kesehatan Helvetia	Pharmacy	1 Students
24.	Universitas Syiah Kuala	Agricultural Engineering, and Mining Engineering	2 Students
25.	Universitas Jambi	Mathematics	1 Students
26.	National Central University	Environmental Engineering	1 Students
27.	Universitas Darma Agung	Accounting	1 Students
28.	Universitas Singaperbangsa Karawang	English Education	1 Students
29.	Politeknik Imigrasi	Immigration Law	1 Students
30.	Universitas Udayana	Machine Engineering	1 Students
31.	Universitas Islam Negeri Sumatera Utara	Biology Education, and Public Health	2 Students
		Total	117 Students

Data collection was carried out by asking students to fill out online questionnaires adopted from Zulkarnaen (2021) and Apriyani & Sirait (2021). Each participant answered nine questions: seven questions about their experiences learning mathematics and integral calculus, as well as their use of cooperative learning models and instructional media such as animated PowerPoint, and two questions specifically related to indefinite integrals. The questions focused on students' understanding of integral calculus. The researcher then reviewed and classified the responses based on the answers provided.

The data validity in this research was tested using SPSS version 26 by comparing the value of r_{count} and r_{table}. The assessment criteria were based on the degree of freedom (df) = n-2, where n is the sample size. In this case, df = 115 with a significance level of 0.05, resulting in a value of 0.181. If the r_{count} value is greater than the r-table value and the r-value is positive, then the statement is considered valid. The instrument test in this research was conducted on 117 respondents with an r-table value of 0.181. The validity test in this research can be seen in Table 2.

Table 2. Instrument Validation Test

Questions	r_{count}	r_{table}	Description
Q1	0.903	0.181	Valid
Q2	0.918	0.181	Valid
Q3	0.914	0.181	Valid
Q4	0.917	0.181	Valid
Q5	0.924	0.181	Valid
Q6	0.891	0.181	Valid
Q7	0.935	0.181	Valid
Q8	0.887	0.181	Valid
Q9	0.893	0.181	Valid

Based on the questionnaire test involving 115 respondents, at a significance level of 5% with degrees of freedom (df) = 115 and an r-table value of 0.181, Table 2 shows that the r-count value > r-table value, indicating that all items in the instrument are considered valid. Subsequently, the instrument underwent reliability testing.

Reliability testing was conducted to assess the consistency and dependability of the measurement tool. A questionnaire is deemed reliable if individuals' responses are consistent over time. Construct reliability is evaluated using Cronbach's alpha values calculated from data processed using SPSS 26, where a Cronbach's alpha value > 0.60 indicates good reliability. The reliability test of the instrument in this study is presented in Table 3.

Table 3. Instrument Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
.973	9

The reliability coefficient (Cronbach's alpha) of the research instrument in Table 4 is 0.973, indicating excellent reliability as it exceeds 0.60. This confirms that respondents' answers are consistent and trustworthy over time.

The data analysis technique employed in this study is likely to involve both descriptive and inferential statistical methods. Descriptive statistics will be used to summarize and present the responses to the questionnaire, providing an overview of the students' attitudes, perceptions, and understanding regarding integral calculus, cooperative learning models, and the use of instructional media. This could include measures such as frequencies, percentages, and means.

Results

The results of this study were conducted by giving questionnaires to students of 37 educational institutions with different classes and majors with a total of 117 students. The questions we give are:

1. Have you always been interested in math?

A. Yes, I am interested

B. Ordinary

C. No, I am not interested

D. It is not easy to be interested in it

2. Do you understand the integral calculus material well enough?

A. Yes, I understand it quite well

B. Ordinary

C. No, I did not understand it well enough

D. It is challenging to understand

3. Have you understood enough integral calculus material, especially the topic of indefinite integrals?

A. Yes, I understand it well enough

B. Ordinary

C. No, I did not understand it well enough

D. It is not easy to understand

4. Does the learning model with the teacher/lecturer only explaining in front of the class help you to understand the integral calculus material better?

A. I understand better if the teacher/lecturer only explains in front of the class rather than using other learning media.

B. Ordinary, if the teacher/lecturer only explains in front of the class rather than using other learning media

C. No, I need clarification on whether the teacher/lecturer only explains in front of the class. Instead, they should use other learning media

D. It is complicated to understand if the teacher/lecturer only explains in front of the class instead of using other learning media

5. Does the learning model using PPT with animation help you to understand the integral calculus material better?

A. Yes, I understand better if the teacher/lecturer uses a learning model using an animated PPT compared to the teacher/lecturer who only explains

B. No, I understand less if the teacher/lecturer explains the material using animated PPT learning media compared to the teacher/lecturer who only explains in front of the class

C. It is complicated to understand if the teacher/lecturer explains the material using animated PPT learning media, compared to the teacher/lecturer who only explains in front of the class.

D. It is normal if the teacher/lecturer explains the material using animated PPT media, compared to the teacher/lecturer who only explains in front of the class.

6. Which one do you prefer? The learning model of the teacher/lecturer who only explains in front of the class or the learning model using animated PPT?

A. I prefer the learning model of the teacher/lecturer who only explains in front of the class, compared to the learning model of the teacher/lecturer explaining the learning using the animated PPT.

B. I feel that the teacher/lecturer should use two methods, namely explaining in front of the class and using a learning method coupled with learning media with animated PPTs

C. I prefer the learning model of teachers/lecturers using PPT with animation in explaining learning, compared to the learning model of teachers/lecturers who only explain in front of the class.

7. Which one do you prefer? The individual learning model or the group learning model?

A. I like the individual learning model more than the group learning model.

B. The individual and group learning models are the same.

C. I like the group learning model more than the individual learning model.

8. What is the result of the indefinite integral of ∫3x^2 (4-2x) dx=

A. 4x^3-6/4 x^4+c

B. -4x^3-6/4 x^4+c

C. 3x^3-2/4 x^4+c

D. 5x^3-1/4 x^4+c

9. What is the result of the indefinite integral of $\int(3 \sin x + 4)\, dx$=

A. -3 cosx + 4x + C

B. 3 cosx + 4x + C

C. -3 sinx + 4x + C

D. 2 cosx + 4x + C

Question Number 1: Have you always been interested in math?

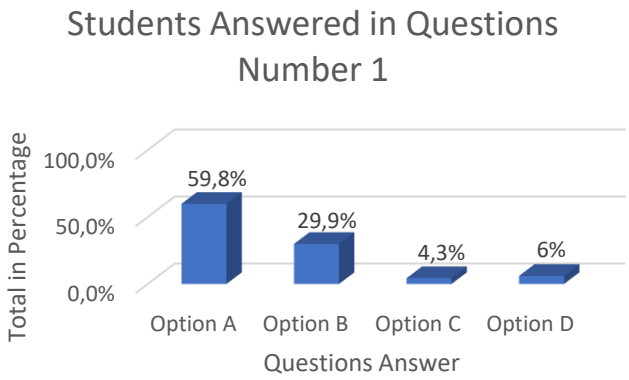

Figure 1. Results of Students Answered in Questions Number 1

In Figure 1, we can see the students answered question number 1, the majority of students (59.8%) showed a positive interest in the Integral Calculus course, indicating a general enthusiasm for the subject. A significant portion (29.9%) had a neutral stance, while only a small minority (4.3%) were not interested, and 6% found it difficult to develop an interest. These results suggest that most students are engaged with the course material, but there is still a need to address the challenges faced by those who are less interested.

Question Number 2: Do you understand the integral calculus material well enough?

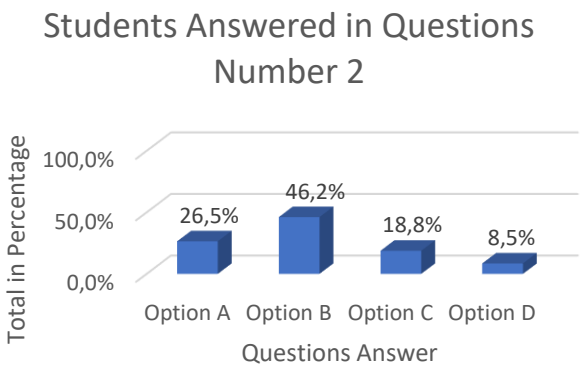

Figure 2. Results of Students Answered in Questions Number 2

In question number 2 as we can in Figure 2, the data indicates that a relatively small proportion of students (26.5%) fully understand the material in the Integral Calculus course. The largest group of students (46.2%) have a moderate level of understanding, while 18.8% have a limited understanding, and 8.5% find the material challenging to understand. These findings highlight the need for additional support and instructional strategies to improve comprehension among students.

Question Number 3: Have you understood enough integral calculus material, especially the topic of indefinite integrals?

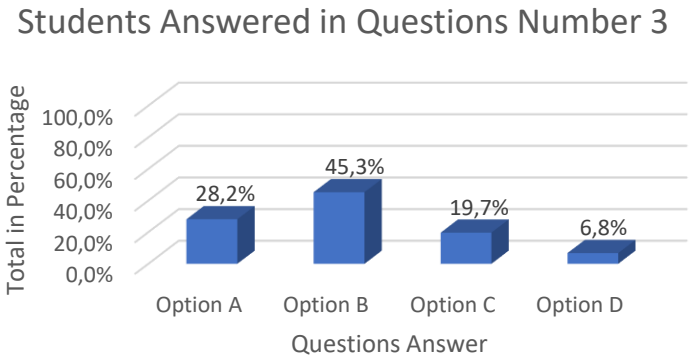

Figure 3. Results of Students Answered in Questions Number 3

In question number 3 as we can see in Figure 3, the survey results show that 28.2% of students fully understand the material in the Integral Calculus course. Meanwhile, 45.3% have a moderate level of understanding, 19.7% have a limited understanding, and 6.8% find the material challenging to comprehend. These findings suggest that while a significant portion of students have a reasonable grasp of the course content, there remains a need for improved instructional methods to support those who struggle with understanding the material.

Question Number 4: Does the learning model with the teacher/lecturer only explaining in front of the class help you to understand the integral calculus material better?

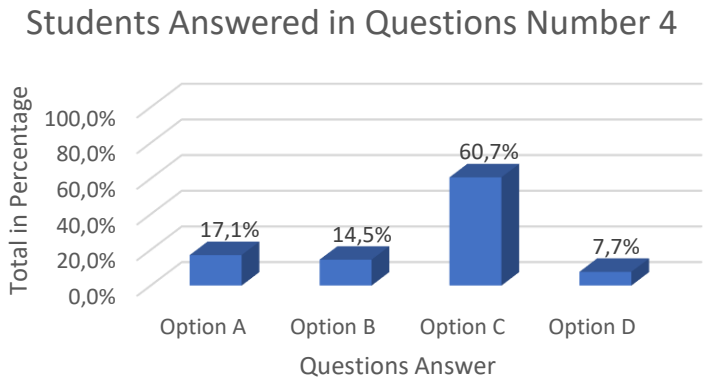

Figure 4. Results of Students Answered in Questions Number 4

As we can see in Figure 4, in question number 4, the survey results indicate diverse student preferences regarding traditional in-class teaching versus the use of other learning media. Specifically, 17.1% of students preferred the traditional method where the teacher only explains in front of the class. Meanwhile, 14.5% of students were indifferent, finding no significant difference between traditional and media-enhanced teaching. A majority of 60.7% of students, however, reported that they do not understand the material well if only traditional methods are used, emphasizing the need for other learning media. Additionally, 7.7% found it particularly challenging to understand without the incorporation of diverse learning tools. These findings highlight a substantial demand for varied teaching methods to enhance student comprehension and engagement.

Question Number 5: Does the learning model using PPT with animation help you to understand the integral calculus material better?

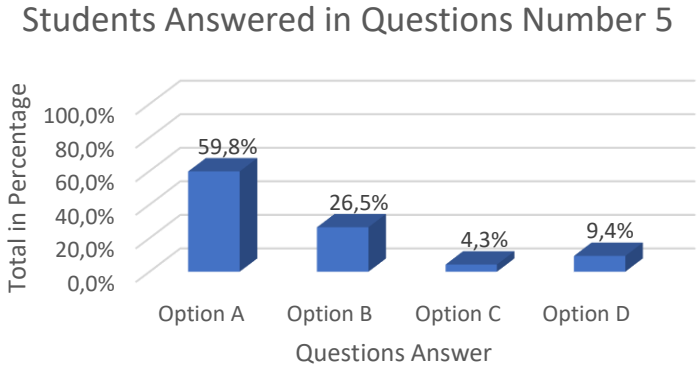

Figure 5. Results of Students Answered in Questions Number 5

In question number 5, the survey outcomes highlight varying preferences among students regarding the effectiveness of using animated PPT learning models

compared to traditional classroom explanations. A significant majority, constituting 59.8% of respondents, indicated a preference for understanding material better when presented with animated PPTs. Conversely, 26.5% of students reported understanding less with this method compared to traditional explanations. A smaller proportion, 4.3%, found it challenging to grasp concepts with animated PPTs, while 9.4% expressed indifference towards this learning approach. These findings underscore the importance of considering diverse instructional strategies to cater to students' learning needs and preferences effectively.

Question Number 6: Which one do you prefer? The learning model of the teacher/lecturer who only explains in front of the class or the learning model using animated PPT?

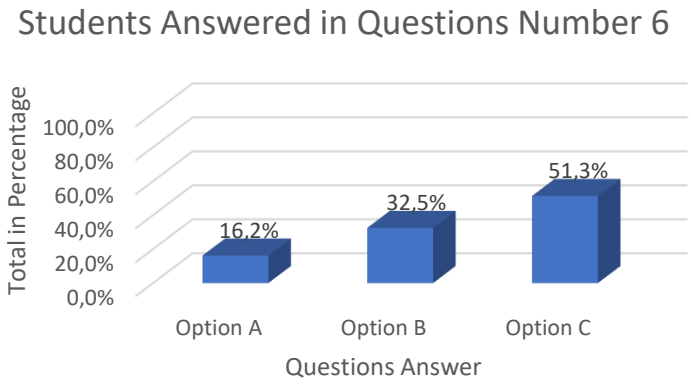

Figure 6. Results of Students Answered in Questions Number 6

In question number 6, the survey reveals students' varied preferences regarding teaching methods. Only 16.2% of respondents preferred the traditional approach of the teacher or lecturer explaining solely in front of the class. A larger group, 32.5%, favored a blended approach that combines direct explanation with animated PPT learning media. The majority, 51.3%, preferred the use of animated PPTs for explanations over the traditional method. These results indicate a significant inclination towards incorporating multimedia tools in teaching to enhance student engagement and comprehension.

Question Number 7: Which one do you prefer? The individual learning model or the group learning model?

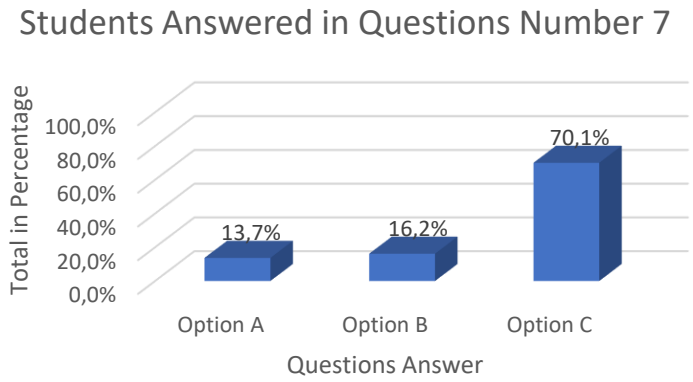

Figure 7. Results of Students Answered in Questions Number 7

In question number 7 in Figure 7, the survey indicates a strong preference for group learning models among students. Specifically, 70.1% of respondents favored group learning over individual learning. A smaller proportion, 16.2%, felt that both individual and group learning models are equally effective. Only 13.7% preferred individual learning models. These findings suggest that collaborative learning environments are highly valued and may be more effective in enhancing student engagement and understanding.

Question Number 8: What is the result of the indefinite integral of ∫3x^2 (4-2x) dx=

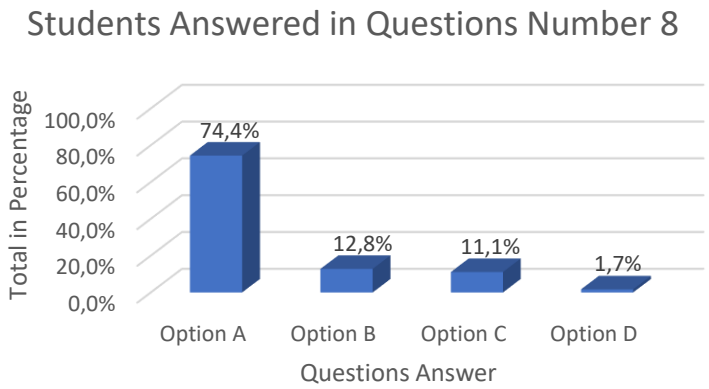

Figure 8. Results of Students Answered in Questions Number 8

In question number 8 as we can see in Figure 8, the survey results demonstrate a clear preference for the answer 4x3-6/4x4+c, with 74.4% of students selecting this option. Meanwhile, 12.8% chose -4x3-6/4x4+c, 11.1% selected 3x3-2/4x4+c, and only 1.7% opted for 5x3-2/4x4+c. These percentages highlight that a significant majority of students favor the first option, suggesting a strong consensus or understanding regarding this particular expression.

Question Number 9: What is the result of the indefinite integral of ∫(3 sinx + 4) dx=

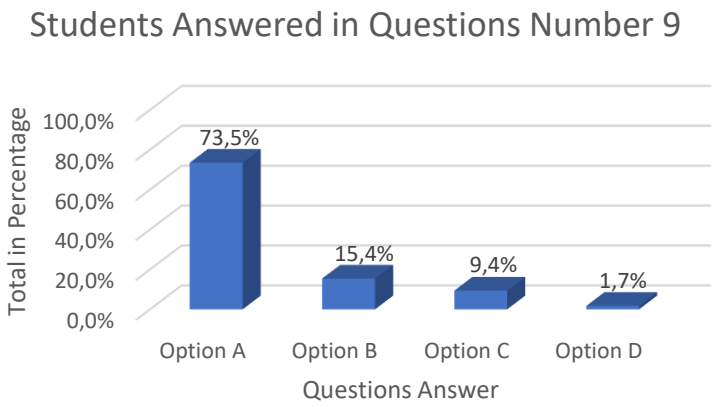

Figure 9. Results of Students Answered in Questions Number 9

In question number 9 the survey results indicate a predominant preference for the answer -3 cosx+4x+c, with 73.5% of respondents selecting this option. Additionally, 15.4% chose 3 cosx+4x+c, 9.4% selected -3 sinx+4x+c, and 1.7% opted for 2 cosx+4x+c. These percentages reflect a strong consensus among students favoring the first expression, suggesting it is widely understood or considered the most accurate.

Discussion

The average student's comprehension of indefinite calculus is satisfactory, as evidenced by their correct responses to the given questions. Students tend to favor and better understand lessons presented using cooperative/group learning models and animated PPTs. Additionally, most students demonstrate a solid grasp of integral calculus, particularly indefinite integrals.

Understanding and Response to Integral Calculus Material

The findings on students' understanding and response to integral calculus material offer valuable insights into their academic experiences and attitudes towards mathematics. The significant percentage of students expressing interest in mathematics (59.8%, option A) is encouraging, indicating a positive inclination towards the subject matter. This interest in mathematics may stem from various factors, such as personal curiosity, and previous exposure to engaging mathematical experiences.

However, despite the majority showing interest in mathematics, a substantial portion of students (18.8%, option C) reported difficulty in fully grasping integral calculus material, particularly the topic of indefinite integrals. This disparity between interest and comprehension suggests potential challenges in translating interest into academic success. Factors contributing to this gap may include varying levels of prior mathematical preparation, individual learning styles, and the complexity of integral calculus concepts.

In conclusion, it's crucial to not only acknowledge students' interest in mathematics but also their ability to comprehend the material taught. Efforts can be made to strengthen their mathematical foundations, provide diverse learning approaches, and offer additional support to students facing specific difficulties (Muhtarom et al., 2019; Malasari et al., 2024; Dasari et al., 2024). This way, it can be hoped that existing interest can be translated into higher academic achievements in mathematics, including integral calculus (Hassim et al., 2023).

Preferences Regarding Learning Models

The findings regarding students' preferences for learning models emphasize the critical role instructional methods play in facilitating understanding and engagement with integral calculus material. The substantial majority of students (59.8%, option A) favour the learning model that incorporates animated PowerPoint (PPT) presentations, indicating a strong inclination towards multimedia-enhanced learning approaches. This preference underscores the importance of visual aids and interactive media in enhancing students' comprehension and retention of complex mathematical concepts (Fokuo et al., 2023; Prihatin et al., 2024).

The preference for multimedia-enhanced learning suggests that students respond positively to instructional methods that utilize technology and incorporate dynamic visual elements. Animated PowerPoint presentations can provide visual representations of abstract mathematical concepts, making them more tangible and easier to grasp. Additionally, interactive features can engage students actively in the learning process, promoting deeper understanding and retention (Zaim, 2016; Abdulrahaman et al., 2020; Anwar et al., 2024).

On the other hand, a smaller percentage of students (16.2%, option A) expressed a preference for the traditional learning model, which relies solely on teacher-led explanations. While this preference may stem from familiarity with traditional instructional methods, it also highlights the importance of educators adapting their teaching strategies to meet the evolving needs and preferences of

contemporary learners. Simply relying on traditional approaches may not fully engage or meet the diverse learning styles of today's students.

To address this, educators can integrate multimedia resources, collaborative activities, and other innovative instructional techniques into their teaching practices. By creating dynamic learning environments that cater to diverse learning styles and preferences, educators can enhance student engagement, promote deeper understanding, and ultimately improve academic outcomes in integral calculus and other mathematical subjects (Sadaphal, 2023; Eden et al., 2024). This adaptation of teaching strategies ensures that instruction remains effective and relevant in meeting the needs of 21st-century learners.

Effectiveness of Cooperative Learning and Animated PowerPoint (PPT) Media

In this article, we can observe that the use of the cooperative learning strategy STAD (Student Teams Achievement Division) can be an effective approach to enhancing students' understanding and interest in integral calculus. The data presented indicate that the combination of group-based learning and individual accountability can yield positive outcomes in the context of integral calculus education.

Firstly, from the provided survey results, we can see that a significant portion of students exhibit interest in the subject of integral calculus. However, when asked about their understanding of the material, some students express difficulties in grasping it. Secondly, the data also highlight the variance in students' preferences for different learning methods. While the majority of students favor the use of animated PowerPoint (PPT) presentations to enhance their understanding, there are also those who prefer traditional teaching methods where the teacher provides direct explanations in front of the class.

In this context, STAD can serve as a fitting solution. By leveraging cooperative learning strategies, teachers can integrate various learning methods, including the use of animated PPTs and direct explanations, to cater to the diverse needs of students. STAD allows students to work in small groups, where they can support and teach each other (Sufanti & Santosa, 2021; Afriansyah et al., 2023). This not only enhances their understanding of the material but also develops social skills and collaboration.

Furthermore, STAD enables teachers to accommodate individual student preferences. For instance, when designing group tasks, teachers can allow students to choose their preferred presentation method, whether it be using animated PPTs

or direct explanations (Cahyadi & Wikanengsih, 2020; Syifa & Utami, 2021). Thus, each student can feel motivated and actively engaged in the learning process. The use of the cooperative learning strategy STAD can provide a holistic and effective approach to enhancing students' understanding and interest in integral calculus. By considering students' preferences and integrating various learning methods, teachers can create a dynamic and inclusive learning environment that supports academic growth and comprehensive student development.

Conclusion

The study investigated students' understanding and preferences regarding integral calculus, focusing on indefinite integrals, and their responses to various learning models. Through quantitative analysis and online questionnaires administered to 117 students from 37 educational institutions, the findings revealed that while a significant portion of students expressed interest in mathematics and felt they understood integral calculus adequately, there was also a notable percentage facing difficulties in grasping the concepts fully. However, most students preferred instructional methods beyond traditional teacher-centered approaches, favouring cooperative learning models and animated PowerPoint presentations. Despite varied levels of understanding, the assessment of student's knowledge through questions related to indefinite integrals indicated a satisfactory level of comprehension among the majority of participants, suggesting the effectiveness of preferred learning models in enhancing understanding and engagement with integral calculus concepts.

Some suggestions for enhancing students' understanding of integral calculus, particularly indefinite integrals, include encouraging active engagement through initial comprehension of the material followed by extensive practice. Utilizing learning models developed by experienced educators can also prove beneficial in classroom settings. Emphasizing dedication and consistency in the learning process can further stimulate student interest and foster deeper insights into indefinite integrals.

References

Abdulrahaman, M.D., Faruk, N., Oloyede, A.A., Surajudeen-Bakinde, N.T., Olawoyin, L.A., Mejabi, O.V., Imam-Fulani, Y.O., Fahm, A.O., & Azeez, A.L. (2020). Multimedia tools in the teaching and learning processes: A systematic review.

Heliyon, 6, 1-14.

Afriansyah., Sari, S. M., & Akmaluddin. (2023). Application of the STAD Type Cooperative Learning Model to Improve Student Learning on The Indonesian Foreign Politics Topic in Class VI of SD Negeri Rotteungoh. *Proceedings of the 1st International Conference on Education, Science Technology and Health*, 973-980.

Akhmad, F. (2020). Penerapan Model Pembelajaran Kooperatif Tipe Student Teams–Achievement Division (STAD) Untuk Meningkatkan Hasil Belajar Siswa Pada Mata Pelajaran Pemeliharaan Mesin Kendaraan Ringan. *Jurnal Pendidikan Vokasi Otomotif*, *2*(2), 35-48.

Anwar, A., Hasan, S., & Haerani, E. (2023). Increasing Student Learning Enthusiasm Through Multimedia-Based Learning. *Al-Ishlah: Jurnal Pendidikan*, *15*(3), 3210-3217.

Apriyani, D. D., & Sirait, E. D. (2021). Pengembangan Instrumen Minat Belajar Siswa Pada Pelajaran Matematika. *SAP: Susunan Artikel Pendidikan*, *6*(1), 99-104.

Ariani, T., & Agustini, D. (2018). Model Pembelajaran Student Team Achievement Division (STAD) dan Model Pembelajaran Teams Games Tournament (TGT): Dampak terhadap Hasil Belajar Fisika. *SPEJ (Science and Physic Education Journal)*, *1*(2), 65-77.

Ario, M., & Asra, A. (2018). Pengaruh Pembelajaran Flipped Classroom Terhadap Hasil Belajar Kalkulus Integral Mahasiswa Pendidikan Matematika. *Anargya: Jurnal Ilmiah Pendidikan Matematika*, *1*(2), 82-88.

Azis, A. A., Adnan., Muis, A., & Musawwir., & Faisal. (2013). Penerapan Pembelajaran Kolaboratif Untuk Meningkatkan Aktifitas Belajar Siswa Kelas XI IPA 3 Melalui Lesson Study Berbasis Sekolah Di SMA Negeri 8 Makassar. *Bionature*, *14*(1), 38-43.

Bien, Y. I. (2018). *Kalkulus Integral Berbasis Maple*. Yogyakarta: CV Budi Utama

Cahyadi, Y., & Wikanengsih. (2020). The Comparison Between STAD +3r Based on Digital Media Methods and The Cooperative Model STAD Type in Writing Explanation Text. *JLER: Journal of Language Education Research*, *3*(2), 135-143.

Dasari, D., Muhammad, I, & Juandi, D. (2024). Crafting math minds: A bibliometric odyssey into innovative didactical designs for learning (2006-2023). *Jurnal Elemen*, *10*(1), 181-198.

Depdiknas. (2006). *Standar Kompetensi dan Kompetensi Dasar Matematika SMA/MA.* Jakarta: Depdiknas

Djamarah, S, B, & Zain, A. (2002). *Strategi Belajar Mengajar*. Jakarta: Rineka Cipta.

Eden, C. A., Chisom, O. N., & Adeniyi, I. S. (2024). Harnessing technology integration in education: Strategies for enhancing learning outcomes and equity. *World Journal of Advanced Engineering Technology and Sciences*, *11*(02), 1-8.

Febriana, K., Sunarjan, Y, Y. F. R., & Atmaja, H. T. (2018). Pengaruh penggunaan media Power point terhadap minat belajar sejarah siswa kelas X SMA negeri 1 Bumiayu tahun ajaran 2017/2018. *Indonesia Journal of History Education, 6*(1). 31-41.

Fokuo, M. O., Opoku-Mensah, N., Asamoah, R., Nyarko, J., Agyeman, K. D., Owusu-Mintah, C., & Asare, S. (2023). The use of visualization tools in teaching

mathematics in college of education: A systematic review. *Journal of Science and Technology*, *09*(01), 1-9.

Hadi, S. (2005). *Pendidikan Matematika Realistic dan Implikasinya.* Banjarmasin: Tulip.

Hassim, N. H., Mat Zin, S. H. H., & Yusri, M. Y. (2023). Investigating The Attitudes Towards Learning Calculus Among Science and Technology Students: A Case Study in UiTM Johor, Malaysia. *International Journal of Modern Education*, *5* (18), 75-89.

Hayati, L, & Romdhini, U, M. (2012). Kalkulus Differensial dan Integral Oleh Fermat, *Jurnal Pijar MIPA*, *7*(1), 1-42.

Hoesny, M. U., & Darmayanti, R. (2021). Permasalahan dan Solusi untuk Meningkatkan Kompetensi dan Kualitas Guru: Sebuah Kajian Pustaka. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, *11*(2), 123-132.

Indriyati, K. (2019). *Kalkulus Dasar untuk Perguruan Tinggi*. Jakarta: Universitas Katolik Indonesia Atma Jaya.

Joseph, J. U. (2020). Understanding the Concept of Language of Mathematics for Effective Teaching and Learning of Mathematics in a School System. International *Journal for Educational and Vocational Studies*, *2*(10), 853-860.

Kesumawati, N. (2008). Pemahaman Konsep Matematik dalam Pembelajaran Matematika. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematik*. Yogyakarta:Universitas Negeri Yogyakarta

Li, V, L., Julaihi, N. H., & Eng, T. H. (2017). Misconceptions and Errors in Learning Integral Calculus. *Asian Journal of University Education*, *13*(1), 17-39.

Machromah, I. U., & Purnomo, M. E. R. (2017). Process Skill Error: The Majority Student's Error in Problem Solving of Integral Calculus. *Jurnal Daya Matematis*, *5*(3), 358-376.

Malasari, T., Siregar, F. A. N., Syakira, R. I., & Asrizal, S. S. (2024). Analysis of Students' Errors in Solving Indefinite Integral Problems. *Jurnal Keislaman dan Ilmu Pendidikan*, *4*(1), 1-16.

Malda., & Surya E. (2017). Improving the Learning Outcomes of Students using Numbered Heads Together Model in the Subjects of Mathematics*. International Journal of Sciences: Basic and Applied Research (IJSBAR), 33*(3), 311-319*.*

Manurung, G. A., Simanjuntak, L. A., & Sihombing, R. A. (2021). Misconceptions On the Concept of Photosythesis and Plant Respiration for Class VIII at SMP Negeri 27 Medan in Science Learning. *Indonesian Science Education Research (ISER)*, *3*(2), 12-19.

Misbahudin, D., Rochman, C., Nasrudin, D., & Solihati, I. (2018). Penggunaan Power point sebagai media pembelajaran: Efektifkah?. *Jurnal Wahana Pendidikan Fisika, 3*(1), 43-48.

Muhtarom, M., Nizaruddin, N., Nursyahidah, F., & Happy, N. (2019). The effectiveness of realistic mathematics education to improve students' multi-representation ability. *Infinity*, *8*(1), 21-30.

Napfiah, S. (2021). Identification of Understanding Student in Solving Integral Calculus Based on Mathematical Ability. *Journal of Education and Learning Mathematics Research (JELMaR)*, *2*(2), 7-13.

Ngalimun, F, M, & Salabi, A. (2016). *Strategi dan Model Pembelajaran*. Yogyakarta: Aswaja Pressindo.

Octavia, S. C., Sihombing, R. A., Destine, K. T., & Hutagalung, J. F. (2022). Analysis of Obstacles on Limited Face-To-Face Learning During the Covid-19 Pandemic Junior High School in Medan. *Tarbiyah: Jurnal Ilmiah Kependidikan*, *11*(1), 18-28.

Panggabean, F. T. M., Simanjuntak, L. A., Sihombing, R. A., Octavia, S. C., & Tambunan, J. (2023). Analysis of 7th-grade Students' Misconceptions of Acid-Base. *J-PEK (Jurnal Pembelajaran Kimia)*, *8*(1), 1-7.

Prihatin. A. Y., Arcana, I. N., & Kusumaningrum, B. (2024). Development of trigonometric comparison teaching materials based on ICT and Tri-N for face-to-face and distance learning. *Union: Jurnal Ilmiah Pendidikan Matematika*, *12*(1), 187-201.

Rafiepour, A., & Farsani, D. (2021). Cultural Historical Analysis of Iranian School Mathematics Curriculum: The Role of Computational Thinking. *Journal on Mathematics Education*, *12*(3), 411–426.

Sadaphal, U. (2023). Advancing Pedagogy and Evaluation for Effective Teaching Learning Practices Using Virtual Environment. *MSW MANAGEMENT Multidisciplinary, Scientific Work and Management Journal*, *33*(1), 236-245.

Setiawan, A. (2015). Penerapan Belajar Kelompok Untuk Meningkatkan Minat dan Prestasi Belajar Bahasa Indonesia SD Negeri Kepek. *Jurnal Pendidikan Sekolah Dasar*, *7*(4), 1-10.

Sholihah, U., & Mubarok, D. A. (2016). Analisis Pemahaman Integral Taktentu Berdasarkan Teori Apos (Action, Process, Object, Scheme) Pada Mahasiswa Tadris Matematika (Tmt) Iain Tulungagung. *Cendekia: Jurnal Kependidikan dan Kemasyarakatan*, *14*(1), 123-129.

Sihombing, R. A. (2023). Implementasi Program Kampus Mengajar Angkatan 4 Dalam Meningkatkan Literasi, Numerasi, Adaptasi Teknologi Siswa. *REKA KARYA: Jurnal Pengabdian Kepada Masyarakat*, *2*(2), 204-213.

Sihombing, R. A., & Hasruddin. (2024). Development of Science, Technology, Engineering, and Mathematics (STEM)-Based E-Book on Human Digestive System Material Based on Scientific Literacy. ***Jurnal Pendidikan Matematika dan IPA***, *15*(2), 182-197.

Sihombing, R. A., Manurung, G. A., & Simanjuntak, L. A. (2021). Analysis of Implementation of TPACK by Teachers Through Distance Learning at Junior High School in Medan. *Indonesian Science Education Research (ISER)*, *3*(2), 1-11.

Sihombing, R. A., Manurung, G. A., & Simanjuntak, L. A. (2022). Analysis Implementation of Technological Pedagogical Content Knowledge by Science Teachers Through Distance Learning at Junior High School in Medan. *Jurnal Pendidikan Matematika dan IPA*, *13*(2), 214-230.

Sihombing, R. A., Muslim., & Rahman, T. (2023). The Development of Interactive Audio-Visual-Based Media Using VideoScribe to Reduce Misconceptions Electrical Potential and ECG Material. *Tarbiyah: Jurnal Ilmiah Kependidikan*, *12*(2), 69-80.

Sihombing, R. A., Muslim., Rahman, T., & Karimi, A. (2024). Literature study of the E-book based on Education for Sustainable Development (ESD) as the main solution to improving sustainability awareness. *INSECTA: Integrative Science Education and Teaching Activity Journal*, *5*(1), 108-120.

Siregar, H. M., & Solfitri, T. (2019). An Analysis of Students' Errors in Solving Indefinite Integral Problems Viewed from Gender Differences. *Journal of Research on Mathematics Instruction*, *1*(1), 17-24.

Skemp, R. R. (1971). *The Psychology of Learning Mathematics.* Baltimore: MD Rahimah, D. 2012. Identifikasi kesalahan mahasiswa dalam menyelesaikan soal-soal pokok bahasan integral pada mata kuliah kalkulus integral. *Exacta: Jurnal Pendidikan Matematika dan Sains, 10*(1), 89-97.

Sufanti, M., & Santosa, C. A. H. F. (2021). The Influence of STAD Cooperative Strategies (Teaching Aids and Multimedia Power Points) and Learning Style on Mathematics Learning Outcomes. *Jurnal Pendidikan Matematika dan IPA*, *12*(1), 40-52.

Sulthon, S. (2017). Pembelajaran IPA yang Efektif dan Menyenangkan bagi Siswa MI. *Elementary Islamic Teacher Journal*, *4*(1), 38-54.

Suryana, Y. R., & Somadi, T. J. (2018). Kajian Model Pembelajaran Kooperatif Tipe STAD (Student Teams Achievement Division) Dalam Upaya Meningkatkan Efektifitas Proses Belajar Mengajar Akuntansi. *Oikos: Jurnal Kajian Pendidikan Ekonomi dan Ilmu Ekonomi*, *2*(2), 133-145.

Susilo, B. E. (2019). Kesulitan Belajar Mahasiswa pada Materi Aplikasi Integral untuk LuasDaerah dalam Perspektif Disposisi Matematis. *Jurnal Matematika Kreatif-Inovatif, 10*(1), 86-93.

Susilo, B. E., Darhim., & Prabawanto, S. (2019). Students Critical Thinking Skills Toward Concepts Differences in Finding Area of A Plane Region and Definite Integral. *Unnes Journal of Mathematics Education*, *8*(1), 1-7.

Syifa, U. L., & Utami, N. R. (2021). The Development of Student Team Achievement Division (STAD) Online Learning Tools to Improve Students' Analytical Ability. *Journal of Biology Education*, *10*(3), 270-276.

Varberg, D., Purcel, E. J., & Rigdon, S. E. (2010). *Kalkulus Jilid 1 Edisi 9*. Jakarta: Erlangga.

Wulandari, I. (2022). Model Pembelajaran Kooperatif Tipe STAD (Student Teams Achievement Division) dalam Pembelajaran MI. *Jurnal Papeda*, *4*(1), 17-23.

Zaim, M. (2016). The Power of Multimedia to Enhance Learners' Language Skillsin Multilingual Class. *Proceedings of the Fourth International Seminar on English Language and Teaching*, 22-29.

Zetriuslita, Z., Ariawan, R., & Nufus, H. (2016). Analisis Kemampuan Berpikir Kritis Matematis Mahasiswa Dalam Menyelesaikan Soal Uraian Kalkulus Integral Berdasarkan Level Kemampuan Mahasiswa. *Infinity Journal*, *5*(1), 56-65.

Zulkarnaen. (2021). *Analisis Kesulitan Belajar Matematika Dalam Pembelajaran Berbasis Daring Mahasiswa Semester III Prodi Tadris Matematika UIN Mataram Tahun Akademik 2020/2021*. *Skripsi*. Fakultas Tarbiyah Dan Ilmu Keguruan Universitas Islam Negeri (UIN) Mataram: Mataram.