

## **Analysis of student difficulties in calculus and intervention strategies for problematic students**

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**Abstract.** In engineering-based colleges, calculus is one of the compulsory subjects that is generally given to first-year students. Although this course is important to be mastered by students, some students do not like this lesson and become the cause of their failure to learn the material next. The purpose of this study was to analyze the difficulties students as well as describing the results of the intervention were given to students who have difficulty in learning calculus. This study uses a mixed-method. To see the difficulty of students used instruments in the form of tests given at the end of lectures. The test material is in the form of multiple-choice with 40 items consisting of 12 limit items, 14 Derivative items, and 12 Integral items. The results of tests on 56 students showed that the average tenure of the calculus of 57.3 percent which includes mastery of the Limit on average by 61.5 %, mastery Derivative average 54 percent and mastery Integral average of 56.5 percent. Furthermore, students who do not reach graduation standards are given a remedial intervention program. Through the remedial program provided, students can achieve the specified graduation standards.

### **1. Introduction**

Calculus is a branch of mathematics that has relations with other material which is quite broad in various disciplines such as engineering, social and others. Ideally students studying in the first year must be able to: (1) Make calculations with agility, accuracy, intelligence and flexibility; (2) Explain the basic concepts of calculus clearly and reason mathematically with them; (3) Solve extended problems with good judgment in the choice of tools and in checking answers; (4) Make a connection between different incarnations of the same idea; (5) Use calculus to model realistic situations from engineering and the physical, life and social sciences [1].

Fact, these calculus lessons are often the main sources of failure for students to complete their studies. Calculus is considered as one of the difficult subject matter for students [2-3]. As stated [4] that the difficulty of students in calculus is caused by its nature in the form of abstract ideas and very complex

calculations. Besides calculus is seen as a boring and only procedural subject [5], educators in the practice of learning calculus material in the classroom are done traditionally [6-7]. More than that students do not know how to apply concepts in real-life situations [8-9]. As a result, many students fail to get good grades in these subjects, including students of the Manufacturing Polytechnic, Bangka Belitung.

This will certainly be a problem for students who will take part in lectures and challenges for lecturers who will teach. Such a condition if left unchecked will harm the quality of learning in calculus courses, especially in the electronics engineering department of the Manufacturing Polytechnic, Bangka Belitung. Therefore, efforts are needed to overcome these problems. To improve the quality of teaching students, need innovation by using approaches, strategies, and methods of learning new [10]. A few ways that can help to improve student understanding of calculus, among others: (1) active learning; (2) build up intuitions suitable for later formalizations ; (3) computer graphics; (4) computer programming; and (5) symbol manipulators [11]. With technological advances, various ways have been made to help facilitate learning calculus, such as developing graphics using software [12]. This software aims to facilitate student understanding of learning graph functions. Durán, [13] developed a computer algebra system to make it easier for students to explore the concept of calculus. Through the use of technology, students better understand the things that are abstract and complex on lessons calculus [14-16] , help the understanding of students in the conceptual [16-17 ] and procedural skills [18-19]. D ith the technology students showed a positive attitude toward the subject of the lectures are studied [20-21]. Besides, the technology also can help students when visualizing concepts through graphical representations with a better [22].

Although various technologies have been developed and have been applied by educators to students, some students still have difficulties in studying calculus topics, as experienced by students in the Department of Electronics Engineering Manufacturing Polytechnic, Bangka Belitung. Existing technology does not seem to be suitable for every student. Therefore, in addition to technology, other things also need to be considered to be able to overcome the difficulties of students so that they can overcome the difficulties they face when studying calculus. Therefore it is necessary to investigate any topic from the calculus material that is difficult for students, what factors cause it, and what strategies can help them so that later students can complete their studies on time. This study aims to analyze the difficulties of students in learning calculus which includes limit, derivative and integral material. Furthermore, students who have difficulty attending this lecture are given an intervention strategy with a remedial program. From the formulation of the problem, it can be broken down into some problem formulations as follows:

- What topics from calculus material are difficult for students?
- How is the implementation of the intervention strategy given to students?

## **2. Methodology**

The method used in this research is mixed methods research, which is a study that combines or connects qualitative and quantitative research methods [23]. The data obtained are presented in the form of numbers and the results are explained descriptively Analytically. Descriptive aims to describe something that is ongoing at the time of the study and examines the causes of a particular symptom. It also aims to solve problems that arise at that time. The reason for choosing the analytical descriptive method is because this study intends to describe and analyze a student's difficulty that occurs when studying calculus material. Thus this study seeks to describe or describe data obtained from test results obtained by students. From this data obtained topics that are students' difficulties in learning calculus. Furthermore, for the support of this research interviews were conducted on several students who faced problems. This is intended to divert deeper why they have difficulty in studying the material provided and what interventions they think are appropriate to be carried out.

*2.1. Research location and time*

This research was conducted at the Bangka Belitung State Manufacturing Polytechnic in the second-semester electronics engineering students in the 2018/2019 academic year as many as 56 students. This research was carried out through several stages, starting from the preparation stage, data collection, data analysis, and finally reporting results.

*2.2. Data collection techniques*

Data collection techniques used in this study used several methods including (1) Tests; (2) Questionnaire; and (3) interviews. This method is carried out to find out detailed information and understanding per student's problem under study. The interviews used by researchers are interviews that have been arranged systematically and completely to collect data in the form of an outline of the problem to be asked.

**3. Discussion**

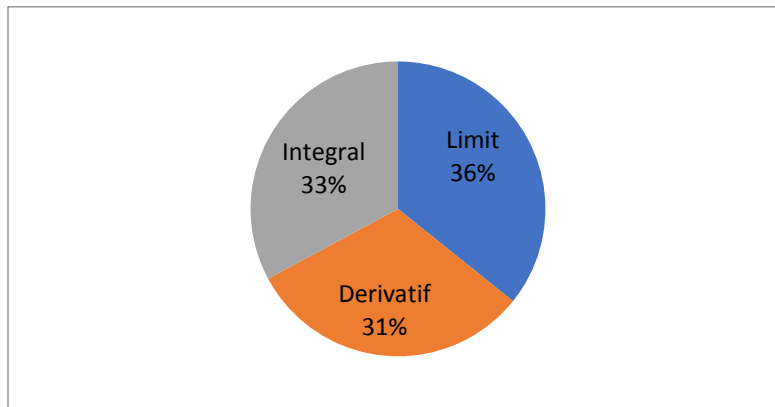
*3.1. Analysis of student hardness*

To see the students difficulty against calculus, at the end of the course students are given a test by the number of about 40 grains (about the limit of 12 items, the issue of derivatives 15 grains and about integral 13 grains), as shown in Table 1 below:

**Table 1.** Calculus test questions.

No	Topics	Number of Questions
<b>The limit</b>		
1	algebraic functions limits	6
2	trigonometric function limits	2
3	infinite function limit	4
<b>Derivative</b>		
4	derived algebraic functions	2
5	derived trigonometric functions	3
6	derived the multiplication of two functions	3
7	derivative Implicit function	1
8	derived logarithm functions	2
9	derived exponent functions	2
10	the second derivative of algebraic and trigonometric functions	1
11	derived on a moving object vertical	1
<b>Integral</b>		
12	integral algebraic functions	3
13	integral trigonometric functions	1
14	integral by substitution	3
15	partial integral	2
16	certain integral of an algebraic function	1
17	certain integral of a trigonometric function	1
18	calculate area with integral	1
<b>Total</b>		<b>40</b>

The test results of the questions given can be seen as in Figure 1.



**Figure 1 . Student calculus test results.**

Figure 1 above shows that the average results of tests on 56 people are 57.3% which consists of a Limit with an average of 61.5 %, Derivatives with an average of 54 %, and Integral with an average of 56.5 %. From the questions given, the lowest value is about determining the area of an area by using integrals.

### *3.2. Intervention strategy*

Giving a strategy of intervention in the form of remedial given to students whose value does not reach the standard set that is minimal with a score of 60. Before the remedial program is given, first, conducted interviews to obtain information from students about what factors cause them not to stigmatize results test well. For remedial activities, students are given questioner to obtain information about what strategies are elected to support their learning progress. Based on interviews given to the two students who scored the lowest, information was obtained that the main factor that caused them to fail was not because of their lack of academic ability, but because of the lack of study time they had. This is due to the economic factors of students. To meet the needs of students and their families, they are forced to work. They work after the lecture program is finished until the evening. They barely had time to study well. With these conditions, as an educator pay special attention, namely by motivating them. Besides, they are also equipped with knowledge of how to manage study time, even though they have to work. Furthermore, based on the results of student assessments, the form of the remedial program they choose is with the help of technology. Then agreed that the students use the software examview used as practice doing problems calculus. Besides they also learn by using peer teaching methods. After the remedial program ends, students are allowed to retake to achieve the minimum standards given. The results of the remedial program provided can help students to reach the minimum standards that have been set.

## **4. Conclusions**

Student test results show that the mastery of students on average of the results of tests on 56 people is equal to 57.3% consisting of a Limit with an average of 61.5 %, Derivatives with an average of 54 %, and Integral with an average of 56.5 %. Of the 40 items given, the most difficult for students to experience is the problem in determining the area of an area using integrals. For this condition, a re-explanation is given to those who have difficulty with this material at the time the remedial program was conducted. Next to that giving intervention in the form of remedial help in enhancing the learning outcomes of students, so that they can achieve the minimum standards set.

## 5. References

- [1] Bulazel A and Yener B 2017 *Proceedings of the 1st Reversing and Offensive-oriented Trends Symposium on - ROOTS* 1-21
- [1] Ganter S L 200 *Calculus Renewal : Issues for Undergraduate Mathematics Education in The Next Decade* New York: Kluwer
- [2] Angeles M R, Fajardo A C and Tanguilig III B T 2015 *International Journal of Engineering and Technical Research* **3** 18-21
- [3] Salazar D A 2016 *Journal of Education and Practice* **1** 119-126
- [4] Sahin A, Cavlazoglu B and Zeytuncu Y E 2015 *Educational Technology & Society* **18** 142–152
- [5] Matthews A R, Hoessler C, Jonker L and Stockley D 2013 *Canadian Journal of Science, Mathematics and Technology Education* **13** 1-17
- [6] Lasut M 2015 *International Journal of Scientific and Research Publications* **5** 1-4
- [7] Axtell M 2006 *Mathematics and Computer Education* **40** 130-137
- [8] Fluck A and Dowden T 2013 *Journal of Computer Assisted Learning* **29** 43- 52
- [9] Nobre C N, Meireles M R G, Junior N V, De Resende M N, Da Costa L E and Da Rocha R C 2016 *Informatics in Education* **15** 253
- [10] Hoic-Bozic N, Vornar V and Boticki I 2009 *IEEE Transactions on Education* **52** 19-30
- [11] Tall D 1992 *Plenary presentation in Working Group 3 ICME Québec*
- [12] Lavicza Z 2010 *ZDM – The International Journal on Mathematics Education* **42** 105-119
- [13] Durán A J, Pérez M and Varona J L 2014 *Notices of The American Mathematical Society* **61** 1249–1252
- [14] Arango J, Gaviria D and Valencia A 2015 *Procedia-Social and Behavioral Sciences* **176** 412-418.
- [15] Zakaria E and Salleh T S 2015 *Mediterranean Journal of Social Sciences* **6** 144
- [16] Bartell T G, Webel C, Bowen B and Dyson N 2013 *Journal of Mathematics Teacher Education* **16** 57-79
- [17] Richland L E, Stigler J W and Holyoak K J 2012 *Educational Psychologist* **47** 189-203
- [18] Rittle-Johnson B and Schneider M 2014 *Developing conceptual and procedural knowledge of mathematics* Oxford: Oxford University Press pp.1102-1118
- [19] Cragg L and Gilmore C 2014 *Trends in Neuroscience and Education* **3** 63-68
- [20] Sang G, Valcke M, Van Braak J and Tondeur J 2010 *Computers & Education* **54** 103-112
- [21] Yuan, Y., & Chun-Yi, L.E.E. (2012). Elementary school teachers' perceptions toward ICT: The case of using magic board for teaching mathematics. TOJET: The Turkish Online Journal of Educational Technology, 11(4). Available at: [goo.gl/EtxVLX](http://goo.gl/EtxVLX).
- [22] Moses P, Wong S L, Bakar K A and Mahmud R 2013 *The Asia-Pacific Education Researcher* **22** 293-299
- [23] Creswell J W 2014 *Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.)* London: Sage Publications Ltd