Implications of Anti derivatives in the Practical Life of Students' Future Career

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ABSTRACT

This study looks into the practical applications of anti derivatives in the academic and professional life of engineering students. The study's goal is to relate theoretical knowledge gained throughout academic studies to its application in real-world circumstances. The study explores how students use anti derivatives in practical circumstances, analyzes problems encountered in their professional application, and measures students' recall of important ideas and theories. Semi-structured interviews were conducted with 58 engineering students from various domains to find significant differences in gender across disciplines. While the majority of participants were men, certain fields, such as chemical engineering, saw increasing female involvement. The findings highlight the various applications of anti derivatives. Civil engineers frequently use them for area calculations, structural analysis, and project assessments, whereas mechanical engineers use them for volumetric calculations, control systems, and energy studies. Electronic engineers claimed applications in signal processing, fluid dynamics, and thermal analysis. Chemical engineers use anti derivatives in reactor design, thermodynamics, and plant construction, whereas information technology professionals use them in data science and network theory. Despite their importance, difficulties such as limited practice and comprehension were identified, limiting practical application. The study also highlights the respondents' varying levels of satisfaction, with training methods having an important effect on their assessment of anti derivatives' applicability. Recalling concepts frequently relied on resources such as books, internet tools, and advice from peers and teachers.

KEYWORDS

Anti derivative, Calculus, Engineering students, Implication of anti derivatives

INTRODUCTION

Calculus is the study of the nature of the curve, tangents and properties of the curved shape figure. Derivative is the result in the variable y when infinitesimal change in the variable x.

(Bajracharya, 2075) has defined derivative as: Let f be a continuous function defined in a closed interval then the derivative of the function f denoted by $\frac{df}{dx}$ defined by the limiting position of Δx as $\lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(x+\Delta x) - f(x)}{\Delta x}$. Simililarly, (Bajracharya, 2075) defined anti derivative of the function as: Let f(x) be the function defined in the closed interval, then the anti derivative of f(x) denoted by $\int f(x)dx$ and defined as $\int f(x)dx$ = F(x) where $\frac{dF(x)}{dx} = f(x)$. Both of the topics are the back bone in calculus even though the calculus first development from functions and its nature to be continuity and discontinuity.

Calculus is one of the courses learned by university students coming from mathematics, physics, biology, technique, agriculture, statistic, pharmacy and also Mathematic Tadris at Tarbiyah Faculty, IAIN Imam Bonjol Padang(Sepriyanti, Fauzan, Arnawa, & Lufri, 2017). Since the calculus reforms movement began, many researches were conducted on concept-based approaches to teach the fundamentals of calculus, e.g. a realistic approach as developed by (Kaput, 1994), a guided reinvention (Gravemeijer& Doorman, 1999), a computer-assisted approach (Lang, 1999), and a graphical approach (Tall D. , 1997).

(Tall, Function of Calculus, 1997) describes a possible sequence for differentiation. He presents the following line of reasoning. To be able to understand the derivative of f(x), one has to have the concept of a limit at one's disposal. For, one has to take the limit of the difference of the quotient as $\lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$ where h tends to zero. Thus the concept of a limit has to precede the derivative. Furthermore, one might decide that it is easier to take the limit in the case where x is fixed. The next step then would be to let x vary, to introduce the idea of a derivative in this manner. Further he argues for more emphasis on visualizing mathematical concepts and more enactive experiences in mathematics education.

(HERBERT, 2011) mentions that rate is an important mathematical concept that is often poorly understood by many people. It is a complicated concept comprising many interwoven ideas such as: change in a variable resulting from a change in a different variable; the ratio of two numeric, measurable quantities; constant and variable rate; and average and instantaneous rate. Core idea of calculus is the rate. According to (Thompson, 1994) as mentioned by (HERBERT, 2011) rate expresses the change in the dependent variable resulting from a unit change in the independent variable, and involves the ideas of change in a quantity; co-ordination of two quantities; and the simultaneous co variation of the quantities. (HERBERT, 2011) stresses that Rate is strongly connected to other mathematical concepts, such as ratio; proportion; fraction; division; gradient; and derivative. It is considered constant if the way in which the quantities change in relation to each other remains the same and variable if it differs.

Rowland and Jovanoski's study of the understanding of rate of fifty-nine first year science students with previous experience with calculus as mentioned by (HERBERT, 2011) found that many students confused amount and rate, for example they report one student's response that the constant term in a differential equation "*represents the amount of drug going into the patient's body*" or the constant term in a differential equation "*is the initial amount of drug in the body*".

According to (Bishop et al., 1996) as cited by (Tall, Function of Calculus, 1997) observes that the problem for a calculus course is in the transition from meaningful discussions based on visual imagery to formal mathematical reasoning. Kaput (1994a), emphasizes the relationship between mathematical symbol systems like graphs and everyday reality to introduce the concept calculus.

The researcher here in this research will try to search the utility of studying anti derivative. So here implication implies the utility of any object or matter. But in this research implication implies the utility of integration in our daily life and in our further study. The word above mentioned in the key word Engineering is that field of study that deals with planning and designing of anything.

This topic is of vital important to the success of any science and engineering fields, including engineering technology (Cheshier, 2006). It is critical for students taking engineering and science to excel in calculus, including integral calculus. A growing body of research has shown that students have difficulties in understanding the concept of integral calculus (Mahir, Salleh, & Abdul Rahaman, 2009;2011;2005). One of the main points emphasized is related to the teaching of calculus, where this topic needs the most cautious introduction and development. The consequence of introducing this subject without a proper planning and approach is too risky to students' future understanding about the subject related to calculus. He added that educators should never let students go through the differentiation and integration lessons procedurally without a deep understanding of the underpinning concepts. (Orton, 1995). The first-time students were introduced to calculus; they were exposed to calculations that involved complicated arithmetic and algebra. Thus, to avoid the difficulties, teachers often oversimplify the calculations (Tall D. , 1997).He added that this fact has contributed to the emergence of calculus dissatisfaction.

(Orton, 1995) gave the emphasis a few old, yet still relevant points to the teaching and learning of calculus reported by Incorporated Association of Assistant Masters in 1957(Orton, 1995). In his study, he emphasized one of the main points chained to the teaching of calculus, where this topic demands the most cautious introduction and development. The consequence of introducing this subject without a proper planning and approach is too risky to students' future understanding about the subject related to calculus. He added that educators should never let students go through the differentiation and integration lessons procedurally without a deep understanding of the underpinning concepts with the incorrect pedagogical attitudes of teachers, students tend to choose memorizing steps of solving mathematical problems (Akgün, 2008). Time factor is the most important. So, teacher must think at which time the required topic is to be taught. An appropriate time allocation in learning calculus during high school is also crucial to ensure the understanding of the first-year university calculus (Burton, 1989). Further he adds that the lack of the year of high school calculus can seriously handicap the first-year university student, who must compete with a significant proportion of classmates for whom the subject is not new.

Thus, Calculus is one of the fundamental courses in mathematics and has been introduced into the secondary school curriculum in Malaysia as one of the options in form four and form five mathematics. It provides a foundation and a gateway for more advanced mathematics and to other fields too (Tall, 1997). Further, (Maurice D. Weir, 2006) elaborates the need of calculus while defining the integral using its broad application as *"The integral is a key tool in calculus for defining and calculating many important quantities, such as areas, volumes, lengths of curved paths, probabilities, averages, energy consumption, population predictions, forces on a dam, work, the weights of various objects and consumer surplus, among many others."*

According to (Smith, 1970), Computer capabilities make possible many sequences of topics that have not previously been used. For example, one computer-based text introduced integration before differentiation, because the computer made Riemann sums so much more convenient and accessible than they were with a pencil-and-paper approach. Stressing the need of studying calculus for its utility, (Robinson, 2010) said that the 21st century biology requires interdisciplinary approaches across different disciplines, such as engineering, computer science, physics, chemistry and mathematics to deal with higher level of complex problems, especially related to health, food, energy and environment which are becoming more dependent on other disciplines to collaborate in providing new applicants, new methods, new techniques and new tools.

In the article, (Cheshier, 1998) defines the engineering technology as an applied field. He elaborates it as "*The profession in which knowledge of mathematics and natural sciences, gained by higher education, experience, and practice, is devoted primarily to the implementation and extension of existing technology for the benefit of humanity. Engineering technology education focuses primarily on the applied aspects of science and engineering, aimed at preparing graduates for practice in that portion of the technological spectrum closest to product improvement, industrial practices, and engineering operational functions."*

Above paragraph declares how important is the use of mathematics is in applied fields. In the same article, (Cheshier, 1998) listed the reasons why the bachelors students engineering fields to study from the interviews among pass out students. He explains that they choose these courses because of job satisfaction, challenging work, financial security, intellectual development, opportunities to understand how things work, opportunities to benefit society, variety of career opportunities, professional work environment, prestige and avenues for expressing creativity.

Statement of the problems

The Realistic Teaching Approach creates a contextual and homely learning environment, promoting student learning. Research on calculus and technology is limited, especially among students in basic mathematics. The focus is on practical applications and understanding of these topics. Technology encompasses techniques, skills, methods, and processes used in production, scientific investigation, and is crucial for the success of science and engineering fields.

Learning is useless without real-world applications. As a result, a growing number of parents, students, and even school administrators and planners are wondering why they should learn mathematics. How useful is it? How can we use our understanding of calculus and other mathematics in practical applications? The researcher has taken note of this and has carried out a study entitled "Implications of Anti derivatives in the Practical Life of Students' Future Careers."

Objective of the Study

The general purpose of this research is to find the implication of anti derivative in students' study life and later life. This study seeks the implication of our academic study in the practical fields and seeks the working efficiency in his everyday life. This study tries to join the possible application in future academic purpose and for the academic planner

1. To see how learning anti derivative is used in anti- derivative in their practical life
2. To explore the Problems faced while using Anti derivatives in profession life
3. To assess the recalling sources of anti derivative concept and theory in practical life

RESEARCH METHODOLOGY

An Interview was carried out with semi structured interview questions. A study of 58 engineering students revealed a significant gender disparity across different fields, with 48 men and 10 women in civil, mechanical, and electrical engineering. Despite this, other fields like IT have a more even distribution. Electronic engineering has a modest female representation, while chemical engineering has higher representation. However, computer and electrical engineering have no female responders, indicating a need for more gender diversification efforts. The majority of respondents were male, but certain professions, like computer technology and chemical engineering, are experiencing more equal gender involvement. To address this disparity, measures such as targeted scholarships, awareness campaigns, and mentorship opportunities are needed.

RESULT AND DISCUSSION

Implications of Anti derivatives in Working Area

Anti derivatives are crucial in mathematics, physics, and engineering for calculating areas and solving real-world problems. They help in economics and biology, optimize design characteristics, and understand motion. Identifying anti derivatives allows for more precise modeling and analysis of complex systems, highlighting their importance in both theoretical and practical applications.

Fifty eight engineers explained the implications of anti derivatives in their working area. The most of civil engineer said, *"The implication of anti derivatives is to find the area of land to estimate the area of irregular curve etc…"* Some civil engineer add, *"It can be implied on visualization of the area."* Another civil engineer said that it is being used on structure analysis of project. He said, *"The implication of anti derivative is to find area under limit curve and undefined as well."*

One female civil engineer said, *"..To calculate area and volume of object, estimation of total load from a point or to find the area of unfit land the anti derivatives will be used."*

Similarly, another civil engineer said, *"... we can use anti derivatives to find discharge of irregular area tank and calculate work done by machine."*

A next civil engineer added the implication of anti derivatives is on the rate of change analysis of the project. Supporting his statement another civil engineer said, "The implication of anti derivative is to solve area and volume, to determine work and energy and analyze the behavior of different engineering structure." The most use of implication of anti derivatives were Road and culvert, River Trailing, Drain building construction as well as calculation of hydrostatic pressure, moment of inertia and calculation of centroid."

At last, one civil engineer said, *"Analysis and setting curves in highways was the implication of anti derivatives."*

Anti derivatives play a crucial role in civil engineering, enabling the calculation of areas of plane land, irregular curves, and unfit land, visualization, work done, structure analysis, approximation, quantitative analysis, volume calculation, total load estimation, rate of change analysis, discharge calculation, work and energy analysis, road and culvert construction, work quantities estimation, structural impact calculation, hydrostatic pressure calculation, moment of inertia calculation, centroid calculation, structure analysis, and formula derived from physical quantities.

Some distinct responses got by researcher on the expression of mechanical engineers. Six mechanical engineers were participated on interview out of fifty eight. Among them a mechanical engineer said, *"...The implication of anti derivative is on finding area and volume of different shaped object, Solving electrical circuits, finding energy, work done, emf, electric/magnetic fields etc….."*

Another mechanical engineer said separately, *"...The anti derivatives can be used on control system and robotics as well as Analysis of electronic components, probability analysis and estimation."* Next Mechanical engineer supported his statement and said, *"Usage of different control system algorithms, calculation for capacitor and inductor, signal and probability analysis."*

The next engineer added the implications of anti derivatives to find deflection in beam, used in PID control system.

Six mechanical engineers emphasize the significance of anti derivatives in engineering applications, including calculating areas, volumes, electrical circuits, energy, work done, control systems, robotics, electronic component analysis, signal processing, probability estimation, and structural analysis. They also highlight their role in solving real-world problems in control systems, robotics, and structural analysis.

Eight Electronic engineers were participated on interview. They were asked, *"What are the implications of anti derivatives in their own work life?"* and the provided their experiences.
One of them said, *"... I used integration on CFD and surface area calculation…"* Another electronic engineer expressed his experience saying, *"... it was used on Fluid flow, hydro static, force and thermal analysis."*

The third electronic engineer explained, *"...the implication of anti derivatives is on the study of signals and wave, calculation of force and stress analysis…"*

The next electronic engineer said, *"... anti derivatives is being used on finding MOI and cg of beams and columns as well as finding field strength…"*

One electronic engineer was being used anti derivatives on Area under curve, work done and Biot-Sovat law. *"....in the use of Probability, Control system and filters and machine learning, antiderivatives was used* " expressed another engineer. Another engineer stood for to him and said, *"...Integration can be used on control system algorithm and digital signal processing."*

At the end the electronic engineer supported to the concept of civil engineer and said, *"...The implications of anti derivatives are Calculating irregular area, Fourier series, Laplace transformation."*

Eight electronic engineers emphasize the significance of anti derivatives in their professional work, including fluid dynamics, thermal analysis, stress analysis, control systems, signal processing, and machine learning. These fundamental calculus concepts are crucial for effective problem-solving and innovation in electronic engineering. Their implications include CFD calculations, fluid flow analysis, signal study, beam and column strength, area under curve, probability, control system algorithms, Fourier series, Laplace transformation, reactor design, and control system creation.

The implications of anti derivatives in practical life were on chemical engineering sectors. Among chemical engineers one of them said, *"The implications of anti derivatives are on Analysis of a deflection and Kinematics…"*
On the view of another chemical engineer it was implied on Construction of infrastructures, chemical plants etc. One Chemical engineer provide similar responses as civil engineer and said, *"..It was used on area under curve for design of reactors and thermodynamics"* Supporting him another engineer said, *"it was used to calculate area and volume and is being used on applied mechanics..."*

A female chemical engineer said, *"The implications of anti derivatives are on chemical plants like as size determination and it was used to overfill the gap of unfounded calculation…"*
A chemical engineer said, *"Anti derivatives can be implied in various chemical laws."* Supporting mechanical engineer a chemical engineer said that the implication of anti derivatives was on making of a control system.

Chemical engineers use anti derivatives in various fields, including thermodynamics, reactor design, and infrastructure building. They enhance design and construction precision by aiding in kinematics analysis, area and volume calculations, and size determination in chemical plants. Anti derivatives are crucial in ensuring successful engineering solutions and are used in various chemical laws and control systems to ensure accurate calculations and control systems.
Six Information and Communication engineers were participated on the interview process. They also share their experiences on implication of anti derivatives.

One IT engineer said, *"The implication of anti derivatives to calculate area and predict succession…"* another engineer said, *"the anti derivatives is used to find the total of …."*
Another IT engineer expressed, *"…The anti derivatives were used to run the multiple programs."* The next expression of IT engineer is distinct from other. He said, *"...The implications of anti derivatives are on Signal analysis, calculating areas and volume, finding solutions of differential equation etc."*

Like as computer engineer an IT engineer said, *"…The implication of anti derivatives are on Data science, signal processing and network theory…"*

Similarly, The IT engineer Said, *"The uses of anti derivatives are on Signal reconstruction, Area calculations, cumulative analysis."*

Six engineers discussed the importance of anti derivatives in various fields, including area calculation, trend prediction, differential equation solution, signal analysis, data science, signal processing, network theory, program execution, and signal reconstruction. They found that anti derivatives help resolve complex problems in various fields, including area calculation, finding totals, running multiple programs, signal analysis, data science, signal processing, and signal reconstruction.

Five computer engineers took part in an interview, and they were all asked the same questions. When asked about the usage of anti derivatives, the first engineer stated, *"Anti derivatives are used to calculate both volume and area."* The second engineer agreed, adding, *"Yes, they are particularly important for volumetric analysis."* The third and fifth engineer agreed with a small change, noting, *"They are also used to visualize areas."* The fourth engineer then provided a contrasting perspective, stating, *"Anti derivatives are used in network linking."*
Anti derivatives are crucial in various computational domains, with applications in mathematical calculations, volumetric analysis, network linking, and area visualization. Their adaptability in both theoretical and practical contexts highlights their value in computer engineering.

Problems faced while using Anti derivatives in profession

Anti derivatives are crucial in fields like engineering, physics, and economics but face challenges like finding them, applying boundary conditions, and using numerical integration methods. Out of 58 engineers, 18 experienced no problems, while 40 faced practical or professional issues.
One civil engineer said, *".. I have the clear concept of anti derivatives and formula can be derived so I haven't felt any problems while using anti derivatives in practical life area."*
But one mechanical engineer said, " … Lack of practices I faced the problems while using anti derivatives in our practical life…"
This demonstrates that, while some engineers find anti derivatives simple, others may struggle owing to insufficient experience or comprehension.

Satisfaction of using knowledge of anti derivatives in practical life

Anti derivatives are valuable tools in practical life for understanding change, solving complex problems, and boosting confidence. They help us understand how things change over time, such as calculating distance in physics. They are also useful in fields like engineering and economics, providing tools to solve complex problems. Successfully applying this knowledge boosts confidence and accomplishment in one's abilities.

The engineers were asked, *"Did you satisfy on using knowledge of anti derivatives in practical life?"* Among 58 engineers 33 engineers were not satisfied on using knowledge of anti derivatives in practical life and 25 engineers were satisfied on using knowledge of anti derivatives in practical life. An electronic engineer said, *"I am not satisfaction on using knowledge of anti derivatives in practical life. I felt distinct between Practical life problems and classroom problems…"*

In opposition a chemical engineer said, *"....Due to clear on concept, the study of anti derivatives supports me on practical concepts. Thanks my teachers who illustrate the practical problems while study period."*

The study reveals that engineers' perceptions of anti derivatives' usefulness vary significantly. 33 engineers were unhappy, while 25 found their knowledge useful. The applicability of theoretical knowledge depends on well-defined concepts and practical application. The teaching method significantly impacts how engineers view mathematical concepts in their fields.

Recalling the concept and Theory of anti derivatives

The author reviewed the concept of anti derivatives, concentrating on the interaction between differentiation and integration. They employed major differentiation rules, visual aids, and basic integral formulas to grasp the subject. They also looked at the integration constant, highlighting the need of distinguishing between indefinite and definite integral.

58 engineers were asked, *"What did you use to recall the concept and Theory of anti derivatives?"* different responses are got from them. It is used various tools and approaches to understand anti derivatives theory, including literature, mobile resources, online tutorials, video lectures, and interactive tools. They also sought clarification from teachers, used memory to memorize formulas, and engaged in peer discussions to reinforce the principles through mutual comprehension.

A computer engineer said, *"I have solved the problems while using anti derivatives in professional life from using mobile devices and other learning platform*". But a chemical engineer have different experiences he said, *"..I have solved the problems from teachers and colleges."* and the most of the engineers solve the problems through books some used digital and some had physical books. One of Mechanical engineer said, *"I have solved the problems raised in using anti derivatives from my book and note copy."*

Table 1: The responses in sub theme

Theme	Sub theme	Number of responses
Sources of recalling the concept and Theory of anti derivatives	From Book	26
	Asking Teacher	6
	From mobile or other devices	23
	From memory	2
	Asking Friends	1
	Total	58

Source: (Interview data, 2023)

The Table 1 displays data on students' memorization of anti derivatives, with 26 recalling the idea from a book and 23 using mobile devices. Only 2 can recall the topic from memory, while the remaining students rely on teachers and friends. The data suggests that books and technology are the most popular resources for memorizing information.

CONCLUSION

The paper concludes by highlighting the important uses of anti derivatives in a variety of engineering domains and demonstrating their crucial function in both professional and academic settings. Anti derivatives are widely used in civil engineering to visualize areas, perform structural analysis, and calculate areas like plane land and irregular curves. They are essential for jobs like centroid analysis, hydrostatic pressure calculations, drainage system development, and road construction. Anti derivatives also help with rate of change analysis and approximation jobs, which improves project execution accuracy and efficiency. This illustrates how crucial they are to meeting the real-world needs of civil engineering.

Anti derivatives are equally useful in chemical, mechanical, and electrical engineering. They are used by mechanical engineers to solve electrical circuits, calculate area and volume, and analyze energy and effort performed. Applications include robotics, signal processing, and control systems, with a focus on structural analysis and electronic component evaluation. Anti derivatives are used by electronic engineers for tasks including signal processing, stress analysis, and fluid dynamics, highlighting their crucial significance in both theoretical analysis and real-world problem-solving. These ideas are used by chemical engineers in reactor design, thermodynamics, and infrastructure projects, emphasizing the value of anti derivatives for accurate volume estimation and kinematics.

Anti derivatives have implications in information technology and computer engineering, including signal analysis, differential equation solutions, and data science. IT engineers stress their application in network theory, program execution, and signal reconstruction, which aids in difficult issue solving and innovation. Computer engineers emphasize their importance in calculating volume and area, volumetric analysis, and network connection. This extensive application across engineering fields demonstrates that anti derivatives are important tools for improving practical efficiency, precision, and the ability to tackle complex problems in both academic and professional settings.

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