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Investigating Undergraduate Students Ability in Solving Calculus Problems Using Microsoft Maths Solver Application

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This research work investigated the ability of 100 level undergraduate students in Novena University Ogume, Delta State. Two hundred (200) students from four departments were selected using the stratified random sampling techniques. Frequency counts and percentages were used to obtain a total picture of student ability towards calculus. Also, a student's t-test was used to check whether there was a significant difference between the means. The observed difference between the mean is significant at the .01 level. Results of the research showed that the use of Microsoft Math Solver aided learners in understanding basic concepts in calculus, as compared with the traditional tutorial approach.

Keywords: Calculus, Microsoft Math Solver, Understanding, Modern Technology.

1. Introduction

Modern technologies have become an integral part in our society and are increasingly shaping the teaching of Mathematics at every level of education (Weinhandi *et al.*, 2021). To learn mathematics effectively, the use of modern technologies will go a long way to aid proper understanding of the subject. (Larkin & Calder, 2016). Teaching and learning mathematics have a long list of barriers that are encountered when technologies are integrated into it. Issues such as, lack of competent teachers and access to educational resources are some of these barriers.

BECTA (2003), also asserts that Computer technology has changed the nature of teaching and learning in mathematics. Technologies such as mathematics software, scientific calculators, statistical packages, spreadsheets, have become essential in the classrooms. Thus, these have replaced the traditional tutorial approach that was dominated by pen and paper.

The use of technology serves as a positive drive for learners due to its effective results, because it leads to better performance for the students. The speed of doing calculations using technology also frees up time for deeper learning. A research work by Safdar et al (2011) on the effectiveness of teaching mathematics through technology as compared to using traditional teaching methods observed that teaching mathematics through technology led to better academic achievement by the students. Kushaw (2014), also observed that students who have no positive attitude towards mathematics, are able to get good grades in mathematics. Thus, attitudes do not affect the learning outcomes in Mathematics.

On the other hand, Zakaria et al (2013), were of the opinion that if a student learns to solve mathematical computations with continuous access to a Technology device or computer software, that student will be unable to solve mathematical computations without the assistance of a device. Similarly, this access may limit the student's ability to perform other simple calculations that occur often in everyday life.

Safdar et al. (2011), asserts that Technology may reduce the control of the teacher in the classroom. This make people believe that technology is detrimental to students understanding. In the traditional method of learning, the teacher is in charge of the process, he/she exercises control in the class, and when students have much control, the teacher might sense that his/her effort is hindered by technology. The use of technology for better understanding of mathematics will require major changes to teaching practices. The teacher will need to adopt modern teaching methods in order to effectively use the technology resources available. The use of technology can have a

negative effect on student due to high level of autonomy that students might have. Students might concentrate on their mobile devices or computers unlike in the traditional setting, where major attention is on the teacher.
According to Yu-Wen (2006), different mathematical software such as MAPLE, MATHEMATICA, Geometer Sketchpad, MATLAB, and derived portable technologies like Graphic Calculators, Java applets, spreadsheet, Computer Algebriac System (CAS) and Dynamic are most used. Most recent trends in Mathematics are geared towards a better understanding of various aspects of mathematics. Deep conceptual understanding can be described as the process which allows the learner to form links with other concept and to apply the concept in different contexts. A learner with conceptual understanding will know how to interpret and also finish a question more accurately. He/she will be able to understand the interconnections of concepts and also to state specifically why a particular method is used. On the other hand, Procedural knowledge and understanding were discussed by Rittle-Johnson and Alibali, (2009), as the knowledge of action sequence for solving problems. Procedural knowledge is seen when students are able to display the sequences and the rules they are to maintain when completing a mathematical test question. Though the main goal is to provide learners with the platform to have deeper conceptual understanding, both procedural knowledge and Understanding forms of learning are very important.

Over the years, there had been researches on different areas of mathematics where modern technology had been applied. For example, in biomathematics, Okwonu et al. (2012), discussed on the classification of the Aedes adults mosquitoes in two distinct groups based on fisher linear discriminant analysis and FZOARO techniques, they described the breeding, feeding and measurement of Aedes mosquitoes based on body size. Due to similarity in body size measurements, they were constrained on gender recognition. To reveal the gender identity, Fisher linear discriminant analysis and FZOARO classification models were considered suitable for prediction and classification. Also, in an attempt to robust the Pearson product moment correlation (PPMCC) in mathematical statistics, Okwonu et al. (2020), examined the breakdown analysis of Pearson Correlation Coefficient and Robust Correlation methods, their study focused on robust plug in techniques with high breakdown points. They compared the performance of these technique using real and simulated data sets. The comparative analysis indicates different degrees of robustness and breakdown based on the percentage of contamination and data modification. In environmental mathematics, Rahman et al (2021), analysed the status of air quality before and during reinforcement of MCO due to COVID-19 outbreak in central and southern regions of peninsular Malaysia. They investigated the air quality index (AQI) before and during the Movement Control Order (MCO) implementation.
In game theoretic models, the Sethi's sales-advertising dynamics were explored. Ezimadu, P.E and Nwozo, C.R (2018) applied differential game in modelling dynamic cooperative advertising in a decentralized channel, the work considers the manufacturer as the Stackelberg leader and the retailer as the follower. It incorporates the manufacturer's advertising effort into Sethi's sales advertising dynamics, and considers its effect on the retail advertising effort. The work shows that the direct involvement of the manufacturer in advertising is worthwhile. Ezimadu, P. E. (2019), also analysed a game theoretic cooperative advertising model. The work used game theory to address the possibility of the distributor being fully involved in the supply chain, The multiplicative effect of price and demand was robustly used to model the consumer demand, and particularly showed that the distributor must be involved not partially, but fully in the advertising process for him to be part of the supply chain. Ezimadu (2016) applied differential game theory to model the dynamic effect of retail advertising on sales using the Sethi advertising model. The two-channel structures compared are the subsidized and unsubsidized channel structures and recommends that the manufacturer and distributor should subsidized retail advertising.

Mathematics has long been seen as a subject taught by the teachers to learners who sit quietly and passively to receive the knowledge being transferred. Morgado (2010), Swan (2005). This view is changing and Zakaria et al (2013), discussed that in order for an improvement in understanding mathematics concepts, learners need to be active in constructing knowledge through the interaction with their teachers, their peers or classmates and also the content in question. Most learners struggle with understanding mathematics and Murphy (2016), argued that the methods employed by teachers within the classroom will eventually affect a learner's level of understanding.

Liang (2016), observed that there has been focus on Limits and Functions in calculus recently with emphasis on the basic properties of straight-line graphs. Calculus as a topic in mathematics is very important as it forms the basis for learning other mathematical courses. A proper understanding of major concepts in Calculus will aid the learner to perform better in other concepts in mathematics.

Birgin (2012), described straight line graphs as a multidimensional topic where proper understanding is important for the success of learners. And also, it was found that learners struggle with straight line graphs as well as the concept of slope, and they have a very limited understanding on it.

Ordu (2021), asserted that in a digital era where technology has a greater influence on the society, teachers and learners have greater access to modern technology, internet and media. These channels can be used for presenting lesson, enhancing understanding and verification of results. Teachers need to reflect these changes within their classroom to meet the needs of the changing environment and the needs of the learners.
According to Zengin and Tartar (2017), technology within the classroom is not a tool to transfer knowledge but rather it is a tool that provides the learner with the opportunity to engage his/her knowledge. An important concept often misconstrued is the fear that the introduction of technology in the classroom is used to replace the teacher, but rather, the incorporation of technology in the classroom should be seen as a study tool that will aid learners in the visualization of the concept under study. (Keskin (2016),) Mathematics is a subject that requires a multifaceted approach and technology provides an opportunity for the teacher to teach mathematics with such approach. The software is convenient to use, and it provides a variety of representations and different opportunities to learn. It also ensures that many learners are catered for. These different representations can increase learners understanding of the concept because most learners struggle with the understanding of basic concepts in Calculus.

2. Research Objectives

This research work is guided by the following research objectives.
Research objective 1. To determine whether the use or non-use of the application software affects student ability in solving calculus problems.
Research objective 2. To determine how the use or non-use of the Microsoft maths solver affects student ability in solving calculus problems.
Research objective 3. To find out if there is any difference between the students that used Microsoft maths solver in solving calculus problems and those solved without using Microsoft maths solver.
Research objective 4. To determine the rate of effectiveness on the use of the software and the traditional tutorial approach, in learning basic calculus among first-year students.

3. Methodology

3.1 Design

In designing this study, the quasi-experimental design was employed. Research questions were formulated. Some of the questions were:

1 do you normally use any technology device to solve mathematical equations?

2 find the positive integer $'n'$ so that

$$\lim_{x\to 3}[(x^n - 3^n)/(x-3)] = 108$$

A worksheet consisting of ten questions was administered to 40 students on two occasions. Initially, when the questions were administered to the students, they answered them without the use of the software, but thereafter, they were allowed the use of the software in answering the questions.

3.2 Participants

Participants involved in this research were two hundred (200) first-year students in the College of Natural and Applied Sciences, Novena university, Ogume. Delta State. Stratified random sampling technique was employed to select 200 students in four (4) departments in the faculty. The technique of simple random sampling was used to select forty (40) students out of the 200 students comprising male and female. These students are in 100 level in the University.

3.3 Validity and Reliability of the Instrument Used

Both face and content validity of the instrument were employed for this study. To ensure the validity of the instrument, experts in questionnaires examined the worksheets critically for its correctness. Also, in computing the reliability of the instrument, a t-test was performed and the normal-curve value of 2.423 (0.01 percent) was used to determine the significance of the difference.

3.4 Analysis Procedure

The data used in this research were obtained from two hundred (200) first-year students in four (4) departments in the College of Natural and Applied Sciences, Novena University, Ogume. Delta State. The departments involved were: biological sciences, chemical sciences, computer sciences/mathematics, energy and petroleum studies. The worksheets were distributed to the students immediately after their Computer-based Test (CBT) Examination. Initially, the students were not allowed the use of Microsoft math solver but the second time, they were allowed to use it. The questions given were based on some selected topics in Calculus: functions and variables, limits and continuity, derivatives and integrals. The results obtained were analysed and compared to the objectives of this study using percentage as well as the t-test.

4. Results and Discussion

The test was based on the score that every student had achieved. The results of their response were recorded based on whether their answers were correct or not.

Table 1. Questions 1 through 4 responses without the application software.

Question	AA	IA	% of AA	% of IA
1	26	14	65	35
2	9	31	22.5	77.5
3	18	22	45	55
4	25	15	62.5	37.5
Total	**78**	**82**		

Key: AA – Accurate Answers; IA – Inaccurate Answers

Table 2. Questions 1 through 4 responses with the application software

Question	AA	IA	% of AA	% of IA
1	28	12	70	30
2	32	8	80	20
3	31	9	77.5	22.5
4	36	4	90	10
Total	**127**	**33**		

Key: AA – Accurate Answers; IA – Inaccurate Answers

Table 3. Questions 5 through 7 responses without the application software

Question	AA	IA	% of AA	% of IA
5	32	8	80	20
6	16	24	40	60
7	16	24	40	60
Total	**64**	**56**		

Key: AA – Accurate Answers; IA – Inaccurate Answers

Table 4. Questions 5 through 7 responses with the application software

Question	AA	IA	% of AA	% of IA
5	40	0	100	0
6	39	1	97.5	2.5
7	35	5	87.5	12.5
Total	114	6		

Key: AA – Accurate Answers; IA – Inaccurate Answers

Table 5. Questions 8 through 10 responses without the application software

Question	AA	IA	% of AA	% of IA
8	5	35	12.5	87.5
9	11	29	27.5	72.5
10	11	29	27.5	72.5
Total	**27**	**93**		

Key: AA – Accurate Answers; IA – Inaccurate Answers

Table 6. Questions 8 through 10 responses with the application software

Question	AA	IA	% of AA	% of IA
8	22	18	55	45
9	37	3	92.5	7.5
10	30	10	75	25
Total	**87**	**31**		

Key: AA – Accurate Answers; IA – Inaccurate Answers

A thorough analysis of the result shows that Question 1 was easier than Question 9. This is seen from the fact that there was a minor difference in the accurate answers on Question 1 obtained with or without the computer software; 26 out of 40 accurate answers or 65 percent, without it and 28 out of 40 accurate answers or 70 percent, with the devices, while there was a significant increase in Question 9 accurate answers when the use of the Microsoft math solver was applied; 11 out of 40 accurate answers or 27.5 percent, without the use of it and 37 out of 40 accurate answers or 92.5 percent, with the devices. A summary of all questions can be found in Table 7, which shows a result of the answers in relation to the questions both without and with their devices. It should be understood that both tests were given to the same sample of students.

A t-test was used to analyse the two sets of scores obtained from the research instrument. With a sample size of 40 students for each group, we will use the t –table value of 1.684 (.05) percent and 2.423 (.01 percent) to determine the significance of the difference. Since the calculated t-value of 4.9 exceeds 2.423, we can assume that the observed difference between the means is significant at the .01 level. This shows that students who do use the computer software understands better on simple calculus questions than when the software was neglected.

5. Summary

The instrument used to collect the data for the study was a worksheet consisting of ten questions administered to 40 students on two occasions. Initially, the students were not allowed the use of any software and thereafter, they were allowed to use the software. Most of the questions given except question one involves the use of mathematical computations. The findings from the mathematical computation worksheet were analysed and compared to the objectives established in this study.

Research Objectives 1. To determine whether the use or non-use of technology devices affects student understanding in basic calculus questions.

In order to determine if the use or non-use of the software affect student understanding, a t-test was performed. With a sample size of forty (40) students for each group, the normal-curve value of 2.423 (0.01 percent) was used to determine the significance of the difference. Since the obtained t-ratio of 4.7 exceeds 2.423, the observed difference between the means is significant at the 0.01 level. This study concluded that students who do use this software perform better than those students who do not use it in performing basic questions in calculus.

Research Objectives 2. To determine how the use or non-use of technology devices affects student understanding of the course.

It was easier using the software to complete the questions. But when the students were denied the use of a software, it took more time to complete the test and the students were unable to use it. The students spent 47 minutes to complete the test without any software and 12 minutes with the software. The results of this study showed that students do rely on a software package to do the simplest of calculus questions. Furthermore, the same students do not know if the answer derived from the software is accurate, this is illustrated in the test percentages showing a significant number of wrong answers even with the use of software. These results and observations do not quantify exactly how the students' basic understanding were affected, but they indicated that in some way they were by their inability to proceed through the problem without a software. This requires further study.

Research objective 3. To find out if there is any difference between the students that used Microsoft maths solver in solving calculus problems and those solved without using Microsoft maths solver.

In this research, the group of students studied performed poorly without the use of a software. This is reflected by 169 accurate responses out of 400 possible answers or 42.25 percent without the use of a device compared to 330 correct responses out of 400 possible answers or 82.5 percent with the use of a software.
It was also observed that at the beginning of the computation worksheet, the question, “Do you normally use any technology device to solve mathematical equations?” was asked. The response was 38 students said “YES” and two students said “NO.” This small sample size does not allow a meaningful conclusion about the efficacy of avoiding the use of software for everyday problems. This presents a question that should be expanded upon in future studies since it appears that most students today do rely a great deal upon mathematical software even for simple questions. Lack of motivation on the part of students was listed as a possible limitation of the study. Although the mathematical computations should have been simple to understand. It is possible that some of the students may have faced issues understanding the test questions. Therefore, the use or non-use of mathematical software does affect a student's ability to solve basic calculus questions amongst year one students.

Research Objectives 4. To determine the rate of effectiveness on the use of the software when compared with the traditional tutorial approach, in the understanding of basic calculus courses.

During the course of this research, a total number of 330 accurate answers was collated. That is, out of 400 questions, 330 questions were answered accurately when the student were asked to use the software to solve the questions, which is 82.5% rate of effectiveness. This is a clear indication that there was a high-performance rate on the use of mathematical software. We can therefore deduce that the students understand better with the use of mathematical software, when compared with the traditional tutorial approach

6. Conclusion

A strong recommendation would be to encourage other researchers to use this study to devise more research to examine the results documented in this study. More time could be put into conducting follow-up interviews on how students felt about the use of computer technology and how their usage affected them personally. In particular, some means for

differentiating between students who consider themselves less dependent on computer technology should be determined, and whether such an ability is truly beneficial in calculus understanding. This would be difficult and time consuming but worthwhile for information needed in learning calculus in the future and on the effects of computer technology.
The study has met the established objectives, but further research needs to be done to see if the results hold true for a larger population. This population was a class of 40 year one students of the College of Natural and Applied Sciences at Novena University, Ogume. If the same study is carried out in a different class, or perhaps a different school with a different age level, it will add to the results from this study. Hopefully, this information will benefit future researchers on whether or not the use or non-use of computer technology greatly affects their understanding.

Conflict of interest

The authors declare no conflict of interest.

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