

Original Research Article

ASSESSMENT OF STUDENTS' ABILITY TO APPLY CALCULUS CONCEPTS TO ENGINEERING PROBLEMS.

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Abstract.

This research was carried out to assess the ability of the students to apply calculus concepts to engineering problems. A sample of five (5) students was selected from each of the five departments in the college of engineering Waziri Umaru Federal Polytechnic, Birnin Kebbi giving a total of twenty five (25) students. Pearson correlation and paired samples t-test were used to analyze data using SPSS version 17.0. The results obtained indicated academic performance in calculus has a significant positive correlation with Calculus application to engineering problems ($r = 0.693$). A significant difference was observed in the mean score of Calculus Proficiency Test (mean 67.64, SD = 17.27) and Calculus Application Test (mean 53.48, SD = 13.58).

Introduction.

Mathematics is an essential requirement in every field of human endeavor for sustainable and meaningful development. It is indispensable and fundamental requirement for the development of science, engineering, technology and economics. It is the servant and master of all school subjects as it cut across the school curricula. The place of mathematics in scientific advancement is overwhelming and unlimited. Mathematics plays vital roles in modeling physical and natural phenomena which could help any nation onto the path of sustainable development (Ugwa and Agwu, 2012, Godwin and Iwuchukwu, 2013). To this regard, many researches have been carried out in order to come out with a solution to difficulties facing teaching and learning Mathematics particularly the engineering aspect of mathematics.

Huang (2013) developed a competency-based calculus teaching module for engineering students. The module which was a practical teaching emphasizes the connection between calculus and the technical information in engineering courses. The aim was to provide engineering students with the ability to utilize the concepts and skills of calculus to formulate and solve technology problems. The method used was to put the sample in two groups (experimental and control groups). One of the groups was taught with competency-based calculus teaching module while the other was taught with traditional teaching method. The result obtained proved the competency-based approach to be effective. This serves as a pointer that application oriented teaching is necessary for engineering mathematics. Bridging technology with mathematics provides students with mathematical understanding and confidence. Practical applications of mathematical concepts such as trigonometry, rates of change, higher order derivatives, definite integrals to engineering problems like statics, dynamics, fluid dynamics, strength of materials etc make students appreciate the power of mathematics in their field of study (Ford et al, 2007). Arosha et al (2003) carried out a research that confirmed that the application approach to teaching helps students in understanding the mathematical concepts.

With the present advancement in computer applications packages to engineering, some may argue that engineers may only need to study computational mathematics rather than analytical mathematics. However, analytical mathematics helps in the development of logical and critical thinking which are the fundamental principles in training of any prospective engineer.

Background of the Study.

58 Experience has shown that many students try to avoid mathematical problems that
 59 involve questions related to applications to engineering in semester examinations
 60 especially the worded problems. This research is motivated by the evidence that Students
 61 present mathematics learning as a chore, they have no mathematics goals and their
 62 mathematics learning comprises of repetitive memorization of solutions (Goold, 2014).
 63 Therefore, this paper tried to assess the students' ability to apply calculus to engineering
 64 problems.

65 **Methodology.**

66 The population of this study is made up of year two engineering students from Waziri
 67 Umaru Polytechnic Birnin Kebbi ($n < 400$). A sample of twenty five (25) students was
 68 selected using a stratified random sampling. Each department is considered as a stratum
 69 and five students were randomly selected. An additional criteria was set such that only
 70 the students with grade B or higher in MTH 211 (Calculus) at the last semester
 71 examination were selected for the sample. Two instruments were used for data collection
 72 namely, the Calculus Proficiency Test (CPT) and Calculus Application Test (CAT). Both
 73 instruments contain ten items each and an item carried ten marks. Thus the maximum
 74 mark obtainable is 100 and minimum mark obtainable is zero. CPT was prepared to cover
 75 all topics in MTH 211 curriculum content. The CPT was then re-written as a worded
 76 problem to form the CAT. For instance;

77 CPT If $F = xyz + \lambda (xy + 2xz + 2yz)$ find $\frac{dF}{dx}, \frac{dF}{dy}, \frac{dF}{dz}$.

78 CAT *Find the dimensions of the rectangular box, open at the top, of the maximum*
 79 *capacity whose surface area is 432 sq. cm.*
 80

The two instruments were administered separately in four weeks interval. The performances were analyzed for comparison.

Results.

Table 1. Paired Sample Statistics

	Mean	N	Std. Deviation	Std. Error Mean	Pearson Correlation (at 0.01 sig. level)
Calculus Proficiency	67.6400	25	17.27445	3.45489	0.693
Calculus Application	53.4800	25	13.57731	2.71546	

The data collected in the two tests were analyzed using SPSS version 17. Paired sample test and bivariate correlation test on the scores produced Pearson correlation coefficient ($r = 0.693$). This indicates a significant positive correlation. Moreover, the mean score for Calculus Proficiency Test was 67.64 with standard deviation 17.27 and mean of 53.48, standard deviation 13.58 was observed for Calculus Application Test (table 1).

Table 2 Paired Samples Test

		Paired Differences						
				95% Confidence Interval of the Difference				
		Std Deviation	Std Error Mean			t	Sig. (2 tailed)	
	Mean			Lower	Upper			
Proficiency-Application	14.16000	12.54884	2.50977	8.98009	19.33991	5.642	24	.000

The two means were tested to find out if there is any significant difference. The result showed a significant difference in the means of the two tests ($t = 5.642$, $df = 24$, $P < 0.01$).

Discussion

The result showed a significant positive correlation between calculus proficiency and calculus application to engineering problems. The computed means and standard deviation also indicated that the students performed better in the calculus proficiency test than calculus application test. Generally, it is observed in this research that the students do not demonstrate much value for Mathematics except for the purpose of passing examinations. For instance over 70% of the respondents performed lower in the CAT than in CPT, the remaining 30% performed well in both tests. This attitude resulted in memorization of solutions treated in the classroom.

Conclusion and Recommendations.

This paper revealed a relationship exists between calculus proficiency and calculus application in engineering problems. It is also clear that students find it more difficult to apply calculus in engineering than analytical solutions to expressions in calculus. Teachers are expected to do more on emphasizing applications of mathematics to engineering. There should be more researches on this topic with a view to coming out with an alpha version of the instrument that measure the ability of the students to apply mathematics to engineering problems.

References.

- Andrew O (2007) An Analysis of the Teaching of Mathematics in Undergraduate Engineering Courses. *Proceedings of the 2007 AaeE Conference, Melbourne*. PP 1 – 7. http://aaee.com.au/conferences/papers/2007/paper_69.pdf accessed 20/8/2014 11.34 AM.

- Aroshas S, Verner IM and Berman A (2003). Calculus for Engineers: An Application Approach. <http://ineerweb.osanet.cz/Events/ICEE2003/Proceedings/pdf/4607.pdf> accessed 18/8/2014 9.25 AM.
- Ford LN, Lloyd S and Thomas S (2007) Evaluating the Performance of Engineering Undergraduates Who Entered Without A-level Mathematics via a Specialist Six-week “Bridging Technology” Program. Engineering Education 2(2) 33 – 43.
- Godwin HC and Iwuchukwu AO (2013) Engineering Mathematics Issues in University Education: A Review. International Journal of Engineering Research and Technology 2(6) 522 – 551.
- Goold E (2014) Mathematics: Creating Value for Engineering Students. http://sefi.htwaalen.de/Seminars/Dublin2014/17th%20SEFIMWG%20Seminar/Mondag%20Session%201/MWG2014_Goold.pdf accessed 27/8/2014 12:15 PM.
- Huang CH (2013) A Competency-based Calculus Teaching Module for Engineering Students. World Transaction on Engineering and Technology Education. 11(4) 365 – 370.
- Ugwa KA and Agwu A (2012) Mathematical Modeling as a Tool for Sustainable Development in Nigeria. International Journal of Academic Research in Prospective Education and Development. 1(2) 251 – 258.