International Journal of Mechatronics, Electrical and Computer Technology (IJMEC)
ISSN: 2305-0543 (Online), ISSN: 2411-6173 (Print)
Vol. 13 (47), Jan. 2023, pp. 5317-5322

Attitudes and Perception of Mathematics -A Case for Biomedical Engineering Students

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Abstract— **Mathematics has wide applications to both sciences and engineering. This paper investigates the attitudes and perception of the biomedical engineering students towards mathematics. Confidence, anxiety, learning goals, mathematics myths and belief, persistence, approach, learning strategy prior experience general issues were identified as the attitude and perception constructs that influence mathematics achievement by the students. The research is a survey design. Two research questions and one hypothesis guided the study. A questionnaire of 45 items and 10 objective questions from basic mathematics were administered to 160 students used for the study, for data collections. Descriptive statistics was used to determine the students' attitudes and perceptions towards mathematics while the Pearson product-moment correlation was used to determine the directions of the relationship between attitudes and perception and mathematics. It was observed that anxiety, mathematics myths and belief, general issues have significant negative relationship with mathematics achievement while confidences, learning goals, persistence, approach, learning strategies and prior experience have a significant positive relationship with mathematics achievement.**

I. INTRODUCTION

A. Background Study

The interdisciplinary approach is becoming an increasing need in scientific and industrial communities. The most evident of such need is the strong interconnection between mathematics (Applied Mathematics) and Biomedical Science/Engineering. Indeed, biomedical Science and engineering have become one of the most promising application areas of applied mathematics.

Engineering courses require the awareness of mathematical concepts. The goal of mathematical learning for engineering students is the ability to learn, consolidate mathematical principles and skills to solve problems in their class and later in their professional careers [1].

As part of their undergraduate training, engineering students should increase knowledge in several mathematics areas such as applied analysis, numerical analysis, potential and approximation theory, mathematical optimization, mathematical modeling, differential and integral calculus, difference equation etc.

For instance, when analyzing and designing medical solutions, biomedical engineers routinely use calculus and geometry skills, in designing an artificial heart for instance, the engineer must use advanced mathematics to consider the fit of the organ in the body and its rate of pumping blood.

Again, modern medical imaging system such as magnetic resonance imaging (MRI) and computed tomography (CT) could not have succeeded without the help of advanced optimization theories and reconstruction algorithm. Progress in numerical analysis and biostatistics has also contributed to the rapid advancement of physiological signal processing and computer aided diagnosis of intractable diseases, etc.

In spite of these glaring evidences of the role of mathematics on this emerging discipline staring at us, the achievement of the students in this all important subject is below expectation. There are a lots of research evidence to support this fact.

There is a growing concern about the world wide belief that mathematics is a "hard subject" to learn. A large proportion of students entering schools have that phobia of mathematics difficulty. The attendant consequence is that a large proportion of students in engineering and other fields come to tertiary institution poorly trained in mathematics [2]. The difficulty shown by Biomedical Engineering Student in basic mathematical elements, essential to successful integration in the syllabus, inevitably lead to high failure rates and withdrawal in the mathematical courses and subsequent lack of motivation.

Another point of observation that is worthy of examination is the relationship between attitude and perceptions and students achievement (Learning) in mathematics. Attitude relates to an individual's personality, beliefs, values, behaviors and motivation. It is the complex combination of these attitudes working in an individual to form his/her characterization. Pickens [3] identifies three elements of attitudes as affective behavior (Feeling), the cognition (a thought or belief) and action (mostly psychomotor).

Perception on the other hand is the way in which something is regarded, understood or interpreted. Perceptions are part of attitudes and specifically related to the cognition dimension of attitude.

Perceptions and belief about mathematics originate from past experience; comprising both cognitive and affective dimensions [4]. From a cognitive point of view it relates to a person's knowledge, beliefs and other cognitive representations while from an affective domain it refers to a person's attitudes, feeling and emotion about mathematics.

It is widely believed that negative perceptions and myths of mathematics are widely spread among the students. This claim finds support in [5] in which it was noted that many students are scared of mathematics and also feel powerless in the presence of mathematical ideal. They regard

Article History:
Received Date: Sep. 01, 2022, Accepted Date: Nov. 03, 2022, Available Online: Jan. 01, 2023

mathematics as "difficult, cold, abstract, and also in many cultures largely masculine [6]. Buxton cited by [5] viewed mathematics as "Fixed, immutable, external, Intractable and uncreative" or timed –test". Peterson [7] also noted that even scientists and engineers whose jobs are related to mathematics often habour an image of mathematics as a well-stocked warehouse from which to select ready to use formulae, theorems and results to advance their own theories.

Educators attempt to explain this phenomenon through the widespread beliefs or mathematics myths that "learning mathematics is a question more of ability than effort" [8] or "there is an inherent natural ability for mathematics." Many people hold the view that mathematics is only for those who have "inherited mathematical ability".

Another widely held belief is that mathematics is a male dominant subject. One other stereotyped image is that boys are better in mathematics than girls [9]. Thus, many adults accept this lack of accomplishment in mathematics as a permanent state over which they have little or no control. Parents and significance orders have a strong influence on students' belief and attitude towards mathematics. Authors in [10-11] showed that students' mathematics learning outcome are strongly related to their beliefs and attitudes towards mathematics. According to [5], parents' view about mathematics has strong effect on the way they teach their children. This usually generates tension between the parents and teachers if they share contrasting images of mathematics.

Engineering student's attitudes and disposition towards mathematics can affect their overall achievement in mathematical courses and courses applying mathematical concept and techniques.

Dew et al [12] found that older students and women experience higher level of anxiety towards mathematics than younger students and men.

Biomedical engineering students as an integral component of engineering are not excluded from these myths identified above. Therefore the problem of this work is to identify or find the attitude and perception of mathematics by the students of biomedical engineering. The purpose of the study include:

1. To identify the attitude expressed by biomedical engineering students about mathematics.
2. To examine whether the attitude expressed by the biomedical students affect their achievement in mathematics.
3. To identify the range of students perception towards mathematics belief by biomedical engineering students.
4. To examine whether there is a relationship between the identified perception constructs and students performance in mathematics.
5. To give recommendations to enhance positive attitude and perceptions towards mathematics.

B. RESEARCH QUESTIONS

The following research question guided the study:

1. What are the attitudes and perceptions of biomedical engineering students towards mathematics?
2. What is the relationship between the attitudes and perceptions of biomedical engineering students and their achievement in mathematics?

C. RESEARCH HYPOTHESIS

H_0: There is no significant relationship between the attitudes and perceptions towards mathematics achievements by biomedical engineering students.

II. METHODS:

A. Design Approach

This is a survey research design and the sample approaches were employed in this study.

A total of one hundred and sixty (160) students participated in survey. One hundred (100) students from the department of Biomedical Engineering, Federal College of Dental Technology & Therapy Enugu, (FCTT&T); And sixty (60) students from biomedical engineering department university of Nigeria Nsukka (UNN). The sample is as shown in table 1 below.

Table 1: The Sample for the Survey

School	Number of students	PERCENTAGE
FCT T & T	100	62.5
UNN	60	37.5
TOTAL	160	100

The research instrument employed in the study was a questionnaire which focused on the biomedical engineering students' attitudes and perceptions about mathematics. The items were drawn from a number of sources, in order to cover all areas of interest and more specifically on the work of Nahari [13] who undertook similar studies in their countries.

B. Research Instrument

The instrument consists of 55 items divided into three parts. A questionnaire of 30 items in one part concerning attitudes and perception and 15 items in the second part concerning learning and study strategies, in a four point likert scale format. Response to each of the items was rated with anchors labeled. 1= strongly disagree (SD) 2= disagree (D) 3= Agree (A) 4= strongly agree (SA) the reliability was tested using the Crobanch Alpha.

Coefficient of reliability of 0.853 was achieved, hence the reliability of the instrument can be accepted based on Cooper et al [14] argument that any coefficient of 0.70 implies reliability of the instrument.

The third point of the instrument consists of the performance section. This part consists of 10 objective questions from basic mathematics. The instrument was also validated by experts in measurement and evaluation.

C. Data Collection/analysis:

The researchers sought the permission of the department to administer the questionnaires to the respondents. The questionnaires were administered when the students were not busy with their class works. A covering letter assuring the respondents of the anonymity and confidentiality accompanied the questionnaire. The covering letter also

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stated what the study is all about and asked them to voluntarily respond to the questionnaire.
The researchers supervised the respondents as they responded to the items. The respondents handed in their papers after the exercise. The returned questionnaires were inspected to determine their level of acceptability.
The data collected were coded and was transferred to excel sheet. The data was processed using a computer packaged (SPSS) version 20.0. Descriptive statistics (mean and standard deviations) were used to analyze the data in summary form. Mean and standard deviations were used to answer research question one. While the Pearson product moment correlation was used to answer questions two.
The research hypothesis was tested using the Pearson-moment correlation embedded in the SPSS package at p-value of 0.05.

D. Results

At the end of the data collection phase, the total number of the completed questionnaires and objective questions were one hundred and sixty (60) as presented in the table one above. The research questions were answered and presented in the table two below.

Research question one

What are the attitudes and perceptions of biomedical engineering students towards mathematics?

Table 2: The mean attitude and perception of biomedical engineering students on mathematics.

	N	Mean	Std. Deviation
item1	160	1.2625	.69034
item2	160	3.8750	.66938
item3	160	1.1469	.65032
item4	160	3.5313	.72356
item5	160	1.2500	.52844
item6	160	1.1606	.56186
item7	160	1.4000	.55173
item8	160	1.4875	.63432
item9	160	3.3625	.77287
Total	160	2.0509	.64254

Research Question Two

What is the relationship between attitudes and perception, and students' achievement in mathematics?
To be able to answer this question the researcher correlated all the factors of attitudes and perception against achievement. The results are presented on the following tables' two to ten. Table 3 shows the correlation between confidence and achievement.
Table 4 shows the correlation between anxiety and achievement

Table 3: The correlation between confidence and achievement

		Mathematics achievement	confidence
	Mathematics achievement	1.000	0.632
	Confidence	0.632	
	Mathematics achievement		0.002
	Confidence	0.002	160
	Mathematics achievement	160	160
	Confidence	160	160

Table 4: The correlation between anxiety and achievement

		Mathematics achievement	Anxiety
	Mathematics achievement	1.000	-0.461
	Anxiety	-0.461	1.000
	Mathematics achievement		0.031
	Anxiety	0.031	
	Mathematics achievement	160	160
	Anxiety	160	160

Table 5: The correlation between learning goals and achievement

		Mathematics achievement	Learning goals
	Mathematics achievement	1.000	0.713
	Learning goals	0.713	1.000
	Mathematics achievement		0.000
	Learning goals	0.00	
	Mathematics achievement	160	160
	Learning goals	160	160

III. Discussion.

The data collected were analyzed in an effort to explore the attitudes and perceptions of the biomedical engineering students toward mathematics. In order to achieve this, the following attitudes and perception constructs were identified. (i) Confidence. (ii) Anxiety. (iii) Learning goals. (iv) Mathematical myths and beliefs. (v) Persistence. (vi) Approach. (vii) Learning strategies (viii) Prior experience. (ix) General issues.
The mean for each factor of attitudes and perception were analyzed and presented as shown in the table one above. The results presented in descriptive statistics revealed that anxiety in the biomedical engineering students with mean (M) = 3.8750 and standard deviation (SD) = 0.66938 as the main contributing factor to their achievement in mathematics. This is because their mean score of 3.8750 is well above the benchmark of 2.50 in a four likert scale rating. These results find support in many research works conducted in related topics. Truttsche [15] in his work,

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mathematical anxiety that discovered that mathematics anxiety can have detrimental effects for college students including feeling of nervous, tension, fear of rejection and stress. As a consequence, the students who show anxiety towards mathematics can avoid mathematics and any courses related to mathematics and also show a decline in mathematics achievement.

Mathematical myths and belief were also ranked highly (M=3.5313, SD= 0.72356) in terms of their contribution to students, negative disposition towards mathematics. It shows that the students habour a high level of mathematical myths and belief. This has the ability to dampen ones' interest and achievement in mathematics. Mutodi et al [16] observed that mathematics is valued because it is considered by the community to be an indicator of intelligence. Students' feelings of lack of control could stem from the idea that mathematics is "difficult" or that you have to have "brain math" in order to succeed in the subject. Feeling of lack of control can be a cultural norm such as a negative stereotype about image and gender. Women are often ready to give up in anything mathematical.

General issues which borders on the generally held view that mathematics is so abstract and has little or no real life application. It also relates to the view that mathematics is a subject that is capable of distorting one's mental ability. That is the view that mathematicians are eccentric. From the results presented on the table one above, students reported a mean of 3.3625 and a standard deviation of 0.77287. This indicates that students hold a very high view of this aspect of attitudes and perceptions towards mathematics. Studies by Egbugara, [17] revealed that mathematics has been a subject of mental depression for a number of school children.

Again, from the table the other attitudes and perceptions constructs such as confidence (M=1.2625, SD=0.69034) learning goals (M=1.1409, SD=0.650332), persistence (M= 1.2500, SD =0.52844) approach (M=1.1606, SD=0.56186), learning strategies (M=1.4000, SD= 0.55173) and prior experience (M=1.4875, SD= 0.63432) were all scored very low by the students. There scores are all well below the average benchmark of 2.50 for the four point likert scale

Table 6: The Correlation between Myths and belief and achievement

		Mathematics achievement	Myths and Belief
	Mathematics achievement	1.000	-0.332
	Myths and Belief	-0.332	1.000
	Mathematics achievement		0.038
	Myths and Belief	0.038	
	Mathematics achievement	160	160
	Myths and Belief	160	160

Table 7: The correlation between persistence and achievement

		Mathematics achievement	Persistence
	Mathematics achievement	1.000	0.526
	Persistence	0.526	1.000
	Mathematics achievement		0.012
	Persistence	0.012	
	Mathematics achievement	160	160
	Persistence	160	160

Table 8: The correlation between approach and achievement

		Mathematics achievement	Approach
	Mathematics achievement	1.000	0.132
	Approach	0.132	1.000
	Mathematics achievement		0.048
	Approach	0.048	
	Mathematics achievement	160	160
	Approach	160	160

Table 9: The correlation between achievement and learning strategies

		Mathematics achievement	Learning strategies
	Mathematics achievement	1.000	0.613
	Learning strategies	0.613	1.000
	Mathematics achievement		0.012
	Learning strategies	0.001	
	Mathematics achievement	160	160
	Learning strategies	160	160

Table 10: The correlation between achievement and prior experience

		Mathematics achievement	Prior Experience
	Mathematics achievement	1.000	0.826
	Prior Experience	0.826	1.000
	Mathematics achievement		0.000
	Prior Experience	0.000	
	Mathematics achievement	160	160
	Prior Experience	160	160

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Table 11: The correlation between achievement and general issues

		Mathematics achievement	General issues
	Mathematics achievement	1.000	-0.159
	General issues	-0.159	1.000
	Mathematics achievement		0.022
	General issues	0.022	
	Mathematics achievement	160	160
	General issues	160	160

Table 12: The summary correlation table for the relationship between attitudes and perception and students' achievements

Items	**Factors**	**Correlation(r) with achievement**	**P-value**
1	Confidence	0.632	0.002
2	Anxiety	-0.462	0.031
3	Learning goal	0.713	0.000
4	Myths and belief	-0.332	0.038
5	Persistence	0.526	0.012
6	Approach	0.132	0.048
7	Learning strategies	0.613	0.001
8	Prior experience	0.826	0.000
9	General issues	-0.159	0.022

P-value = 0.05.

rating. These factors which mediate attitudes and perceptions, affect in turn students' achievement in mathematics [18-19]. The students' high confidence on mathematics can lead to better motivation to do well.

Research question two: What is the relationship between attitudes and perception, and biomedical engineering students' achievement in mathematics?

Pearson product-moment correlation analysis was used to determine the strength and direction of the relationships. Pearson correlation coefficient(r) is a measure of the strength of the association between two variables.

The results emanating from the research also indicate that there is a statistically significant positive relationship between confidence, learning goal, persistence, approach, learning strategy, and prior experience and achievement in mathematics. From the above analyses, one can assert that confidence, learning goal, persistence, approach, learning strategy, and prior experience can predict performance in mathematics. However, there was a statistically significant positive weak relationship between approach to mathematics learning and achievement among the biomedical engineering students. Since the P-values were less than 0.05, it therefore means that we reject the null hypothesis and conclude that these identified attitude and perception constructs can predict performance.

Also, the results presented on table eleven indicate that there is a statistically significant negative relationship between anxiety, myths and belief and general issues and mathematics achievement. These results can also predict performance in mathematics achievement. This is because the null hypothesis is rejected since the P-values were all less than 0.05.

Several relationships observed in this study were similar to the findings of previous researchers. For example, students' beliefs were significantly related to academic outcome. [20] found that students' self-perceptions of their reading ability were significantly associated with achievement, whereas self-confidence beliefs were associated with good performance in mathematics.

In general, students who attributed their academic success to factors such as confidence, interest, setting learning goal, persistence, good approach, prior experience etc., tend to show higher achievement levels than students who attribute their performance to natural talent or good luck. In support of this assertion, Wentzel *et al* [21] shared the same sentiments.

IV. CONCLUSION/RECOMMENDATIONS.

The study investigated the attitudes and perception of mathematics by the biomedical engineering students. Results from the descriptive statistics revealed that the nine factors of attitude and perception constructs contribute to mathematics achievements. The correlation analyses showed that some of these factors have statistical significant positive relationship with mathematics achievement while some also have statistical significant negative relationship with mathematics achievement. Prior experience and learning goals have a very strong positive significant relationship with mathematics achievement, confidence, learning strategies have strong positive relationship with mathematics achievement, and persistence has moderate positive relationship with mathematics achievement, while approach has a weak positive relationship with mathematics achievement. On the other hand, anxiety has a considerably negative moderate relationship with mathematics achievement, while myths and belief and general issues have negative weak relationship with mathematics achievement.

This study has implications for all stakeholders, including students, teachers, schools and parents. The research reveals that students who believe that their efforts will improve their performance are likely to enhance their achievement.

Therefore this study recommends that parents and teachers should play a significant role in shaping students' perceptions and attitudes towards mathematics. It also recommends that students should not be discouraged by past experiences in lower grades that convince them that they cannot do well in mathematics.

Additionally, higher mathematics ability is often believed to go hand-in-hand with greater levels of general intelligence. Many students tend to subscribe to this attitude towards mathematics. However the study recommends that students should not hold on to such myths and beliefs about mathematical intelligence that can affect their performance. If they believe that intelligence in mathematics is a fixed

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quantity, something they have or do not have, but not something they acquire over time, and they may not see the point of extra effort. Finally, if students attribute their success to their innate talents rather than effort, they may not be motivated to work.

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