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Full Length Research

An investigation into undergraduate students' attitude towards statistics: A case of a university in Ghana

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ABSTRACT: Students' mastery in statistics is of great importance since it serves as a tool for conducting a good research in every academic sphere. This study investigated undergraduates' attitude towards the study of statistics and its possible implication on their academic achievement in this subject with particular reference to determining plausible differences between male and female students. A purposive sample size of two hundred and sixty (260) students drawn from 2016/2017 and 2017/2018 academic year was used. This sample did not include students who read mathematic as a major programme in the University. A self-structured multidimensional questionnaire with four components which had internal consistencies ranging from 0.69 to 0.74 was used as the data collection instrument. Data obtained were analyzed using linear regression model and MANOVA. Analysis of the result revealed that students' attitude has a significant effect on their learning outcome. Also, significant differences were observed between male and female on a linear combination of their attitude towards statistics and achievement. Further analyses showed only gender differences in attitude towards statistics but not in achievement. The implications of the findings for classroom practice were discussed.

Keywords: Academic achievement, attitude, statistics, undergraduate.

INTRODUCTION

Statistics as a course permeates all programmes of study from the elementary school level to institutions of higher learning. Due to its relevance, it is studied by all undergraduate students to equip them with basic statistical knowledge to enable its application in conducting academic research (Rosli and Maat, 2017) and be able to apply it in different ramifications of life. Knowledge in Statistics helps students to collect data, organize, analyse and offer interpretation from the analysis (Gordor and Howard, 2006; Judi et al., 2011; Sudarwo, 2017). Learning statistics enables one to collect and analyse data that explains a particular phenomenon (Sudarwo, 2017). As human beings, tremendous information such as results of election, inflation rates and Gross Domestic Product GDP were received all the time that comes in a form of numbers. These numbers are scores from collecting and analyzing data in some form. It will be difficult to interpret and analyze these scores, unless one has foundational understanding of statistical knowledge (Watson, 2006). Additionally, knowledge in statistics is beneficial to policy analysts, decision makers, teachers and other key people who are at the helm of affairs. Learning statistics offers benefits such as making decisions, solving daily problems, and finding answers to pressing questions in life (Melad, 2016; Cimpoeru and Roman, 2018). Most decisions are considered invalid and unconvincing when there are no figures and numbers to support them (Gordor and Howard, 2006).

Statisticians play a vital role in their various places of work. In the industries, they design and conduct experiments to improve upon services rendered to the general public. They also take charge of quality control issues in manufacturing and ensuring quality and dependability of product. In the health sector, they are responsible for studying and improving the efficiency of delivery systems and practices (Ofosu and Hesse, 2011). Statistical knowledge is required in many areas of life to enable one to understand the world around and also to

make accurate decisions in life (Cimpoeru and Roman, 2018). It is for this reason that early exposure to statistical knowledge is deemed necessary in the life of every students (Rosli et al., 2017). It enables students to acquire statistical knowledge, develops the ability to critically analyse issues and make sense of data they come across in life (Melad, 2016; Cimpoeru and Roman, 2018).

In education and the classroom in particular, teachers often make decisions concerning students' learning. Some of these decisions are how well students progress with instruction, how well students' have mastered what is being taught, the extent to which instructional objectives have been achieved and so on (Okyere et al., 2018). Decisions of such nature are best taken by teachers who frequently obtain data about students through observation, questioning and test. Data obtained through tests often result in large amount of numerical scores which needs adequate knowledge in statistics to make meaning of such data to allow accurate decisions to be taken.

Statement of problem

Statistical knowledge is increasingly becoming important in a number of professions. It is a course that every student is supposed to possess adequate knowledge due to its many applications in life. Consequently, it is increasingly gaining a high level of recognition as a course of study in almost all academic programmes in the universities especially in the area of project or thesis writing, since these are requirements in all institutions of higher learning for the award of degrees (Koh and Mohd Khairi, 2014; Rosli and Maat, 2017). Therefore, demonstrating high knowledge of research writing would equally require a sound and adequate knowledge in statistics for analysis and discussion of research results.

Notwithstanding, the increasing importance attached to statistics, other studies conducted elsewhere indicate that most undergraduate students approach this course with some apprehension (Bechrakis et al., 2011). This apprehension may result from their experiences with mathematics taken earlier in their secondary school days. Students who found mathematics as uncomfortable subject fail to appreciate the usefulness of statistics irrespective of whatever application they might meet in their future disciplines, academia and in their future careers (Bechrakis et al., 2011). These students underestimate their confidence and competencies in learning statistics. This low self-confidence of students may generate negative feelings about statistics course in their studies.

It is generally believed that confidence in doing mathematics is a necessary factor that fuels one's attitude in mathematics and hence improved academic performance. Students would enjoy learning statistics when they have positive attitude towards the subject (Judi et al., 2011).

In the Catholic University of Ghana, the Faculty of Education, makes the study of statistics mandatory for all undergraduate students as means to sharpen and enhance their research writing skills and become abreast with its numerous applications in other programmes of study. In spite of its usefulness in many walks of life and in academia, many students who have taken the course over the past years often show some sort of discomfort during statistics lessons. Some even pass comments such as '*mathematics again'*, *I taught I was running away from anything mathematical.* Students who make such comments are usually seen not to pay maximum attention in class. These observations made the researcher curios in conducting this study to investigate students' attitude towards statistics.

Research questions

1. What is the effect of students' attitude towards statistics on their academic achievement in the subject?
2. What differences exist if any, between male and female students' attitude towards statistics and academic achievement?

THEORETICAL FRAMEWORK

Bandura's Theory of self- efficacy

Peoples' beliefs about their abilities to accomplish or not accomplish performance have tremendous influence that affects their lives. As a theoretical construct, self-efficacy has roots in Bandura's psychological theory of self-efficacy (Bandura,1994). Self-efficacy has to do with people's beliefs in their own capabilities. This determines how people feel, think, motivate themselves and behave. These beliefs are manifested psychologically through four major processes, namely, a) cognitive, b) motivational, c) affective and d) selection processes. Students who have positive high assurance in their own capabilities are more likely to approach difficult task, such as the study of mathematics or statistics as challenges that need to be mastered rather than as threats to be avoided. Such positive perception engenders intrinsic motivation and makes students to become more focused in their activities (Bandura, 1994). Self-efficacy as a cognitive process means that greater part of human behaviour is purposive and it is regulated by what is in the mind (cognition) as a forethought which embodies valued goals. These goals are in turn shaped by self-appraisal capability such that in situations where there is a stronger perceived self-efficacy, the higher would be the goals that people set for themselves. The opposite is equally true, namely, the weaker the self-efficacy that one has, the lower goals one would set for oneself. That means that every human

course of action initially originates from cognition (thought). Students with a high sense of efficacy see successes as scenarios that provide both positive guides and support for performance. On the other hand, students with self-doubt are likely to achieve very little (Bandura, 1994).

Students' attitude and learning statistics

Achieving excellence in any endeavour is associated with the kind of attitude one has or portrays towards the activity (Judi et al., 2011). According to Ashaari et al. (2011), attitude is a mental condition that one possess which is formed by experience. It influences how one reacts towards a phenomenon. Students often develop attitude towards statistics course based on their experience with mathematics. Students who often make good grades in mathematics are likely to react positively towards it. On the other hand, students would show negative attitude to mathematics when they frequently encounter learning difficulties and repeated failures (Yara, 2009). Attitude can be positive or negative and students with positive attitude towards a phenomena often develop interest in acquiring further knowledge about it. Likewise, students with negative attitude are often affected in terms of possibly interest in learning. Several factors influence the formation of attitude among students. Notable among them is their learning environment, teacher behaviour, interaction with people who have had unpleasant experiences in learning mathematics, and many more. When the learning environment is conducive and teachers and students play equal role in the teaching and learning activities, students become more interested in learning and hence promote positive attitude towards the subject of study. A study conducted by Maat and Zakaria (2010) indicated that there was significant relationship between students learning environment and attitude towards mathematics.

Usefulness of statistics

The usefulness of statistics cannot be underestimated. Statistics is useful to finding solutions to complexities in life. Knowledge about statistics helps one to make accurate and intelligent choices. Like mathematics, statistics is important to all students irrespective of the desired career choices one make in life. It provides a powerful and concise means of communication. According to Watson (2006), introducing students to concepts in statistics during early stages in learning enables them to develop statistical reasoning, skills and the ability to apply it in daily life. The Ghanaian mathematics curriculum for instance introduces students to statistical concepts as early as primary level by the topic 'Data handling' which allows students to be exposed to how to collect data in life such as ages of pupils in class, day of birth, month of birth, etc. and to organize it in some form (Ministry of Education, 2007). This topic is introduced to pupils for the purpose of developing their ability to manage data at hand. In spite of this early exposure, many students think they do not need statistics (even though it is embedded in mathematics lessons) since they would not study mathematics related courses at higher levels of education. This is sometimes not surprising because most researches indicate that lessons in mathematics and statistics focus on theoretical concepts and not its usefulness and application to real life context. Students will learn with understanding and develop high interest in what they learn if they know how useful what they are learning and how it would be applied in their life (Ashaari et al., 2011). According to Sudarwo (2017), students exposed to learning statistics are provided with the benefits of presenting meaningful and accurate information about a population, developing the procedures of conducting scientific research, leading to reliable measurements, using present and past experiences to predict some occurrences in the future, and last but not the least, determining the validity and reliability of survey instruments.

Interest in learning statistics

Interest is a major factor that shapes students' attitude towards a phenomenon. It is often believed that one can do something better when interest develops into positive attitude. Interest in learning statistics is a mind bordering issue to many statistics instructors. Many students consider statistics as a course with many fundamental concepts and techniques that are difficult to learn (Judi et al., 2011). Students with this view of statistics often develop little interest in learning. Such students are likely to be affected in terms of academic performance due to possible deficiency in acquiring statistical reasoning (Nolan et al., 2012). Developing a growing interest in an activity can develop one's confidence in his or her own ability. Students also develop interest in learning when the usefulness and applications are outlined. Students' disinterest in learning statistics may also be linked to lack of self-confidence and their ability to perform well (Li, 2012).

Attitude and achievement in statistics

Attitude plays a significant role in students' achievement. It is the disposition and feeling one has in doing or withdrawing from an activity (Boyd et al., 2008). Similarly, Emmioğlu and Capa-aydin (2012) define "attitude towards statistics as a multidimensional construct representing students' learned predisposition that respond positively or negatively to statistics (p. 95). An attitude a person forms towards an activity determines his/her reaction towards it. In academia, students' attitude towards a particular subject

plays a crucial role in their learning and achievement (Bayaga and Wadesango, 2014). Fishbein (cited in Li, 2012) argues that a person's attitude contributes to his/her intended behaviour, which ultimately affects the person's outcome. In this respect, a person's attitude to some extent could be regarded as a significant predictor of the behavioural outcome. It is important for students to develop interest in learning statistics and have the belief that its concepts are not so difficult to understand (Schau, 2003; Melad, 2016). Thoughts of this nature enable students to develop favourable and positive attitude to learning statistics and hence improved achievement.

There is a growing body of research indicating positive relationship between attitude towards statistics and performance (Emmioğlu and Capa-aydin, 2012). This means that the more students react positively towards statistics, the better their achievement in the subject. These are studies conducted in different countries using varied sample sizes, different measures of assessment and students with varied characteristics but most of them reporting positive correlation between the variables attitude and achievement in statistics (Emmioğlu and Capa-aydin, 2012).

Li (2014) conducted a study to investigate the relationship between social science students' attitude towards research methods and statistics, self-efficacy, effort and academic achievement. 153 students participated in the study. The study found a moderate and positive correlation between attitude and academic achievement. Similarly, Li (2014) reported a research conducted by House in the U.S. with the aim to studying the relationship between students' attitude and academic achievement. The study participants were 218 students. Results showed high correlation between students' attitude and achievement.

In spite of most study results indicating positive relationship between attitude and academic achievement (Emmioğlu and Capa-aydin, 2012; Li, 2012), other researchers (Mickelson, 1990; Ma and Kishor, 1997) assert that students attitude might not necessarily be a predictor of achievement.

Gender differences in attitude and achievement

Assessing gender differences in students' attitude towards statistics has received much attention from researchers and statistics educators (Ashaari et al., 2011; Chiese and Primi, 2015). Over the years, there have been several researches indicating gender differences in attitude and achievement in mathematics. With much apprehension towards the study of mathematics especially by females (Eshun, 2000), the question was to find out if this situation also exists in statistics? According to Chiese and Primi (2015), female students tend to underrate their competencies and abilities in learning quantitative disciplines as a result of their negative attitude compared to their male counterparts (Eshun, 2000). This has generated lots of researches into this issue and how best to curtail or bridge the gap since a nation's development depend on both male and female citizens (Larbi and Okyere, 2014). Moved by this desire, Ashaari et al. (2011) conducted a study to investigate into students' attitude towards statistics on first year students taking Statistics and Probability in school. The instrument used in collecting data was questionnaire and the data was analysed using t-test. Results showed no gender difference in all the six components studied except the affective variable. Similarly, Roberts and Saxe (cited in Sutarso, 1992) and Chiese and Primi (2015) in separate studies found that there was significant association between gender attitude and statistics achievement. In addition, male students had more positive attitude and hence better achievement in statistics than their female counterparts (Roberts and Saxe, cited in Sutarso, 1992).

METHODOLOGY

The study followed the descriptive survey design approach. This design was adopted because the researcher wished just to describe what amount of students' achievement in statistics could be explained by their attitude towards the subject. The design was also found suitable for the study since large amount of data was intended to be obtained and analysed for the purpose of achieving the research objectives (Sarantakos, 2005). Data were collected from students on two different academic years which were the 2016/2017 and 2017/2018. The study was conducted on undergraduate students of Catholic University College of Ghana, Fiapre. These study participants were students in the Faculty of Education who majored in various options except mathematics. The students were exempted from the study because having the will to study mathematics at the university level might have been influenced by such factors as interest, usefulness, cognitive competence, etc. It was therefore anticipated that including them in the study may affect the true state of the result. These students numbered up to 260. All education students were required to take a course 'statistics and probability' that was offered in the faculty and was compulsory. This course was to equip the students with statistical knowledge to enhance their understanding of research methods as part of their required courses for their programme. Data on the participants' achievement were their score on the end of semester examinations.

Closed – ended questionnaire was used to collect data from the respondents. The questionnaire was self-constructed instrument and as a result, it was subjected to content validation by colleagues to enable all ambiguous and unclear items to be modified where necessary. The instrument was further pilot tested to determine the internal consistency of the items, an index, which determines

Table 1. Attitudinal subscale and sample items with reliability coefficient.

Subscale	Sample Item	Reliability Coefficient
Interest	Statistics is an interesting course	0.69
Motivation	I find statistics learning very stimulating	0.74
Usefulness	Knowledge of statistics in applied in other subjects	0.71
Anxiety	I struggle with many concepts in statistics	0.69

whether the items measure the same construct or not. The estimates of the reliability coefficient of the subscales of the instrument are presented in Table 1.

The questionnaire was administered to the students and allowed some time to indicate their agreement to the items on a 4 - point Likert scale measure. The questionnaires were then collected for analysis.

The study was quantitative in nature. The collected questionnaires were then screened and the responses were coded. Positive item were coded Strongly agree – 4, Agree – 3, Disagree – 2, and Strongly disagree – 1. Coding negative items was a reverse of the positive ones. An example of the negative worded item is 'I feel less encouraged to study statistics'. The responses were entered into SPSS version 20 and analysed inferentially. The analysis was conducted using regression analysis to model the students achievement based on their attitude to statistics. The students' attitudinal score was taken as the independent variable and their achievement score was the dependent variable. This analysis answered research question one while research question two was answered using Multivariate Analysis of Variance (MANOVA) to check if gender differences existed in terms of attitude and achievement score. Manova is a test statistic that compares groups on more than one dependent variable that are related.

RESULTS

The results of the study are presented in this section and are discussed in accordance to the research questions.

Research question 1: *What is the effect of students' attitude towards statistics on their academic achievement in the subject?*

This research question was answered using simple linear regression to model the two variables with student's attitudinal score as the independent variable and their performance on statistics test as the dependent variable. The model summary of the linear regression analysis is presented in Table 2.

The 'R' value in Table 2 shows the degree of correlation between the independent (predictor) variable and the dependent (criterion) variable. The table shows that there is a moderate positive correlation (r = 0.49) between students mean score of their attitude and achievement score in statistics. Thus, the model moderately predicts students' achievement score in statistics by their attitude.

The 'R'-square value in the model is simply the square of R which is known as the coefficient of determination. The R-square value indicates how much of the variability in the dependent variable is explained by the independent variable. Table 2 shows that 24% of the variability in students' achievement score could be explained by their attitude towards statistics.

The adjusted R-square value in Table 2 is of little significance since the predictor variable in this study was only one. It is only considered for more than one predictor variables since it modifies the R-square to obtain a more realistic indication of the predictive power.

The values of coefficient of the independent variable and the constant term of the estimate of the linear regression model are found in Table 3. Table 3 provides the required coefficients for the model building. These coefficients are found under the letter marked 'B' below the 'Unstandardized Coefficients'. The constant value 11.83 is individual's estimated achievement score when one has no discernable attitude towards statistics and hence is equal to 0. The coefficient 0.31 is the slope of the independent or predictor variable in the model which tells the average increase in achievement score when there is a unit increase in attitudinal score. The estimated regression model is therefore given by:

Achievement score = 11.83 + 0.31 ×attitudinal score

Mathematically, this can be written as

$$\hat{y} = 11.83 + 0.31x + e$$

Where $\hat{y}$ = the dependent variable representing the achievement score, x = the independent variable representing the attitudinal score and e = error in the achievement score.

After obtaining the model equation between the two variables, the next step deemed necessary was to determine how significant the effect of the predictor variable was. This was ascertained using the results from the ANOVA test of significance presented in Table 4.

The test of significance in the model was conducted at 5% significance level. Result from Table 4 shows that the predictor variable was significant considering the F-ratio of

Table 2. Model summary of the Linear Regression Analysis.

R	R Square	Adjusted R Square	Std Error
0.490	0.240	0.237	7.605

Table 3. Coefficient of the linear regression model.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	11.829	3.056		3.870	0.000
Attitudinal Score	0.312	0.035	0.490	9.034	0.000

Table 4. ANOVA Test of significance of the predictor variable.

Parameter	Sum of Squares	df	Mean Square	F	Significance
Regression	4720.093	1	4720.093	81.605	0.000
Residual	14922.892	258	57.841		
Total	19642.985	259			

Table 5. Respondents' scores on attitude to statistics and achievement.

Dependent variables	Males		Females		Df	M Sq	Between	Subject-Effect
	Mean	SD	Mean	SD			F-value	p-value
Attitudinal score	90.71	12.48	82.06	13.85	1	4622.82	27.25	0.000*
Achievement score	39.87	8.29	37.9	9.34	1	240.49	3.1	0.075

81.61 with $p < 0.001$. Thus, students' attitude towards statistics has significant contribution to their achievement score in the subject.

Research question 2: *What differences exist between male and female students' attitude towards statistics and academic achievement?*

Before employing the MANOVA, preliminary test was conducted on its assumptions to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity. There were however no violations detected on the various check of assumptions.

A one-way between-groups multivariate analysis of variance was performed to investigate gender differences in attitude towards statistics and academic achievement. There was a statistically significant difference between males and females on the combined dependent variables: F (2, 257) = 13.92, $p<0.001$; Wilks' Lambda = 0.90; partial eta squared = 0.10. When the results for the dependent variables were considered separately, the only difference to reach statistical significance using a Bonferroni adjusted alpha level of 0.025 was scores on their attitude: F (1, 258) = 27.25, p = 0.000, partial eta square = 0.10. An inspection of the mean scores indicated that males reported higher level of attitude towards statistics (M = 90.71, 12.48) than females (M = 82.06, 13.85) as presented in Table 5.

DISCUSSION

This paper investigated undergraduate students' attitude towards the study of statistics. Data were collected using a questionnaire developed by the researcher and end of semester test. The results show that students' attitude play a significant role in their learning outcome. This resulted from the significant correlation between the attitude to statistics and academic achievement. The square the correlation coefficient indicated that significant percentage of variability in the students' achievement score could be explained by their attitudinal disposition towards statistics. This finding supports the assertion of some researchers (Bayaga and Wadesango, 2014; Fishbein (cited in Li, 2012)) and other study findings in which students' attitude was found to contribute significantly to their academic achievement (Chiese and Primi, 2015; Emmioğlu and Capa-aydin, 2012; Li, 2012). Attitude therefore is a crucial component of students' learning. It is a driving force behind the extent of students' engagement in learning. Students who have positive attitude toward statistics are likely to be highly motivated in leaning, show readiness, develop good

learning habit and respond favourably to learning the subject.

In addition, the results showed significant differences between male and female on linear combination of the two dependent variables, attitude to statistics and academic achievement. Further analysis indicates that there is gender difference in attitude toward the study of statistics in favour of males. However, there was no difference in gender with regard to academic achievement in the statistics course. The result of difference in attitude towards statistic is not surprising. Many students particularly females enter into statistics lessons with some form of apprehension as a result of unfavourable experiences they might have had with earlier studies in mathematics (Eshun, 2000; Yara, 2009). This feeling often impedes students' successful understanding to learning and may result in partial withdrawal. This present study indicates that female students compared to their male counterparts had lesser attitude towards the discipline. This finding is in consonant with that of Chiese and Primi (2015).

In spite of the results showing gender difference in attitude to statistics, there was no gender difference in academic performance. Although males mean score was a little higher than that of the females, it was not significant. Thus, males' performance was at par with that of the females. This indicates that there are no differences in academic performance of undergraduate students with respect to gender.

Implications for classroom practice

Developing a positive attitude towards the learning of statistics in students can be a contributing factor to achieving improved performance in their learning outcome. Attitudinal status of an individual towards an activity critically determines whether he/she would accept or withdraw from it. Having a positive attitude towards learning sustains a persons' learning desire. Many students enter into statistics lessons with fear from prior mathematics experiences. It is important therefore that teachers use several mechanisms to develop students' positive attitude to learning statistics in students since attitude is found to correlate with performance. Another factor for developing students' positive attitude to statistics hinges on the introductory stage of the lesson. Lessons need to be introduced in a more captivating manner that will enable students to respond positively and pay attention during the teaching and learning process. In addition, students need to be informed about the usefulness of statistics in their daily lives and its applications to enable them feel the usefulness of the course. Knowledge of statistics also has applications in various programmes of study particularly in research methods and project writing. Students learn with high degree of getting understanding when they know the usefulness of what they are learning. This would make students feel they are learning something worthwhile and hence would develop positive attitude to the subject.

It has been a common practice where teachers often introduce students to calculating statistical concepts using data the students know nothing about. This can result in abstractness of what students are learning. Practical teaching of statistics demands that lecturers often generate data from or among the students' attributes. Particularly, students' ages, weights, heights, learning materials in their possession, marks obtained in a test or homework, day of birth, etc. Determining the mean age, or mean marks obtained by students in class depicts the immediate importance of statistics course to students and are likely to learn with high degree of interest.

Conclusion

The conclusions of this study based on the findings are as follows: The undergraduate students' attitude towards statistics was found to be a significant predictor of their academic achievement in the course. Secondly, gender differences existed in their attitude towards statistics in favour of males. However, there was no gender differences in academic achievement in the statistics course although males registered slightly higher mean score than their female counterparts but was not significant.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest.

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