



Mathematics Background Knowledge and Gender among University Students' Achievement in Circuit Theory and Analysis in Bauchi, Nigeria

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ABSTRACT

The study examined the influence of mathematics background knowledge and gender on university students' achievement in circuit theory and analysis in Bauchi state. Two hypotheses were formulated and tested at a 0.05 level of significance. The study adopted a descriptive survey research design, the study was conducted in Bauchi state and specifically at Abubakar Tafawa Balewa University Bauchi; ninety-four (94) Electrical/Electronic Technology Education students form the population of the study and there is no sample and sampling technique because the population is manageable. Students' mathematics background knowledge questionnaire (SMBQ) was used as an instrument of data collection, the instrument was validated by experts and a reliability coefficient of 0.75 was obtained for the instrument using Cronbach's alpha; data was collected with the help of two research assistants. Data collected was analysed using Statistical package for social sciences (SPSS) version 23 where multiple regression was used to test the hypotheses. Findings of the study revealed that mathematics background knowledge has a significant influence on students' achievement in circuit theory and analysis and gender has no significant influence on students' achievement in circuit theory and analysis. It was recommended that the university management should encourage the curriculum review committee at department levels to consider adding mathematics courses at 100 and 200 levels as this will enable students to improve their mathematics background knowledge/skills and develop an interest in Mathematics, as this improves students' academic achievement in circuit theory and analysis.

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INTRODUCTION

Students' success is assessed by academic achievement, or how well a student meets the benchmark set out by the university. Academic achievement means how students will accomplish or achieve in a certain exam. Academic achievement is defined by as the extent to which a student is earning from teachings in a certain subject area of learning; that is, academic achievement is echoed by the degree to which knowledge, attitudes and skills, have been conveyed to the learner. It also symbolizes the

knowledge attained and skills developed in the school subject, usually designated by test scores (Crow and Crow, 1969). Poor academic achievement or excellent academic achievement is hinge on three main factors; student, teacher, and education materials (Osama, 2015). All stake holders in education; educators, students, parent, government and general public concentrates on students' academic achievement. It was pointed out by Abdullahi (2014) that employers, parent and prospective students voice concern about outcomes of assessment.



Student's prior academic achievement has been an imperative concern of universities for making policy on student admission into its various program. Circuit theory and analysis is a three credit unit course taken by students of electrical/electronics engineering and electrical technology education students in two hundred level in Nigerian universities; the course is divided into two as circuit theory and analysis I and II taken in first and second semester respectively. The course introduces students to electric quantities, Ohms' law and Kirchoff's law, circuit theories and principles as well as general description of signals, methods of analyzing circuit to obtain its total response. ((Abubakar Tafawa Balewa University, Bauchi, 2019)

The basic background knowledge in mathematics is one of the prerequisite for entry into science, engineering and technology programs (Garzak, Banimahd and Esmaili, 2011) Mathematics, deals with the creation, representation, analysis, interpretation of numbers and symbols and have impact in all facets of the human environs significantly but at varying degrees. One very important fact is that all other disciplines of numbers- Arithmetic, statistics, engineering, technology etc. depends to the large extent on mathematics (Ogunleye, Awofala and Adekoya, 2014).

Mathematics is often referred to as "language of science, technology and engineering". But, some found it to be a mental activity that deals with quantity, symbolic logic and carries out constructs one after the other in numeric terms. Mathematics is closely related to natural science in such that it is a language science, technology and engineering uses to convey its observation, experimentation and conclusion. It is a science of structure, order and relation that has evolved from fundamental practices of counting, measuring and describing the shapes of objects (Maton, 2014). However, Daron (2016) in his study "mathematics as a language for involving secondary school children in science and technology" concluded that student performance in West African schools' certificates examination (SSCE) in mathematics highly correlates with their performance in other subjects which involved calculations in the same examination which remained generally poor.

Even in the western world, Daron (2016) has observed that students performance in the subjects involving logical reasoning and calculation such as mathematics and physics in upper secondary school are in continued decline in a number of countries which includes Sweden and Norway. Poor background in mathematics is manifested in their overall performance in math related subjects which over the years have faced a continuous downward trend in Senior Secondary School Certificate Examination results. (Ogunleye, Awofala, & Adekoya, 2014).

Mathematics Achievement, Science, Technology and Engineering (STE) Achievement, and the Transference of Learning between Mathematics and Science, Technology and Engineering found that, mathematics is essential for learning in these courses; achievement in mathematics is extremely linked to achievement in STE courses (Doris, 2019). Dehipawala, Shekoyan & Yao (2014) affirmed that mathematics is foretelling of STE achievement and well established in more specific models of Physics and Engineering. Therefore, STE students need to have a sound background knowledge of mathematics for structured thinking about physical processes and how to deduce mathematical structures in physical terms in order to ascend in their achievement. Diverse mathematical elements or representations such as geometrical objects, diagrams, algebraic expressions and verbal explanations have their definite roles for supporting, understanding by describing exactly, quantifying and visualizing various processes and phenomenon (Doris, 2019).

However, gender is a generally recognized attribute which distinguish female from male (Robinson & Akue, 2019) gender is imperative as it have a tendency to influence the pattern of school admission and academic achievement of students (Igrubia, Shetima & Paul, 2021). Gender is sex discrimination applied in the education system which have emotional impact male and female throughout and after their education experience. Sex discrimination in technical education, Raymond (2013) stated that it's the general societal faith that engineering related tasks be appropriate to the male students



which could be responsible for the high ratio of male to female in electrical/electronics courses in universities in Nigeria. Researchers for a long were of the view that, gender was one of the elements that influenced the academic achievement of students (Atsumbe, Owodunni, Raymond & Uduafemhe, 2018). Ogbuanya, and Owodunni, (2013) stated that difference exists between male and female students' achievement in engineering, science, mathematics, vocational and technical subjects. Some researchers opined that male students often perform better than their female counterparts in mathematics, engineering, sciences and technical subject areas, while some researchers deduced the other way round (Jabor, Machtmes, Kungu, Buntat & Nordin, 2011). Recent researches revealed that the gap that once existed between genders is fast closing (Abubakar & Bada, 2012). This suggests that females are getting more exposure to educational activities. It is against this background that the current study investigates the influence of mathematics background knowledge and gender among university students' achievement in circuit theory and analysis

LITERATURE REVIEW

Doris (2019) studied the role of Mathematical competencies in enhancing students' academic performance in Physics in Port Harcourt local government area Rivers State. The study revealed that student who has high achievement in mathematics also performed extraordinarily in Physic achievement test. This implies that students' mathematics competency is a major determinant to their achievement in Physics that is students who are good in rational mathematical reasoning will also successful in Physics. Loughlina, Wattersa Browna and Johnstona (2015) conducted study titled snapshot of mathematical background demographics of a broad cohort of first year chemistry science students. Results showed that the most important factor influencing academic progression of chemistry students was the strength of mathematical background, and student confidence with their mathematical skills. Confidence is lower for those with poorer backgrounds in mathematics. Osama, (2015) studied the relationship between mathematics

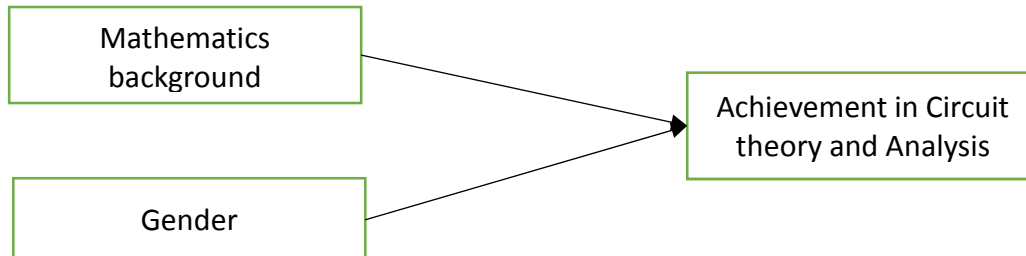
grades and the academic performance of the accounting students' department al-zaytoonah university of Jordan. The result obtained revealed that there is a significant positive relationship between mathematics' subjects and the accumulative average of the accounting students and also there is no relationship between gender and the accumulative average of the accounting students.

Nevertheless, Boateng, (2015) studied the influence of mathematics ability on students' academic performance in financial accounting. The results show that Mathematics ability has a great influence on the Financial Accounting discipline performance. That is the higher the mathematics knowledge of the Financial Accounting student, the better the performance in Financial Accounting by the student, also the results indicate that male Financial Accounting students' academic performance in mathematics and Financial Accounting was significantly higher than their female counterparts. The results further show that male students academically performed better in mathematics and Financial Accounting compared to female students. Ogunleye, Awofala and Adekoya, (2014) conducted a study to determine effect of students' background knowledge of mathematics on senior secondary school students' achievement in physics. The result indicated that there was a statistically significant main effect background knowledge of mathematics on students' achievement in physics and also there was a significant main effect of gender on students' achievement in physics. Nonyelum and Folasade (2018) studied effect of knowledge of mathematics on achievement of students in physics. Findings revealed that there was significant effect of Mathematics knowledge on achievement of students in Physics. This mean that Mathematics knowledge has effect on achievement of students in Physics and there was significant effects of gender on achievement of students in Physics. This mean that gender affect achievement of students in Physics.

Moreover, Adigwe (nd) conducted a study on effects of mathematical reasoning skills on students' achievement in chemical stoichiometry. Findings of the study revealed that there is a significant relationship between students' achievement in chemical stoichiometry

and mathematics skills and significant relationship exist between the overall growth-mean scores of the students in chemistry and mathematics; also there is significant sex difference in students' achievement mean-scores in chemical stoichiometry before and after mathematics remediation. These findings are in agreement with Charles-Ogan and Francis (2017) in their studies on the effects of mathematics knowledge on physics students' performance in electromagnetism. Findings shows that students with high mathematics abilities performance higher in the concepts of electromagnetism' while those of low mathematics ability performed poorly. Also there is no significant effect on performance in electromagnetism by students of high, average, and low mathematics abilities, whether male or female. Based on the reviewed literature none of the existing studies focus on the influence of mathematics background knowledge and gender on students' achievement in circuit theory and analysis. This paper therefore addresses this gap.

RESEARCH FRAMEWORK



Hypotheses

The following hypotheses were formulated:

H₁: Mathematics background knowledge has no significant influence on students' achievement in circuit theory and analysis.

H₂: Gender has no significant influence on students' achievement in circuit theory and analysis.

METHODOLOGY

The study adopted descriptive survey research design which is a quantitative research method that allows the researcher to collect data from entire population or part of the population

From the theoretical viewpoint and empirical suggestion discussed in literature, a research framework displaying the bond between mathematic background knowledge, gender and students' achievement in circuit theory and Analysis was developed as shown in the figure below. The frame work was based on the constructivist learning theory; Constructivism is a theory of knowledge that make a case that humans make knowledge and meaning from an interaction between their experiences and their ideas. Students build their insight on learning materials offered to them and this perception significantly affects their performances and achievement in schools based on their previous know-hows and characteristics (Mukherje, 2002). According to Oludipe and Kpolovie (2010), constructivism is not accommodating what you are taught but your prior knowledge about what you are taught and your perceptions about it. Students vigorously take information, connect it to earlier assimilated knowledge and make it theirs by building their own understanding (Cheek, 1992).

which are consider to representative sample of the population, to describe attitudes, opinions, behaviors or characteristics of the population (Sambo, 2005). The study was conducted in Bauchi state and specifically at Abubakar Tafawa Balewa university Bauchi; the population of the study was ninety- four (94) of electrical/electronics technology education students which comprised of sixteen 500 level students, fifty 300 level students and twenty-eight 200 level students from department of vocational and technology education in 2020/2021 academic session. The entire population was used and hence no sample and sampling technique. The instrument for data collection was Students' Mathematics



Background Questionnaire (SMBQ) which was adopted from Usher and Pajares (2009), the instrument consists of 20 items which was design on five point Likert scale. The instrument was assessed by three experts for content and face validity and all the suggestions and recommendations was considered before the final draft of the instrument hence the validity of the instrument was determined by experts' judgment (Baykul, 2000), the reliability of the instrument was 0.75 which was obtained using Cronbach's alpha; Cronbach's alpha value of 0.70 is considered as acceptable and sufficient (Hair, Hult, Ringle & Sarstedt 2013). Hence reliability coefficient in the current study is 0.75 suggesting that the instrument is reliable. Data was collected with help of two research assistants within the period of three weeks. Also record of students' achievement in Circuit Theory and Analysis was obtained for the following sessions: 2016/2017, 2017/2018 and

2018/2019. The data collected was analysed using Statistical package for social sciences (SPSS) version 23, where multiple regression was used to determine the influence of mathematics background knowledge and gender on students' achievement in circuit theory and analysis. Multiple regression is a statistic for ascertaining the influence of multiple independent variables on a single dependent variable (Creswell, 2012). The decision rule is that any hypothesis with a P-value of 0.05 and above was accepted while a hypothesis with P-value of less than 0.05 was rejected.

RESULTS

Hypothesis one: Mathematics background knowledge has no significant influence on students' achievement in circuit theory and analysis.

Table 1: Summary of Multiple Regression on Influence of Mathematics Background Knowledge on Students' Achievement in Circuit Theory and Analysis.

Variables	Standardized Coefficient Beta	T Value	P Value
Students mathematics background knowledge	0.354	3.536	0.001
Gender	-0.040	-0.404	0.687
R squared			0.130
Adjusted R squared			0.110
F Value			6.566
P value			0.002

Significant at $p \geq 0.05$

Table 1 presents the results of multiple regression analysis. The statistical evidence revealed that the model is statistically significant base on the F ratio 6.566, $p=0.002$ the result shows the significant power of this model in predicting students achievement in circuit theory and analysis.

The result also revealed the R^2 value of 0.130, which indicates that the model fit is large. The students' mathematics background knowledge has standardised coefficients beta value of 0.354, $p=0.001$ which less than 0.05 level of significance, this indicate a significant contribution of the variable in the model, that is Mathematics

background knowledge has significant influence on students' achievement in circuit theory and analysis. This result didn't support the prediction of hypothesis one, which stated that Mathematics background knowledge has no significant influence on students' achievement in circuit theory and analysis. Hence hypothesis one is rejected.

Hypothesis Two: Gender has no significant influence on students' achievement in circuit theory and analysis



Table 2: Summary of Multiple Regression on Influence of Gender on Students' Achievement in Circuit Theory and Analysis.

Variables	Standardized Coefficient Beta	T Value	P Value
Students mathematics background knowledge	0.354	3.536	0.001
Gender	-0.040	-0.404	0.687
R squared			0.130
Adjusted R squared			0.110
F Value			6.566
P value			0.002

Significant at $p \geq 0.05$

Data presented in table 2 above revealed that gender as variable has standardised coefficients beta value of -0.040, and $p = 0.687$ which greater than 0.05 level of significance, this indicate that gender has no significant contribution in the model, meaning that Gender has no significant influence on students' achievement in circuit theory and analysis. Hypothesis two was accepted.

FINDINGS

The following findings emanate from the study:

1. Mathematics background knowledge has significant influence on students' achievement in circuit theory and analysis.
2. Gender has no significant influence on students' achievement in circuit theory and analysis.

DISCUSSION

The finding with respect to hypothesis one revealed that Mathematics background knowledge has significant influence on students' achievement in circuit theory and analysis. This finding is agreement with Doris (2019) who conducted a study on the role of Mathematical competencies in enhancing students' academic performance in Physics in Port Harcourt local government area Rivers State. The findings indicated that student who has high achievement in mathematics also performed amazingly in Physic achievement test, this is also in harmony with the finding of Loughlina, Wattersa, Browna and Johnstona (2015) who discovered that the

most important factor influencing academic achievement of chemistry students was the strength of mathematical background, and student confidence with their mathematical skills. Nevertheless, the finding also is in synch with the findings of Shaban (2015) who discovered that that there is a significant positive relationship between mathematics' subjects and the accumulative average of the accounting students. Similar findings was discovered by Ogunleye, Awofala and Adekoya, (2014), Nonyelum and Folasade (2018) in their study which indicated that there was a statistically significant main effect of background knowledge of mathematics on students' achievement in physics. These findings are in agreement with Ibibo and Francis (2017) in their studies on the effects of mathematics knowledge on physics students' performance in electromagnetism. Findings shows that students with high mathematics abilities performance higher in the concepts of electromagnetism' while those of low mathematics ability performed poorly.

This finding implies that students' mathematics background/competency is a major determinant to their achievement in Circuit theory and Analysis, that is to say students who are good in cogent mathematical reasoning will also successful in Circuit theory and Analysis and also it is important to stress that Mathematics skill facilitates students' knowledge and skills Circuit theory and Analysis.

The study further revealed that Gender has no significant influence on students' achievement in circuit theory and analysis. This finding is supported by the findings of Shaban (2015) who discovered that there is no relationship



between gender and the accumulative average of the accounting students. However, this finding was in disagreement with Boateng (2015) whose findings specified that male students academically performed better in mathematics and Financial Accounting compared to female students, that is to say gender influences achievement in mathematics and Financial Accounting, also the findings of Nonyelum and Folasade (2018), Ogunleye, Awofala and Adekoya, (2014), Nonyelum and Folasade (2018) showed that there was a significant main effect of gender on students' achievement in physics.

CONCLUSION

Based on the findings of the study the following conclusion was drawn from the study. Students with good mathematics background knowledge have a better achievement in circuit theory and analysis in Nigerian Universities than those students low/poor mathematics background knowledge. Gender difference is not an index to define difference in the academic achievement of students' in circuit theory and analysis if they have the same background knowledge/skills in Mathematics and are exposed to the same learning environment. It is thus, recommended that the university management should encourage curriculum review committee at department levels to consider adding mathematics courses at 100 and 200 levels. This will enable students to improve their mathematics background knowledge and develop interest in Mathematics so as to improve their future academic achievement in circuit theory and analysis. It is suggested that future research in this area should consider to determine if prerequisite mathematics courses will have moderating effect between mathematics background knowledge and students' academic achievement in circuit theory

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