RÉPUBLIQUE DU CAMEROUN
PAIX-TRAVAIL-PATRIE
****
UNIVERSITE DE YAOUNDE 1
****
CENTRE DE RECHERCHE ET DE FORMATION DOCTORALE EN SCIENCES HUMAINES, SOCIALES ET EDUCATIVES
****
UNITE DE RECHERCHE ET DE FORMATION DOCTORALE EN SCIENCES DE L'EDUCATION ET INGENIERIE EDUCATIVE
DEPARTEMENT DE CURRICULA ET EVALUATION
****

REPUBLIC OF CAMEROON
PEACE-WORK-FATHERLAND
****
THE UNIVERSITY OF YAOUNDE I
****
DOCTORAL RESEARCH AND TRAINING IN SOCIAL AND EDUCATIONAL SCIENCES
****
DOCTORAL UNIT OF RESEARCH AND TRAINING SCHOOL IN EDUCATION AND EDUCATIONAL ENGINEERING
DEPARTMENT OF CURRICULUM AND EVALUATION
****

THE PREDICTIVE VALIDITY AND DIFFERENTIAL PREDICTIVE VALIDITY OF HIGH SCHOOL RESULTS IN SCIENCES TO STUDENTS' ACADEMIC PERFORMANCE IN ENGINEERING IN CAMEROON

A Thesis submitted in the Department of Curriculum and Evaluation in Partial Fulfillment of the Requirements for the Award of a Doctor of Philosophy Degree (PhD) in Curriculum and Evaluation

Specialty: Measurement and Evaluation (Psychometrics)
Theses Presented and Defended on the 30/ 12 /2021

By
ADE CYRIL MANCHO
Master of Education (M. Ed) in Measurement and Evaluation
Matricule Number: **18W6608**

Jury

President:	MOUPOU MOÏSE, Pr	University of Yaounde1
Rapporteur:	EINSTEIN MOSES EGEBE ANYI, Pr	University of Bamenda
Membres:	AGBOR BECHEM PETER TAMBI, MC	University of Buea
	MAUREEN EBANGA TANYI, Pr	University of Yaounde 1
	BELINGA BESSALA SIMON, Pr	University of Yaounde 1

DECLARATION

I, **Ade Cyril Mancho**, Registration No. **18W6608**, Department of Curriculum and Evaluation, in the Faculty of Education, of The University of Yaounde I, hereby declare that, this work titled: **“The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to Students’ Academic Performance in Engineering in Cameroon”** is my original work. It has not been presented in any application for a degree or any academic pursuit. I have sincerely acknowledged all borrowed ideas nationally and internationally through citations.

Date_________________ **Signature_________________**

CERTIFICATION

This is to certify that this research work titled "**The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to Students' Academic Performance in Engineering in Cameroon**", was carried out by **ADE CYRIL MANCHO** under the supervision of **Prof. Einstein Moses Egebe Anyi.** This is in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy (Ph. D) in Psychometrics of the University of Yaounde I.

Supervisor

Prof. Einstein Moses Egebe Anyi

Signature: _________________

Date: _____________________

Head of Department

Signature: _________________

Date: _____________________

DEDICATION

This work is dedicated to my mum Mme Boma Sera, to my wife

Mrs Ade Yvonne Michele and to my kids David, Joy and Janelle

ACKNOWLEDGEMENTS

First and foremost, I want to thank and appreciate my indefatigable supervisor Professor Einstein Moses Egebe Anyi for the guidance, support and encouragements he gave me in carrying out this research work.

I appreciate all the Lecturers of the Doctorate school of Social and Educational sciences, the lecturers of the Faculty of Education and the lecturers of the Department of Curriculum and Evaluation of the University of Yaounde I, for the academic and moral support I received from them through out my studies in the University of Yaounde I.

I thank earnestly the honourable members of the jury for accepting to fine tune and reshape this research work

I thank also all my colleagues, friends and classmates who in one way or the other helped and supported me in carrying out this research work.

I appreciate the efforts of Rev.Ngwasiri Ezekiel and Pastor Fozeh Walters for their constant support and prayers.

I also appreciate my lovely wife Mrs Ade Yvonne, my kids David, Joy and Janelle, my mum Mme Boma Sera, my sisters Hydie, Meredith and my brother Divine for their constant love and support.

ABSTRACT

In a bid to know if high school results in sciences predict students' academic performance in engineering and to subsequently prepare guides for the selection and placement of students into various branches of engineering from their high school results in sciences, this study set out to determine the extent to which GCE A/L and BAC results in general sciences predict students' academic performance in engineering and to also determine the extent to which these high school results predict students' academic performance in engineering differently in terms of gender, motivation for engineering studies and the type of high school attended. The study made use of the correlation survey research design. The sample population was 952 engineering students from six different engineering schools which are NAHPI of the University of Bamenda, FET of the University of Buea, NASPW Yaounde, CATUC Baham, CUIB Buea, CUIB Douala selected through the judgemental sampling technique. The engineering students came from the following engineering departments; civil engineering and architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering, chemical and petroleum engineering. From this sample population a sample of 500 engineering students were selected using the proportionate simple random sampling technique. The instrument used for data collection was a questionnaire for students. The validity of the questionnaire was ensured by taking into cognizance the content validity and face validity. The content validity index of the questionnaire was ascertained at 0.91 and the face validity was ensured by peer review. The reliability of the instrument was ascertained using the split half reliability method and a reliability coefficient of 0.89 was arrived at. The data collected was analyzed using the multiple linear regression analysis using SPSS version 26.0. The findings of the study revealed that the GCE A/L results in sciences significantly predicted students' academic performance in all the six engineering branches considered in the study. BAC 'C' results significantly predicted students' academic performance in all the branches of engineering except for electrical engineering where it did not predict students' academic performance significantly. BAC 'D' results also significantly predicted students' academic performance in civil engineering and architecture, computer engineering and in mining engineering while BAC 'IT' results significantly predicted students' academic performance in computer engineering. GCE A/L, BAC 'C', BAC 'D' and BAC 'IT' results significantly predicted students' academic performance in most of the branches of engineering differently in terms of gender, motivation for engineering studies and type of high school attended. It was recommended that the synergy between the Ministry of Secondary education and engineering schools should be improved upon in order to prepare a better transition for students from high school to engineering schools. It was also recommended that the regression models generated in this study for the prediction of students' academic performance in engineering by their high school results in sciences should be used for the selection and placement of students into various branches of engineering taking into consideration the students' gender, their motivation for engineering studies and the type of high school they attended

Key words: High school results, Sciences, Academic performance, Engineering

Résumé

L'étude avait pour but de determiner si les résultats du lycée en sciences prédisent la performance scolaire des élèves en ingénierie et de préparer par la suite des guides pour la sélection et le placement des élèves dans diverses branches d'ingénierie à partir de leurs résultats du secondaire en sciences. Ce travail visait à déterminer dans quelle mesureles résultats du GCE A / L et BAC en sciences générales prédisent les performances académiques des étudiants en ingénierie et déterminent également dans quelle mesure ces résultats du secondaire prédisent différemment les performances académiques des étudiants en ingénierie en termes du genre, de la motivation pour les études d'ingénieur et le type d'école secondaire fréquentée. L'étude a utilisé le plan de recherche de l'enquête de corrélation. L'échantillon de population était de 952 étudiants ingénieurs de six écoles d'ingénieurs différentes qui sont NAHPI de l'Université de Bamenda, FET de l'Université de Buea, NASPW Yaoundé, CATUC Baham, CUIB Buea, CUIB Douala sélectionnés par la technique d'échantillonnage au jugement. Les étudiants ingénieurs provenaient des départements d'ingénierie suivants ; génie civil et architecture, génie informatique, génie électrique, génie mécanique, génie minier, génie chimique et pétrolier. À partir de cet échantillon de population, un échantillon de 500 étudiants en génie a été sélectionné à l'aide de la technique d'échantillonnage aléatoire simple proportionnel. L'instrument utilisé pour la collecte des données était un questionnaire destiné aux étudiants. La validité du questionnaire a été assurée en tenant compte de la validité du contenu et de la validité apparente. L'indice de validité du contenu du questionnaire a été établi à 0,91 et la validité apparente a été assurée par un examen par les pairs. La fiabilité de l'instrument a été vérifiée à l'aide de la méthode de la demi- fiabilité fractionnée et un coefficient de fiabilité de 0,89 a été obtenu. Les données collectées ont été analysées à l'aide de l'analyse de régression linéaire multiple utilisant SPSS version 26.0. Les résultats de l'étude ont révélé que les résultats du GCE A / L en sciences prédisaient de manière significative la performance académique des étudiants dans les six branches d'ingénierie considérées dans l'étude. Les résultats du BAC «C» prédisaient de manière significative les performances académiques des étudiants dans toutes les branches de l'ingénierie, à l'exception de l'ingénierie électrique, où ils ne prédisaient pas de manière significative les performances académiques des étudiants. Les résultats du BAC « D » prédisent également de manière significative les performances académiques des étudiants en génie civil et architecture, en génie informatique et en génie minier, tandis que les résultats du BAC « TI » prédisent de manière significative les performances académiques des étudiants en génie informatique. Les résultats du GCE A / L, du BAC « C », du BAC « D » et du BAC « TI » prédisaient de manière significative les performances académiques des étudiants dans la plupart des branches de l'ingénierie différemment en termes du genre, de la motivation pour les études d'ingénieur et de type de lycée fréquenté. Il a été recommandé d'améliorer la synergie entre le ministère de l'Enseignement secondaire et les écoles d'ingénieurs afin de préparer une meilleure transition des élèves du lycée aux écoles d'ingénieurs. Il a également été recommandé que les modèles de régression générés dans cette étude pour la prédiction des performances académiques des étudiants en ingénierie par leurs résultats au secondaire en sciences soient utilisés pour la sélection et le placement des étudiants dans diverses branches de l'ingénierie en tenant compte du genre, leur motivation pour les études d'ingénieur et le type de lycée qu'ils ont fréquentés

Mots clés : Résultats du secondaire, Sciences, Performance académique, Ingénier

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABET	Accreditation Board for Engineering and Trchnology
ACT	American College Testing
AIME	American Institute of Mining and Metallurgical Engineers
APC	Advanced Process Control
AQA	Assessment and Qualification Assessment
BAC	Bacalaureate
B.E.P.C	Brevet d'Etudes du Premier Cycle
CAD	Computer Aided Designs
CAT	Computer Adaptive Testing
CATUC	Catholic University of Cameroon
CCAST	Cameroon College of Arts Science and Technology
CUIB	Catholic University Institute Buea
COLTECH	College of Technology
C.M	Construction Management
DIF	Differential Item Functioning
ECUK	Engineering Council for the United Kingdom
E.N.S	Ecole Normale Superieure
E.N.S.A	Ecole National Superieure Agronomique
E.N.S.A.I	Ecole Nationale Superieure des Sciences Agro-Industrielles
E.N.S.E.T	Ecole Normale Superieure de l'enseignement Technique
E.N.S.P	Ecole National Superieure Polytechnique
E.S.I.J.Y	Ecole Superieure International de Journalisme de Yaounde
ETEA	Educational Testing and Evaluation Agency
ETS	Educational Testing Service
FET	Faculty of Engineering and Technology
F.C.S	Fundamental Construction Science
G.C.E	General Certificate of Education
GDP	Gross Domestic Product

G.E.S.P	Growth and Employment Strategy Paper
GPA	Grade Point Average
G.R.E	Graduate Record Examinations
HBO	Higher Professional Education
HSGPA	High School Grade Point Average
I.B	International BACalaureate
ICC	Item Characteristic Curve
ICT	Information and Communication Technology
IUT	University of Institute of Technology
IRT	Item Response Theory
I.Q	Intelligence Quotient
JSCE	Junior Secondary Certificate Examination
K.A.B	Knowledge, Attitude and Behavioural skills
L.C.E	Leaving Certificate Examination
LSAT	Law School Admission Test
M.A.E	Motivation and Attitude in Engineering
M.C.A.T	Medical College Admission Test
MLP	Multilayer Perception
MLSS	Mathematics Learning Support System
MLR	Multiple Linear Regression
NAHPI	National Higher Polytechnic Institute
NASPW	National Advanced School of Public Works
NCME	National Council on Measurement and Evaluation
NDS	National Development Strategy
NPI	National Pedagogic Inspector
OCR	Oxford and Cambridge Royal Society of Arts
OPEC	Organization of Petroleum Exporting Countries
PAP	Percentage of Accurate Predictions
PERT	Post-Secondary Readiness Test
PVR	Predictive Validity Research

RPI	Regional Pedagogic Inspector
SAT	Scholastic Aptitude Test
SAVE	Society of Value Engineering
S.E.S	Socio Economic Status
SSCE	Senior Secondary Certificate of Education
S.C.C.T	Social Cognitive Career Theory
STEM	Science Technology Engineering and Mathematics
STEP	Sequential Test of Educational Progress
SVM	Support Vector Machine
SVT	Sciences de la vie et la Terre
U.C.L.E.S	University of Cambridge Local Examination Syndicate
UNESCO	United Nations Educational Scientific and Cultural Organization
U.P.M	Universidad Politica de Madrid
VWO	Voortgezet Wetenschappelijk Onderwijs (Dutch Secondary Science Education)
WASCE	West African School Certificate Examination

CHAPTER ONE

GENERAL INTRODUCTION

Introduction

Most nations in the World today are striving towards technological development in order to suit with the fast-growing trends in scientific and technological knowledge. Education is seen as the major means through which technological growth and economic development could be confidently ascertained. According to Okumu et al, (2008), Education is a fundamental human right as well as a catalyst for economic growth and human development., Good (1973) opines that Education is the totality of all the processes through which people acquire knowledge, attitudes and skills which could be of positive value to them and their society. To be of value in the highly digitalized world of today entails the acquisition and nurturing of creative and critical thinking skills which could be quite pertinent for invention. Science is seen by most countries to be a gateway for such. The reason is that science has the proficiency to exert a dominant and even decisive influence on the life of individuals as well as on the developmental effort of a nation (Emovon,1985).

In modern societies, science is increasingly becoming a central aspect of work and our everyday lives. Consequently, educators, policymakers, and researchers are bent on ensuring that science education continues to help prepare future citizens to be scientifically literate and more prone to apply science knowledge to their daily lives: which could consequently serve as an assert for societies to use in overcoming the new challenges they are facing (Tytler, 2014). Science education should be orientated towards enabling students to acquire knowledge and understanding that could help them to explain, predict and interpret natural phenomena in their environment, wherein, instruction in science should be linked and applicable to daily experiences (Salandanan and Gloria 2001). Thus, sciences in secondary and high school are considered to be the bases for fields of applied sciences such as engineering, as the future of most nations depends to a great extent on the advancements in both technology and knowledge offered by fields such as engineering (Bothaina et al,2019). According to Clayton (2019), Engineers are the backbone of modern industrial society. From automobiles to airplanes, computers to smart phones, engineers are behind all the multitude of devices that make life possible in the 21st century. By the same token, the discipline of Engineering has grown by leaps and bounds, and now includes as many as a dozen sub - disciplines. This means that 21st Century Engineers come from a wide variety of backgrounds, and practice Engineering in a very different context. Engineers generally in the 21st Century should have characteristics such as; a desire to figure out things, applied creativity, Mathematical skills, mechanical skills, listening and problem-solving skills, interpersonal and leadership skills amongst others. These thus go to buttress the Barcelona Declaration of 2004 which states that:

> It is undeniable that the world and its cultures need a different kind of engineer, one who has a long term systematic approach to decision making, one who is guided by ethics, justice, equality and solidarity and has a holistic understanding that goes beyond his or her own field of specialisation (Barcelona Declaration, 2004).

For students therefore to best suit for engineering studies, the curriculum for sciences in High school has to be up to date in order to adequately prepare students for such a field of study. Moreover, advanced techniques of scrutiny are to be adopted in the selection of students into schools of Engineering and into specific branches of engineering in particular so that they could easily be equipped with the 21st Century engineering skills.

Thus, this study was designed to determine the extent to which high school results in sciences predict students' academic performance in Engineering, in Cameroon. This chapter covers the Background of the study, the statement of the problem, objectives of the study, the research questions, the hypotheses, significance of the study, justifications for the study, scope of the study, operational definition of terms and conclusion.

Background of the Study

The background of the study is seen from four different perspectives which are; the historical background to the study, the conceptual background, the theoretical background and the contextual background.

Historical Background

Students with high school qualifications such as GCE A/L or the BAC in the sciences certified by appropriate examination boards could easily transit into engineering studies in the university. In order to get the appropriate jigsaw puzzle, with respect to students' grades as they leave high school for engineering studies nowadays, it is pertinent to trace the history of the Cameroon educational system which will illustrate detailly how Cameroonians embraced the western education which they practice today and the evolution of the respective evaluative organs which are responsible for certification and finally the history of engineering education from its inception to the present context.

Cameroonians and Africans in general in the yesteryears before the coming of the white man had their own cultures, values and ways of doing things. They never had engineers per say but they had local craft men who manufactured local farm tools and other tools for their indigenous activities. With the coming of the white man and Western philosophies, Africans then started adjusting their cultures and customs in order to accommodate the philosophies from the West. The white man came with his own language, values and cultures which they sought to transmit through formal education and with the mentality that, that which was theirs was worth emulating by the Africans.

The first people from the West to come to Cameroon were the Portuguese. The Portuguese came with the primary mission to set up trade and commercial activities with the Cameroonian people. Cameroonians thereafter developed trading deals with Spanish, Dutch, German, French and English (Akoko, 2010).

In 1844 the London Baptist Missionaries arrived in Cameroon, consequently, western education was introduced in the country in 1844 with the opening of the first school in Bimbia by Joseph Merrick of the London Baptist Missionary Society. Following the opening of the first school, the Missionary society expanded extensively by the opening of more educationnal facilities all at the primary level of education. The curriculum then emphasized on English, reading, writing and arithmetic and the study of the Bible. Native languages were used for instruction especially in the lower classes. Their main objective for schooling was evangelization. During this pre-colonial era schools were limited to the coastal areas especially along the two coastal towns of Douala and Victoria(Limbe) and by the time colonial powers came, schooling had already spread to about 60km inland (Tambo,2003). The daily interaction of Cameroonians with the missionaries gave them much exposure to the English language and thus some Cameroonians could then be able to read and write the English language which significantly boosted their self-esteem (Vernon-Jackson,1967).

Between 1844 and 1884, the British had a strong grip on trade and commercial activities in Cameroon and were also in control of the educational system through their missionary activities. But in 1884, the Germans smartly overtook the British and annexed Cameroon as Hewett came too late. Initially, the Germans were more pre-occupied with the establishment of German authority inn Cameroon rather than with educational matters. But in 1887, the first Government education officer, Herr Theodore Christaller, arrived in Cameroon to begin the setting up of a government administrative structure for delivering educational services and in 1888, the first government school was opened in Douala. The Basel mission in 1889 opened a missionary seminary in Bonaku in Douala and there, the Basel mission started a girl's boarding school. In 1890, the German Pallotine missionaries arrived in Cameroon to begin their work in evangelism and education. Consequently, in1891, they opened the first Roman catholic primary school in Cameroon. The Germans became more interested in educational matters by 1892 when the German government authorized Betz Christaller and Kobele who were educationists to draw up a syllabus for Government schools in Cameroon and Togo. The syllabus covered a five-year course and emphasized the teaching of the German language. In 1899, the Roman Catholic Mission opened the first girls' school (convent) in Cameroon at Bojongo. Following the drawing up of this syllabus a conference which involved the mission and the government was organized in Douala in 1907 which had as aim to formulate guidelines for education in Cameroon. In 1903, the Basel mission opened the first mission and school in the grassfield area in Bali. From 1910, the German government gained control over both government and mission schools. In 1913, the Roman catholic mission opened its first school in the grass field area in Shisong. German administration of Cameroon abruptly came to an end at the outbreak of the first world war in 1914, and at the end of the war in 1916, Germany had lost total control of Cameroon. Despite this, the Germans had major successes in the educational land scape of Cameroon such as; the taking over of the activities of the London Baptist missionaries by the Basel mission from Germany, the opening up of more schools inland as the Germans explored

Cameroon, the replacement of the English language by the German language as the major language of instruction in schools (Tambo,2003).

After the first world war, Britain and France took over the territory of Cameroon from the Germans. The period from 1914 to 1922 was seen as gloomy period for education in Cameroon, as this time was used to recover from the destructions incurred during the war and to pick up from where the Germans ended. Following the creation of the league of nations in 1922, Cameroon was partitioned to Great Britain and France. Britain received 1/5 of the territory while France received 4/5 of the territory. The French territory was governed directly from Paris in France, while the British territory was governed from Lagos in Nigeria, because at that time Nigeria was also under British control. (Akoko, 2010).

The French government started exercising its authority in Cameroon from 1920, following the signing of the treaty of Versailles. By 1922, the League of nations formally recognized 4/5 of Cameroon as a mandate of France. In 1920, a Government order was signed which prescribed that only schools which teach exclusively in French and followed the government syllabus would be recognized and therefore receive financial support from the Government. Another order was signed in 1921 regulating the functioning of public schools and categorized them into 5 categories which were: village schools, regional schools, higher primary schools, domestic science schools, and vocational schools. The French also embarked in the opening up of schools, in 1921, the first higher primary school in French Cameroon was opened in Yaounde, in 1945, Lycee Leclerc in Yaounde was opened and in 1947, the first lay private was opened in French Cameroon at Nkol- Ossanaga. These, schools under the French mandate were compelled to implement the French curriculum which was six years of primary education with the acquisition of a C.E.P.E at the end of primary education, four years of secondary education which leads to the award of a B.E.P.C certificate and high school which was for a period of three years in which at the end of the 6^{th} year a Probatoire examination is taken and at the end of the 7^{th} year, the BACalaureat exams are taken which lead to the award of an end of high school certificate called the BACalaureat (Tambo, 2003). The BAC exams were organized by the BAC board from France.

When the British got control of 1/5th of Cameroon after the first world war, they entrusted Southern Cameroon to be governed from Nigeria. The Bristish adopted a language policy which was opposite to that of the French. The management of schools were under the control of local government education officers from the neighboring provinces in Nigeria (Akoko, 2010).

The British contrary to the French rule had the intention to involve the missionaries in the provision of education. In 1922, the British colonial office issued a letter to the League of Nations indicating the intention to involve mission bodies fully on behalf of the government in the provision of education in the British Cameroons. The letter stated that in due course, all schools will come under the direct control of missionary societies, whom they consider to be in a better position to develop, discipline and character with the aid of moral instructions without which all knowledge could become harmful to the individual and a danger to the state. Four missionaries namely; John Campling, Benedict Robinson, Michael Moran and William Kelly of the Saint Joseph society at Mill Hill in England arrived in British Cameroon on the 25th of March 1922 to continue the work begun by the German Pallotine Missionaries. In 1925, the Basel Mission returned to British Cameroons and in 1926, the German Baptist mission also returned to British Cameroon. Since British Cameroon was administered as part of Nigeria, the Nigeria ordinance on education of 1926 was applied to British Cameroon. In trying to lay a good foundation for education, the first teacher training college was opened in Kake in 1931, and in 1939, the Roman catholic mission opened the first secondary school in British Cameroon in Sasse and it was an all- boys secondary school. In line with this an all-boys secondary school was also opened in Bali in 1949 by the Basel mission. In order to bring educational administration closer to the people of British Cameroon, in 1954, the first British colonial director of education was installed in Buea, and he was charged with the administration of primary, secondary, technical colleges and universities. In 1956, Queen of rosary college Okoyong which is an all-girls school was opened by the Roman catholic mission (Tambo, 2003).

During this period, students in British southern Cameroon were taking end of course examinations offered by international boards. According to the Cameroon GCE board booklet (2007), as far back as 1944, most secondary schools in Nigeria and the then Southern Cameroon took the University of Cambridge Local Examination Syndicate

(UCLES) as their final examination. The examination was taken at three levels. Junior Cambridge was taken in form four, and the senior Cambridge was taken in form six. Upper sixth form students wrote the Cambridge higher school certificate examination. In 1954, Southern Cameroon withdrew from the Cambridge examination board to take the West African school certificate examination, which had been created in 1951. This went on until the re-unification of southern Cameroons with East Cameroon in 1961.

Due to the waves of nationalist movements which blew across Africa after the second world war, Cameroonians also got the consciousness and consequently formed trade unions and political parties which strived for independence and also for reunification of the two Cameroons which were partitioned by the Milner and Simon agreement along the picot line in 1922. French Cameroon finally got its independence on the 1st of January 1960 and British Cameroons on the 11th of February 1961. While British Northern Cameroon got its independence by joining the Federal republic of Nigeria, British Southern Cameroon got its independence by joining the Republic of Cameroon. Thus, with the birth of a new Cameroon in 1961, there was a need to come out with a constitution in order to accommodate the coming together of the two Cameroons with a dual heritage. Consequently, the new constitution of 1961 adopted French and English as official languages (Yembe, 1979).

Therefore, after the reunification in 1961, Cameroon became the Federal Republic of Cameroon, having two states of equal status, that is, the states of West and East Cameroon. During this era, there were three authorities in the country that is: The Federal government, the West Cameroon government and the East Cameroon government. The federated states controlled the nursery schools, primary schools and the teacher training colleges for primary and nursery education, whereas, the Federal government controlled secondary and Higher education. During this era, many primary schools, secondary schools as well as a university and other higher institutes were opened. As early as 1960, after French Cameroon got its independence, the National School of Agriculture (E.N.S.A) was opened in Nkolbissong Yaounde and in the same year a Protestant Faculty of Theology was opened in Yaounde. In 1961, the Ecole Normale Superieur (ENS) was opened in Yaounde for the training of teachers of secondary school. With the opening of ENS as a premise, the Government of Cameroon opened the Federal University of Yaounde in 1962 (Tambo,2003).

Following the rapid growth of education in Cameroon, UNESCO in 1962 advised the Federal Government of Cameroon for an educational system to be put in place which will take into consideration the harmonization of the two educational systems inherited from colonization. In response to this, the first law (Law No. 63/DF/13 of 19/6/63) which stipulated the organization of public schools, secondary grammar and technical schools was put to initiate the harmonization process in education (Loi Federale, 1963).

In line with the implementation of the aforementioned law, the first Bilingual secondary school was opened by the Government in Man O'war Bay in Victoria, now Limbe in 1963. This school was later moved to Molyko-Buea in 1969. As a pilot school in Bilingual education, the institution admitted 35 anglophones and 35 Francophones students in its first Batch. In the same year, the government opened the Cameroon College of Arts, Science and Technology (CCAST) which was a pre- university institute for English speaking Cameroonians at Kumba and was later moved to Bambili. In 1964, another law which was Federal Law No. 64/DF/II of 26 June was put in place to regulate secondary education both general and technical in private schools. Following the Federal law on harmonization of 1963, in 1964, the anglophone primary school course was reduced from 8 to 7 years. Many institutes of Higher learning also sprouted up such as the Advanced School of Economics and Commercial Sciences (E.S.S.E.C.) was opened in Douala in 1968, the University Centre for Health Sciences was opened in Yaounde in 1969, the International School of Journalism (E.S.I.J.Y) was opened in Yaounde in 1970. In order to foster technological development in the sphere of engineering, the government created the National Advanced Engineering school (E.N.S.P.) in Yaounde in 1970 and in 1979, the Advanced School for the Training of Teachers of Techinical Education (E.N.S.E.T.) was opened in Douala (Tambo, 2003). In 1972, the two states of East and West Cameroon were dissolved and a unitary state was formed. This new development did not hamper the educational set up of the country.

During this era of Post-colonial rule, end of course examinations in secondary and high school in both the English and French subsystems of education were still being run. That is, after the re-unification of Southern Cameroons with East Cameroon, Southern Cameroon renamed West Cameroon withdrew in 1963 from the West African Certificate Examination to the University of London GCE Examinations. West

Cameroonians continued with the University of London General Certificate of Education examination until 1976 when the Cameroon ministry of national education took over the conduct of the GCE examinations.

The Cameroonisation of the University of London General Certificate of education examinations had been the pre-occupation of the ministry of national education. Since the re-unification of former East Cameroon with West Cameroon in 1961, the ministry of national education was motivated to this decision by the ardent need it felt to have an examination based on a system that reflects to a great extent the socio-cultural and economic nature of Cameroon, yet ensuring the same rigour and scope in an educational and examination system geared towards maintaining a world outlook and standards. Considering the bi-cultural nature of Cameroon in terms of educational experiences, the Cameroonisation was given just a preliminary step in the eventual harmonization of the existing English speaking and French speaking examinations.

Feasibility studies for the Cameroon GCE were jointly carried out by British and Cameroonian experts. The landmark was the meeting of two delegations in Yaounde from the 5^{th} to the 6^{th} of January 1976 in which the main features of the examination were defined. These included the name, organization, objectives of the ordinary level and Advanced level subjects, number of sessions per year, types of questions, marking, grading, security measures amongst others. On the 24^{th} of November 1976, the president signed Decree No 76/555, instituting the General Certificate of Education examinations in Cameroon. A tentative programme for the Cameroonization of the GCE examination was also drawn up, and the first session took place in June 1977. (CGCEB, 2007)

Other important decisions and conclusions of special note were the British contribution to the creation, organization and implementation of the Cameroon GCE examination. It was agreed that special tripartite liaison arrangements be established among the three authorities involved: the department of examinations, senate house, university of London and the British Government. Such arrangements included assistance in the following areas: drafting of syllabuses, moderation, the supply of consultants and external examiners and the training of Cameroonian personnel. Finally, it was agreed that, subject to the maintenance of appropriate standards, the University of London would be required to do all that it could to ensure the wide scale recognition of the Cameroon GCE examination results and certificates.

The first Cameroon GCE examination was conducted in June 1977. Until June 1987, the marking of the Cameroon GCE examination was done in the lone centre of Yaounde. From June 1988, marking was carried out in three centres, Bamenda, Buea and Yaounde on a rotatory basis such that the subjects marked in one centre in one year, would be marked in another centre the following year. After the Cameroonisation of the London GCE in 1977, things went on smoothly until 1984. From 1984 onwards the GCE began experiencing irregularities as some London officials began withdrawing. From 1990, when the University of London Examination and Assessment Council withdrew completely from the role it had played so far on the Cameroon GCE, the irregularities became even more alarming. Some of these irregularities included, the use of GCE questions reserved for future sessions for entrance examinations into Ecole Normale Superieure in 1990, change of the format of the GCE question papers in 1991 without prior notice to candidates, poor printing, wrong pagination, wrong spellings, shortage of question papers and materials, late arrival of question papers and the postponement of some papers, wrong instructions on question papers and examination leakages. (CGCEB, 2007).

Realising that the GCE was experiencing problems which were definitely carrying the examination down the path of mediocrity, the teachers led by the Teachers Association of Cameroon (TAC) made a popular outcry about the falling standards of the GCE examinations. Parents of Anglophone children joined the teachers and launched a struggle for the creation of an examination board to take over the conduct of the GCE examination and other examinations of English- speaking school system in Cameroon from the department of examinations in the then ministry of National Education. In response to this popular demand, the then Prime Minister of Cameroon signed an order (No 194/CAB/PM of 11 September 1992) creating a technical committee to carry out studies and make recommendations on the organizations and functioning of the GCE Examination Board.

On July 1, 1993, the president of the Republic signed a decree (No. 93/172 of 1st July 1993) creating the GCE Board. The decree empowered the board to organise the General Certificate of Education examinations at the ordinary and advanced levels. Following the creation of the board, the ministry of National Education set up an Ad Hoc committee to write the text of application to the July 1, 1993 decree. On October

12, 1993, the Prime Minister signed the text of Application, order 112/CAB/PM to define and determine the administrative and financial organisation of the Board. This led to the appointment of the pioneer chairman of the Board. The installation of the chairman by the Minister of National Education on the 25th of October,1993 in Buea marked the starting point in the functioning of the Cameroon GCE board. From then on, the GCE board started organizing the GCE examinations yearly and the exams are written in the months of May and June.

Following the creation of the GCE board, the BAC board which is the L'Office du BACaluareat du Cameroun was created by Presidential Decree No. 93/225 of 28/09/93 and modified by Decree No. 97/044 of 05/03/97. The BAC board was created as public establishment with an administrative character in charge of the organization of examinations in the French language such as the BACalaureat general, the BACalaureat technique, the Brevet de technician, Brevet Professionnel and the Brevet d'Etudes Professionnelles. A Prime Ministerial Decree No. 047/CAB/PM of May 17, 1994 organized the adminiatrative structure of the BAC board. It is placed under the supervision of the Ministry of Secondary Education (OBC, 2014).

There are now conventional means of testing, measuring and evaluating that examination boards all over the world including the GCE board and the BAC board in Cameroon follow and practice in order to properly test, measure, evaluate and then certify. But how did the practice of testing and measurement start? The history of measurement dates back to the era where tests were designed to measure the differences in individuals pertaining to particular skills. This was brought to the limelight in 1796 when Maskelyne who was England's astronomer royal of Greenwich observatory dismissed his assistant Kinnerbrook for recording wrong measurements of movements of stars across the telescope. That is, his assistant's measurements were eight tenth slower than his. According to Tuckam (1975), a German astronomer Bessel, between the years 1820 and 1823 improved on the works of Maskelyne. He did this by showing the variability of personal equations and as well as observations. He brought up arguments on the existence of fluctuations from one situation to another from person to person because in reacting to a simple stimulus there is variation in simple reaction time.

Most of the measurements done in history both in written and oral form were informal. The informal examinations used by the Chinese in 2200BC for the recruitment of workers into the civil service were the first written tests (Stanley and Hopkins, 1978). In the 5th Century BC, Socrates also conducted an informal oral examination. Proponents such as James, Cattel and Pearson played significant roles in test development. Pearson later went on and discovered the Pearson Product moment correlation coefficient which is even widely used nowadays in checking the validity and reliability in tests (Maheshwari, 2016).

Before the twentieth century, written examination was not being used in schools. Before 1815 in America, oral examination was the means used to administer educational achievement tests. In America, written examinations came into use after 1850. This means of examination was suggested in 1845 by prominent new educator in England called Horace Mann. He emphasized on the desirability of standardization and the use of large number of questions for assessments. He also reinforced the putting in place of written examination by pinpointing the ills of oral examination and the usage of concepts such as validity, reliability and usability which have become the base on which modern theories are built (Stanley and Hopkins, 1978). As a result of suggestions from Horace Mann the state of New York conducted the regents' examination from 1865 to 1878 and Boston schools started administering written examinations (Micheels and Karnes, 1950).

In 1863, Sir Francis Galton embarked on the testing of individual differences. His work was regarded as the pioneer to mental test development. Later in 1884, an anthropometric laboratory was opened by Galton which was used to collect characteristic measurements of individual persons. Also, at the same time, the American psychologist Mckeen Cathel was carrying out studies on identifying individual differences in primary physical terms. These were the earliest histories which were recorded about testing (Maheshwari, 2016).

By 1864, Reverend George Fisher, a dynamic schoolmaster from England proposed the use of objective standardized tests in measuring academic attainment. He later went forward and discovered the first standardized objective test in 1864, and by 1897, he developed the objective standard spelling scale. As soon as written examinations gained prominence, it started receiving criticism. One of such critics was Edgeworth whom in

1890 presented an article which criticized the reliability of essay tests as it lacks objectivity in the journal of royal statistical society (Micheels and Karnes, 1950).

The most prominent contributions in this era was by a young American physician by name Joseph, M. Rice who had studied pedagogy in Germany and had been influenced by experimental psychologists in Jena and Leipzig universities. This influence turned him into a zealous researcher. He conducted two great research works on spelling achievement in American cities because of the huge concern he had at the time for contemporary educational issues. He worked for 15 months in 21 cities and secured the responses of 13000 students from personal contact and 16000 through mails. From this research, he published twenty articles in a leading literacy magazine at the time called 'The Forum'. His first published article brought forth the concept which is referred to nowadays as 'norms'. He was further credited for being the originator of the 'comparative test' (Stanley and Hopkins, 1978).

The period between 1897 and 1906 was known as the incubation period. The work of Joseph Rice titled 'the futility of the spelling grid' greatly refuted the idea which was paramount at the time that learning products could not be felt or intangible and could only be appreciated by the teacher of a particular class. This new finding came at the dawn of the twentieth century and thus ushered in more research works on test development. Through these works, Stone who was a student of Dr. Thondike at the time was inspired. Stone set out to find answers to pertinent problems pertaining to the learning of Arithmetic. In doing this, he developed two tests in Arithmetic. The tests were both objective and had clear guidelines with regards to administration and scoring. The difficulty level of each item of the test was determined in order to make the test scientific though it was not standardized (Wrightstone et al, 1964).

Another great researcher during this first decade of the twentieth century was Courtis. He worked alongside Stone and he was more interested in norms. As he worked together with Stone in administering the tests in Mathematics, he was interested in the establishing of norms while measuring students' growth in Arithmetic. Seeing that Stone's tests could not really give him satisfactory responses with respect to norms, he then went ahead and constructed a series of tests, in which he stated clear instructions which should be followed in the administration of these tests. Scoring of the tests was also made to be objective and norms were also put in place. These tests were thus considered as standardized tests and were put into use in 1909 (Kulkarni, 1962).

Being an ongoing process in the development of measurement instruments at the time, Alfred Binet in 1904 developed the test for measuring intelligence after studying the differences between dull and intelligent children. He named the test Binet-Simons intelligence test. This led to the development of the Binet-Simon scale of 1905 and the Binet-Simon scale of 1908. These two scales at the time made significant contributions to both the theory and the practical application of testing procedures. Alfred Binet and his collaborators also developed these scales in view of accomplishing the task given in 1904 by the French Minister of Public instruction to differentiate between subnormal children and normal children so that the subnormal children could be given instruction in special schools (Freeman, 1968).

The works of Thorndike and his students were the most prominent between the years 1910 and 1920. This period was marked with the publication of the first achievement test and standard scales for measurement. The fight for objectivity of achievement tests was also quite prominent in this era as 1920 marked the beginning of the broad-based implementation of the objective tests in schools (Stanley and Hopkins, 1978). In 1910, Thorndike's hand writing scale was brought to the lime light. The scale was made up of sample handwritings with scores derived from the judgement of experts allocated to the respective hand writings. Therefore, in using this, the teacher could simply compare students' handwritings to be rated with those on the scale and simply match handwritings which look alike and then get down the score as given by the scale. This was considered as the first standardized achievement test which was scientifically built. Later in 1916, Thorndike constructed a test aimed at measuring the drawing abilities of students between the ages of 8 and 15 (Wrightstone et al., 1964).

The quest for standardized intelligence and achievement tests which could be accepted by both the educators and the public was of prime importance in this decade. This quest led to the development and use of a standardized test which was used for a survey in New York between 1911 and 1913. This was an important event because it marked the beginning of the use of standardized tests in such large cities. Also in 1911 another writing scale was developed by Ayres. The writings on his scale were arranged in order of legibility. Later in 1915, Ayres then constructed a spelling test. The spelling test was constructed from educational objectives and so, was of great importance at the time. Also, in 1912, the Hillegas composition scale was developed. In 1913, a renowned student of Thorndike, called Buckingham published a spelling scale. His own spelling scale was unique because in the scale, words were arranged according to their difficulty levels. He began constructing this scale by first of all selecting the words which students of various levels had spelled correctly, then he went further and arranged these words in order of their difficulty levels. Through this scale, the difficulty levels learners could attain in spellings could be easily determined. Woody later used this criterion of difficulty to construct the Arithmetic scale and also by Trabue in building up a language scale (Stanley and Hopkins, 1978).

Also in this era, Alfred Binet's works experienced remarkable revisions. In 1905, Goddard published a translated version of Binet's scale and came out with a revised version of Binet's 1908 scale in 1911. Moreover, Yerkes also published revised versions of Binet's scales in 1915 and in 1923. Alfred Binet's test was later revised in 1916 at Stamford university by Louis Terman and his associates and a new version called the Stamford- Binet version was born. Also, during the first world war between 1916 and 1919, there was the need to measure the intelligence of soldiers, and this led to the start-up of group test development. This led to the creation of a written group intelligence test called Army Alpha and an individual non-verbal intelligence test called Army Beta. Between 1939 and 1967, David Wechsler also discovered a series of tests (Maheshwari, 2016). Starch also published a series of tests before 1916, he constructed reading tests, scales to measure grammar, scales to measure the use of punctuation, grammar tests, and tests to measure latin vocabulary and latin reading skills. The concept of intelligence quotient which was a contribution of Willian Stern was also brought to the scene during this first decade of the twentieth century (Stanley and Hopkins, 1978).

The period between 1920 and 1930 was considered as a period of rapid expansions in educational measurement. This is because during this period, a large number of standardized tests were developed and published. This rapid growth in test development was to some extent due to the fact that during the first world war, expedient measures were needed to examine huge numbers of men. As one the measures to accommodate the demands, Woodworth constructed a personality test called the Personal data sheet.

As remnants of the First World War, by 1930, there were thousands of standardized tests which were used in schools. These tests were developed as preludes of the tests which were developed for the armed forces during the first world war (Wrightstone, Justman and Robbins, 1964). The tests, covered all traditional subjects such as; Arithmetic, reading, language, science, health, engineering, aeronautics and commerce. Survey tests were also developed during this period. The first of such tests was a survey test for high schools published by Ruch in 1920. The surveys measured the efficiency of curriculum and methods of teaching, comparative achievement and retardation, as they made use of intelligence and achievement. In addition to this, educational journals which were focused on measurement were established. The sprouting of journals such as ‘Psychometrica’ which focused on evolution of psychology as a quantitative rational science and ‘Educational and psychological measurement’ were keen to the development and application of instruments for the measurement of individual differences. This decade was also marked by the construction of some major pertinent measuring instruments such as the Rorschach Ink Blot Test, the Downey Will temperature test and the emotional tone test (Noll, 1965).

The next decade between 1930 and 1940 also witnessed the development of many tests and measuring instruments because of the Second World War which came with a lot of innovations in testing as was the case in the First World War. The Educational testing service at the time came out with tests such as; the Scholastic Aptitude Test (SAT), achievement test such as the CEEB and the California Achievement Test, the Sequential Test of Educational Progress (STEP), Medical College Admission Test (MCAT) (Stanley and Hopkins, 1978). As the objective test continued gaining prominence, more and more people questioned its credibility as an efficient tool of measuring students’ achievement as the pundits felt that the test did not measure some of the most crucial educational objectives and that emphases should be laid more on measuring aspects such as attitudes, interest and appreciation. Measurement during this period was greatly influenced by Gestalt psychology which focused on the interrelation existing within the parts of a whole. Test developers were therefore made at the time to understand that assessing an individual should entail the measurement of different aspects and facets of the individual’s personality such as his or her knowledge, interest, experience, ability, health and family. Consequently, more testing procedures were developed for better appraisal of individual’s potentials and capabilities (Noll, 1965). Moreover, in order to promote objective scoring, the IBM 805 which was the first machine used for the scoring of answer sheets was developed in 1935. The machine led to more efficient test development as tests were now developed with greater use of item analyses.

As part of growing criticisms of tests at this period, in 1935, one of the most stand-out pundits on measurement by name Lindquist criticised even the best of tests at the time by saying that the tests all fall short of measuring the outcomes of instruction in various fields of study. Tytler later re-iterated that changes observed in pupil's behaviour should be considered as reflection of the attainment of educational objectives and that measuring the extent to which learning has also taken place requires the usage of devices capable of measuring broad learning areas such as; social sensitivity, critical thinking, aesthetic appreciation, social adjustment and personal adjustment. The works of Lindquist and Tytler led to the assessment of application and analyses which are higher mental processes (Stanley and Hopkins, 1978).

The book titled 'Psychometric methods' which laid emphases on technical and theoretical aspects of testing was published by Guilford in 1936. The use of statistical methods at the time also became more prominent and widespread. These methods x-railed the weaknesses of the tests which were earlier discovered. During this decade, the focus was on the appropriate measurements of instructional objectives through all aspects of growth and by the development of improved tests for personality assessments, intelligence and achievement measurements.

The fifth decade of the 20th century which was the period between 1940 and 1950 was characterised by the usage of measurement instruments great precision and accuracy. As efforts continued to better measurements, the National Council on Measurement in Education was founded in 1940 with the objective of fostering the understanding and the use of various measurement tactics in education. In line with, this many evaluation programs were founded such as; the eight-year study of secondary schools and general education at large, teacher education evaluation programs, and evaluation programs activities in elementary schools. During this decade, the statistical technique which demonstrated intercorrelations between related tests called the factor analyses gained prominence. The use of this statistical technique came as a back drop of the factor theory of general intelligence and specific factors of special abilities brought forth by Spearman who was an English statistician in 1904. Thurstone and Thurstone in 1944, developed the Chicago tests of primary mental abilities which were used for mental testing via its application to factor analyses (Noll, 1965).

The importance of tests in educational establishments such as schools and the development of positive attitudes regarding the use of tests for measurement characterised this decade. Criticisms were also brought up during this decade as it was observed that teachers' assessment of students' learning was geared towards the memorisation of facts rather than assessing in order to measure the pertinent educational goals which are; understanding, attitude and appreciation. Thus, these tests could not give a wholistic picture of the person being assessed and this led to the use of anecdotal records, interviews and tests measuring higher order cognitive learnings (Adams, 1966).

From 1945, the development and employment of standardized tests have been on the rise as it is being used in industries, in the armed forces, in business and in the public service. Bloom, Engelbert, Furst, Hill and Krathwohl in 1956, came out with the taxonomy of educational objectives which was a step forward for classifying learning objectives. Krathwohl and others published taxonomy on the affective domain in 1964. The taxonomies greatly improved on the quality of educational measurement. The taxonomies therefore helped teachers to know how they could objectively measure higher mental processes. Testing students with the higher mental processes helped them a great deal in final examinations as they could also perform considerably well on knowledge based items as well as those high up in the taxonomy (Stanley and Hopkins, 1978).

Recently, the use of factor analyses has greatly expanded and has led to the refinement of already existing tests and in the development of new tests. According to Kelinger (1995), there are a good number of methods of factor analysing a correlation matrix such as; principal factors, centroid, diagonal, image alpha, multiple group, maximum likelihood and minres amongst others. Also, a good number of self-report inventories have been developed using factor analyses. Recently also, approaches to evaluation such as the projective tests of personality have been used and this came to continue in the same light as earlier tests used by clinical psychologists such as Rorschach Inkblot Test (1921) and the Thermatic apperception Test by Murray (1943). Lindzey had classified the projective methods in 1959 acording to the type of responses which were; association, construction, ordering, expression and completion. A number of projection techniques were later developed, one of such was the projective device of Veldman and Menaker, in which, the subjects who were teacher trainees were expected to tell four fictional stories the experiences of teacher's (Kelinger, 1995). Moreover, Schmuck (1963) also developed a test to measure students' attitudes towards school. Mann also came out with his own works where he focused on role play experimentally as this laid the base of several copying measures which have come up lately. Also, tests have been developed to screen and identify both the gifted and the retarded, and seven different procedures were discovered to be used in identifying the gifted and retarded learners (Noll, 1965).

Efforts were also made designing tests for creativity. One of such proponents was Guilford, whom through factor analyses identified what he called divergent thinking. In order to measure this newly found pattern of thinking, he designed tests for word fluency, ideational fluency, expressional fluency and associational fluency as well as tests to assess flexibility and originality. The concept of the consensual assessment of creativity was brought forth by Amabile (1982). She carried out an experiment where she assessed the creativity of students by sharing pieces of papers to them along-side glue and a card board paper and then allocated 18 minutes to each of the students, then after the allocated time, the students' creativity was assessed by judges pertaining to what they could come out with in respect to the materials offered them (Kelinger 1995).

Nowadays, educational assessments are mainly done in order to determine students' achievement in particular subjects or courses. The concept of creativity has then been interwoven in the Bloom's taxonomy of learning outcome which is commonly used to design test blue prints. Examinations today are crafted to cover and assess learning outcomes via various techniques such as written examination, oral examinations and practical examinations especially in the case of science and technical subjects. Moreover, examination boards worldwide are adopting new and current assessment techniques which could be supported by today's technologies. An example of such is the multiple-choice questions as assessment items introduced by the GCE board in 2009.

Since this study is based on the results of testing and students' performance in engineering, it is quite pertinent to trace the origin of engineering education to where it finds itself today. Historically, the putting in place of training systems dates as far back as 4000BC in the lands of Egypt which is considered the cradle of civilization. Even nowadays Alexandria is still considered the center for engineering in Egypt where a variety of Egypt's technical culture could be found. Engineering is a new branch of science which came about as a merging of Greek scientists' knowledge and philosophical orientations (Bagherzadeh, et al., 2017). Archimedes because of his complete form in science and practice is sometimes referred to as the founder of the science and art of engineering. The chief and engineer of the Alexandria school of engineering then was Heron. Throughout history, the figure of an engineer was seen in personalities like Heron Alexandria, Archimedes, Artakhaleps, and Imhotep. Nevertheless, in the 19th Century, engineering was established as a coherent system of human activities (Hejazi et al., 2011).

During the era of industrial revolution, that is, in the 19th Century and the first part of the 20th century, engineering had started gaining prominence and was considered a specific and different profession, thus fundamental programmers for engineering education laid emphases on preparing students via practical training. Despite this, the role of science and mathematical models were seldom accepted and thus were not given the chance to improve much (Motoahari et al., 2011). The first group of people to replace traditional internship methods which were highly practical based with a simple educational programming consisting of easy to hard practical lessons which were separate from workshops were the Russian engineers from the Tamperial school of Moscow. Imitation then was the traditional means through which learners gained skills and information usually in a limited number all taught by a master (Hampshire Technology Education, 2012)

During the period from 1913 to the launching of the first satellite in 1950, engineering education embraced both statistical and scientific orientations in order to improve upon engineering in general and to some extent the industry. This could be seen in the control of the six-sigma process by Henry Ford and Dr. Shuat. However, engineering took a major leap after the Second World War (Akbarpoor, 2005).

In the years 1950- 1980, the engineering science approach emerged in Europe and was later developed and made more flamboyant in the United States of America after the second World war. This approach was proposed because previously scientists were more open and prepared in facing new and upcoming modern technologies than were the engineers (Bagherzadeh et al, 2017). Thus, the application of Mathematics and sciences in engineering improved, while the amount of time students spent in workshops for technical activities together with professional engineering activities decreased (Grimson, 2002). After the Second World War in 1945, Lawrence Miles who was a senior engineer at General Electric Company was sent to carry out investigations in order to determine why the cost of consumption during the Second World War increased. After carrying out the investigations, he found out that during the course of the war, because of pressures and difficulties which are habitual of wars, as well as operational and time requirements, some materials were coincidentally replaced by Wothers which were more performant and of lower costs. Consequently, in 1947, he established the fundamentals and principles of value engineering which was geared towards taking a giant step in reducing the expenditure and costs of General electric company. The US navy then thereafter started considering employing value engineering in its contracts for building warships. Consequently, the former secretary of defense in America by name Mack Namara gave orders for the ministry to include value engineering in its activities. By 1980, the reduction of government expenditure through the use of value engineering had gained prominence.in America. Thus, American ministries minimized costs and expenditures by millions of dollars (Bagherzadeh et al, 2017).

By 1969, due to enhancements in value engineering across the United States, the Society of Value Engineering (SAVE) came into existence and started operating formally, thus making value engineering known by other countries. Nowadays, the society is globally known as the International value engineering society (SAVE International) which has a purpose to improve and develop value engineering by training evaluators and value engineering teachers, publishing articles, by recruiting real and legal individuals together with value engineering societies from other countries in order to provide them with academic support. Despite the usage of advanced methods in order to optimize activities by many countries, the place of value engineering in re-optimization is very clear such that for every dollar of investment, there is a 20-dollar return. For the past 50 years, value engineering has been employed worldwide to promote productivity and reduce cost, and this applies even to Arab countries of the Persian Gulf, but it is not very common in Iran except for some few cases of late (Saghafi et al., 2004).

In the 21s century, technological advancements in the areas of the sustenance and usage of nuclear energy, the advent of geopolitical realities such satellites led to more mastery of science and Mathematics and also led to the reshaping of engineering education programs with regards to the changed requirements. To a great extent, this structural change has continued until recent times, although there has been a gradual increase in the design context. In the early 90's, it was discovered that there was a need for something more than science and as a result there was emphasis on non- technical skill such as group work and communication by engineering colleges. The conceptions during this era were as such because engineering finds its self somewhere between science and society an d it involves systematic principles of science and Mathematics which are used to finalize scientific results in order to make life better (Grimson, 2002). Therefore engineering education calls for emphasis in both science and practice so that students of engineering could be equipped with the necessary skills and attitudes which is warranted by the 21^{st} century work place. (John, 002).

Engineering education in the last few decades has been criticized by a plethora of countries in their respective educational systems. In France, industry owners in the 90's complained about the practical inabilities of engineers. While in Britain, such similar complaints were raised a decade earlier. In the United states of America, during the 90's the academic boards of many engineering colleges sought for suitable strategies in order to get the best methods of engineering education to be implemented for engineering undergraduate programs across the US. The main discussions of the colleges then were to adequately match engineering education to the needs of the industry. Pundits in general criticized the fact that engineering education had shifted from practical orientations and had further led to the imbalance of real requirements (Motahhari et al., 2011).

The 21^{st} century came with rapid developmental changes throughout the world which when coupled with the changes made in engineering education in the 90's has led to a significant growth in engineering education. Though these new changes and modifications laid emphases more on science and Mathematics preparedness there would also be great emphasis on the professional role of engineers, and for the award of new qualifications following the world's current trends. Empowering the triangle knowledge which comprises of education research and innovation is seen as a hinge pin for producing wealth through national investments. (Motahhari et al, 2011).

This approach intends to make the first year of engineering undergraduate program be more of fun and an entertainment period rather than a dull and boring one by adopting the approach which is based on equipping the students with soft skills through practical innovations in engineering. A general overview of engineering education is given by this approach, it also improves upon supporting skills and formulates interesting ways which could attract more talents for STEM based professions. It transforms and portrays the curricular in the manner that ensures different fields of learning (Apelian, 2013).

Engineering education of today demands for a renaissance which is concretized on entrepreneurship and technological advancements geared towards meeting recent requirements. Engineers should thus be equipped with not only with technical knowledge but also with group, problem solving and human power promotion skills. Intellectual power alongside physical power is fundamental global knowledge as considered by engineers. In general, analysis of engineering education national institutes and international councils have revealed that engineering education in recent times have undergone significant changes in the last decade in order to suit adequately with the current trends.

Engineering education has undergone significant metamorphosis over the years, and these changes experienced in the field of engineering education is due to the different evolutions of the various engineering fields. Firstly, Civil engineering came into existence between 2000BC and 4000BC when humans saw a need to abandon their nomadic life styles and build shelters for themselves. This first started in ancient Egypt, and Mesopotamia which is present day Iraq. During this era, the wheel and sailing were developed in order to ease transportation. The term civil engineering was always often used interchangeable with architecture and the usage of each depended on geographical location. Some of the first large civil engineering constructions done were the pyramids which were constructed in Egypt, the Qanat water management system, the Parthenon in Ancient Greece, the Appian way constructed by the Roman engineers and the Great wall of China (Oakes et al, 2001).

The term civil engineering in the 18th century was used to refer to anything civilian did as engineering as opposed to the military engineering. The first recognized civil engineer was the constructor of the Eddystone Lighthouse by name John Smeaton. He later together with some of his colleagues formed the Smeatonian society of civil engineers. Though this organization was created in a social gathering, it was little more than a social gathering with respect to the formal face it wore. Civil engineering later became more prominent and a course which was studied in the university. The civil engineering institute was created in London in 1818 and the great engineer by name Thomas Telford became the institute's first president. A royal chater was also later received by the institute, and this charter gave civil engineering a professional recognition.

Mechanical engineering also emerged as a field of study in the 18th century, during the industrial revolution in Europe. Moreover, its advent could be traced some thousands of years ago in most parts of the world. Developments of Physics in the 19th Century led to the birth of mechanical engineering science. Also, various ancient and medieval societies have facets of the applications of mechanical engineering. Different societies invented different mechanical facets were invented in different eras and in different societies. During the prehistoric times, the wedge and the inclined plane were invented. Likewise, the ancient near East came out with the six classic simple machines (Moorey and Peter, 1999). In the 5th millennium BC in Mesopotamia which is today Iran, the wheel together with the wheel and axel were invented (Potts, 2012). Also, the lever which was first used in a simple balance and to move large objects in ancient Egyptian technology, came into existence about 5000 years ago in the Near East. The lever was also used in the first Crane machine which was invented in Mesopotamia Circa in 3000 BC called the shado of water lifting device (Paepetis et al, 2010). Pulleys which are more advanced machines than the lever had their earliest evidence in the 2nd millennium BC in Mesopotamia (Moorey and Peter, 1999).

By the early 4th Century BC, the water wheel and watermill which were the earliest water-powered machines were invented in the Persian empire at the time, which is present day, Iraq and Iran (Selin,2013). The works of Archimedes between 287 BC and 212BC greatly influenced mechanics in Ancient Greece. In Roman Egypt though the discoveries came later, some important one's were made, one of such was the first steam -powered device (Aeolipile) made by Heron of Alexandria. Also in China between (78-139 AD), the seismometer was invented after improvements made on the water clock by Zhang Heng. Between 200 to 265 AD, the chariot with differential gears was discovered by Ma Jun. Later, Su Song who was medieval Chinese horologist and engineer, used the astronomical clock in which he incorporated escapement mechanism in. This was done interestingly about two hundred years before the discovery of escapement devices were found in medieval European clocks. The first endless power transmitting chain drive was also invented by Su Song (Needham, 1986).

Between the 7th and 15th century which was known as the Islamic golden age, mechanical technology received significant contributions from Muslim discoverers. In 1206, a famous book titled 'Book of knowledge of ingenious mechanical devices' was written by Al-Jazari. Moreover, crankshaft and camshaft which are today the fundamentals of many mechanisms was first created by him (Al-Jazari, 1973).

During the 17th Century, England experienced remarkable breakthroughs in the field of mechanical engineering. It was during this century that Sir Isaac Newton developed the Newton's laws of motion and calculus which is the mathematical foundation for Physics. Despite these magnificent discoveries, Newton was not moved to do publications, until sir Edmond Halley convinced him to do so, which he did and today these discoveries are of benefit to mankind. Another proponent of calculus during this era was Gottfried Wilhelm Leibniz. The 19th century came with the industrial revolution, consequently, countries such as England, Germany and Scotland experienced the production of machine tools. The massive production of mechanical tools alongside the use of manufacturing machines and engines paved the way for mechanical engineering to emerge as a field separate from engineering. The emergence of mechanical engineering as a separate field led to the creation of the British professional society of mechanical engineers in 1847, and this came thirty years after the creation of such professional organization formed by the civil engineers (Buchanan, 1985).

The American society of mechanical engineers was later created in 1880 in the United States to become the third of such societies, after the first two created in England. This was a prelude for the creation of more of such organizations in the United States, like the American society of civil engineers created in 1852, and the American Institute of

Mining Engineers in 1871. Mechanical engineering education from inception has had a strong hold on Mathematics and science (Columbia encyclopedia, 2001).

Chemical engineering on its own part came into existence in later parts of the 19^{th} century and was born out of industrial chemistry. In the 18^{th} century before the industrial revolution, batch processing was the main method used in the production of chemicals industrially and in the making of consumer products such as soap. The process was quite labour intensive because it entailed the putting together of different chemical components to form a mixture, passing the mixture under specific thermodynamic conditions of pressure, temperature and allocated time for each thermodynamic process. After which, the desired product is chemically isolated, purified and later tested to make sure it is ready for the market. The demand for high quality and large quantities of chemical products such as soda ash became very high from the period of the industrial revolution. This thus demanded for increase in the size of the activity and an improvement in the efficiency of operation and secondly, an alternative of batch processing such as continuous operation has to be used (Kostick, 1998).

As a result of this backdrop, chemical engineering emerged. It was primarily based on the industrial applications of chemistry and separation technics in chemical processing industries. The production of soda ash which was used in the making of soap and glass in 1823 in England was the first large scale chemical process. During this same period, research in organic chemistry led to the discovery of chemical processes for the production of synthetic dyes to be used in the textile industry from coal. In the later part of the 19^{th} century, Britain experienced a boom in the growth, development and implementation of industrial chemical processes. Also, a collection of lectures which was based on the industrial chemical process was presented in England in 1887, these lectures gained prominence in the United states and thus led to the formation of the first chemical engineering curriculum. Through this curriculum, a good number of universities in the United States embraced chemical engineering and started offering fields of study in chemical engineering. This later led to the creation of the creation of the American institute of chemical engineers in1908. (David and James, 2012).

During this early stage of chemical engineering practice, knowledge gaps were identified in mechanical engineers. This was because chemical engineers were versed with the mechanics of process operation as well as aspects in fluid mechanics and heat transfer but lacked a background in Chemistry. Moreover, chemists had a good footing in chemical concepts and chemistry in general but lacked processing skills. The chemical processing industries inherently needed skills in separation science, but this gap could neither be filled by the chemical engineers nor the chemists. The United States sought to solve this problem by offering degrees in industrial chemistry in some departments. These industrial engineering departments later grew up to become what we have today as chemical engineering departments. The willingness to begin the usage of carriages not carried by horses led to increase in the demand of gasoline and consequently, these changes precipitated the exploration of oil. This later led to the opening up of various oil drilling firms, like the wildcatters of Texas and the Spindletop too based in the United States of America. This massive oil exploration at the time led to widespread use of automobiles, given that the cost of gasoline was low (David and James, 2012).

During these early days of the practice of chemical engineering, the chemists and chemical engineers were not well equipped with the appropriate tools for their work as chemical engineers. Between 1930 and 1940, a number of nomographs which are charts which help represent physical properties such as boiling and melting point, and boiling point were invented which were used in designing and in analyses pertaining to the chemical processing industry. Computer based technology was later brought into the scene in 1960's and by the 1970's computer aided designs (CAD) packages which helped chemical engineers in carrying out designs and tedious calculations were put into use. Between 1960 and 1980, the chemical processing industry experienced a paradigm shift from developing new chemical processes and inventing new products in order to make profits to the fabrication of products with high levels of technology and with the use of more efficiency in order to make profits. The chemical processing industry's market became more globalized in the mid 1980's. The process of automation which made use of advanced process control (APC) also cropped up with the advent of the computer. With the use of the APC chemical industries could then make products of higher quality and with greater efficiency, but with little capital investment. By the mid 1990's new scientific fields such as the microelectronics industry, the biotechnology industry, nanotechnology and the pharmaceutical industry sprouted. These industries employed about 50% of chemical engineering graduates and thus leaving a limited man power in the chemical industry (David and James, 2012). The field of chemical engineering today has therefore spread its tentacles to such fields in terms of employability and even research.

Mining engineering came into existence since the unset of civilization as people started making using minerals found in the earth's crust such as ceramics, metals and stone in order to make tools and weapons. Examples of such were flint tools which were found in France, Poland and Southern England (Hartman, 1992). Egyptians started mining early enough in the early dynamists. Egyptians began by making pottery with use of malachite which they mined at Maadi. Gold was also being mined at Nubia (Shaw, 2000). The commencement of mining in Europe dates back long time ago before the 7th BC Century. These mining activities at the time were carried out in Greece with the mining of Silver in Laurium, marbles in Thassos and the Gold mines of Mount Pangeo and Thrace which were captured and exploited by Philip of Macedon. Romans in Spain in a bid to exploit Gold Las Medulas as well as silver from the mines of Cartagena, Linares, Plasenzuela and Auaga developed and employed hard-wearing methods (Calvo, 2003).

During the medieval periods in Europe, the mining industry's focus was on the mining of copper and iron. The mining iron even became more prominent with the production of military weapons. Medieval Europe by 1465 experienced the silver crises, in which there was acute shortage of metals as a result of the fact that shafts could no longer pump minerals at the depths which they had reached. As a result of this, water mills which made use of water power were brought to the scene. The crushing of ores alongside the raising of ores from shafts were done with the water mills (Heiss and Oeggl, 2008). By the 18th and 19th Centuries, mining was not only done in Europe, but was also done in the Philippine's and the Americas.

By the 20th Century, the exploration of coal and other base metals such as iron, lead and copper were enhanced by the high demand for silver and gold in the western parts of the United States. The need for large amounts of copper which is used for the making of household electrical equipment was met by the copper suppliers of Arizona and Alaska of the United States. The growth of Canada's mining industry was rather slow despite Ontorio being the lead producer of nickel, copper and gold in the 20th Century, due to lack of transportation means (Miller, 2013). Australia was also a lead producer of gold and this was backed up with the opening of mines such as the Mount Morgan mine.

The 21st Century came with mining being carried out by large multinational companies. The concept of Environmental Impact Assessment in the 21st Century has also made the activity of mining to reshape its self to become more professional, profitable with less negative effects on man and the environment.

Petroleum engineering is that branch of engineering born from mechanical, chemical and mining engineering. This branch of engineering was first established in California in 1890. From the beginning, geologists were used to channel water in order to make sure it doesn't mix up with oil. From this stage, a need was seen for applying technology is the exploitation of crude oil. This led to the establishment of a technical committee in 1914 by the American Institute of Mining and Metallurgical Engineers (AIME). Petroleum engineering started gaining prominence in universities in 1898 when universities started offering petroleum related courses and one of such universities which started offering the petroleum related courses was the Stanford university where the department of Geology was named the department of Geology and mining and was later named as the department of Geology, mining and petroleum studies in 1914. Other universities such as the Universities of California and Pittsburg started offering petroleum engineering related courses (Priscilla and Baxter, 2020).

By 1920, petrophysics which is a branch of Physics became a fundamental element in the petroleum engineering sector. This branch of Physics later became the part and parcel of the wire line logging. By the year 1940, the study had become quite advanced and could comfortably be used to differentiate between oil depositions and water in the reservoir rocks. After the Second World War, in 1945, the techniques of reservoir analyses and petrophysics were continuously being fine-tuned by the petroleum engineers. In 1947, the first offshore oil well was created by the Kerr Mc Gee oil company in the Gulf of Guinea. This offshore oil production then gained more prominence by the 1950's. In 1960, the Organization of Petroleum Exporting Countries (OPEC) was founded in Baghdad Iraq. As a result of advances realized in computing, in the 1960's, seismology was introduced by 1970. Digital seismology made it possible for geoscientists to accurately determine the quantity and nature of the total reservoir outside the apertures of what the wire line logging could determine. By 1975, gas and oil companies started sharing and comparing their new discoveries via the ARPANET, which is what was used before the coming of the internet (Priscilla and Baxter, 2020).

In the last two decades of the 20th Century, the profession of petroleum engineering was slowed down by a drop-in oil prices. This made most petroleum engineers to drop the profession for other professions. In the year 2000, in a bid to pick up in again in oil exploitation, a plat form known as Hoover-Diana which was built in 1,463 metres of water in order to recover petroleum in the Gulf of Mexico was launched by the Exxon Mobil and BP. Shell oil later in the year 2014 came out with the world's deepest oil platform of depth 8000ft called the Perdido which was located in the Gulf of Mexico. The 21st Century came with geoscientists, economists and surface engineers exploiting unconventional oils as well as gases found in both shale and sand. The exploitation of petroleum then grew massively and by 2010, petroleum engineers had got more prowess than they had before 1985. Extreme deep-water drilling which reaches depths greater than 12000 feet and which could go to an additional 11000 feet spread across the Gulf of Mexico and Brazil to Russia and to West Africa (Priscilla and Baxter, 2020).

Looking at the history of electrical and electronics engineering, by the 17th century, electricity was still an aspect of intellectual curiosity for many. In a bid to understanding what electricity is, William Gilbert differentiated between static electricity and electric current by extending Cardano's study on electricity and magnetism Stewart (2001). He later coined the word the latin word 'electricus' from the Greek word 'amber' which refers to the attractivity of objects after they have been rubbed. From the word 'electricus', the English words 'electric' and 'electricity' came to existence and made their premier appearance in Thomas Browne's book titled 'Pseudodoxia Epidemica'. Otto Von Guericke also went ahead and did works on electrostatic repulsion (Guarnieri, 2014). By 1705, the works of Francis Hauksbee on the generator invented by Otto Von Guericke led to the discovery of the gas discharge lamp which later led to neon lighting and mercury vapor lamps (Burke, 1978). Thereafter, Stephen Gray found out the significance of conductors and insulators and from there, the two-fluid theory of electricity was discovered by C.F. du Fay (Guarnieri, 2014).

By the 18th Century, many more researchers in the field of electricity had sprouted out. One of such was Benjamin Frankline who found out that lightening was indeed electrical in nature. He arrived at this conclusion after flying a kite which had a metal key attached to the bottom of its dampened string in a stormed threatened sky and observed a succession of sparks jumping from the key to the back of his hand. In 1791, a discovery was made on bioelectricity by the Italian called Luigi Galvani. He made illustrations of the fact that electricity was the medium through which nerve cells passed signals to the muscles. Scientists were also later provided with an alternative to electrostatic machines with a more dependable source of electrical energy through the fabrication of the voltaic cell using zinc and copper layers in 1800 (Kirbi, 1990).

Due to these multiple discoveries, the practice of electrical engineering became a profession in the later parts of the 19^{th} century. In order to back up the new-found profession, electrical engineering institutions were created in the United Kingdom and in the United States of America. Francis Ronalds made the working electric telegraph in 1816 and further wrote on how the world could be transformed through the use of electricity and thus he stands out as one of the first electrical engineers (Ronalds, 2016). Moreover, the use of modern research techniques in the field of electrical engineering, influenced its development greatly. Amongst these developments were the works of George Ohm in 1827 who came out with the relationship between electric current and the potential difference along a conductor and Michael Faraday whom in 1831, discovered the electromagnetic induction. Also in 1873, James Clerk Maxwell did a lot of research works on electricity and magnetism and he came out with the Maxwell's equations which served as bases for many more theories. It was until the later parts of the 19^{th} century that electrical engineering became a program in the university which until then it was being considered as part of Physics. The Darmstadt University of Technology in the year 1882, laid host of the first faculty of electrical engineering worldwide. In this same year, the Massachusetts Institute of Technology (MIT), within its Physics department opened up an electrical engineering option. Also, in the United Kingdom by in 1885, the first chair of electrical engineering was founded in the University College of London. Furthermore, by 1886, the first department of electrical engineering was founded in the United States in the university of Missouri (Ryder and Donald, 1984)

During this period also, there was tremendous increase in the use of electricity commercially. In the 1880's the transformer also came into existence and this led to the usage of electric equipment which adopted alternating current. Maxwell's four equations by the mid 1890's had gained so much prominence and popularity and it even rivalled Newton's laws of mechanics as it was recognized as the bases on which one of the most prominent theories in Physics was built. The Maxwell's equations were also put in use in the discovery of the radio communication, and also in the development of telegraph, telephone and even electric power industries. During the development of radio technology, many scientists contributed massively, amongst which are Heinrich Hertz whom through his UHF experiments in 1888 discovered the electromagnetic or radio waves and Jagadish Chandra whom between 1894 and 1896 investigated on the millimeter wave and reached a very high frequency of 60GHz, and he also found out that radio waves could be detected with the use of semi-conductor junctions (Emerson ,1997).

The 20th century saw the birth of most electronic gadgets. In 1904, John Fleming invented the diode which was the first radio tube. The recognition by Reginald Fessenden for the need for a continuous wave to be generated led to the transmission of the first broadcast voice in 1906. More electronics such as the triode was also discovered by in 1906 and by 1931 enabling technologies were already advanced for the development of electronic television. The development of domestic applications which use electricity was quite dominant in the 1920's (Beauchamp, 1997).

The second world war came with a lot of growth in the field of electronics especially with the advent of the radar and the magnetron in the University of Birmingham by Randall and Boot. Radio communication, radio location, and the guidance of air crafts with the use of the radio were all innovations of this era. The colossus which was an early electronic computing device was also discovered by Tommy Flowers. The United States of America also engaged in huge works in the fields of radio direction finding and pulse linear networks as part of the war training programs. After the second world war, the electronic field became broadened and more electronic devices were made such as modern televisions, audio systems, computers and microprocessors. These modern technologies further influenced the development of more advanced technologies and the accomplishment of objectives such as the Apollo missions and the NASA moon explorations. The term radio engineering was later replaced by the term electronic engineering in the 1950's. This then became a course in the university and was taught along-side electrical engineering because of their similarities. By 1947 the point polar transistor was discovered by Bardeen and Walter and by 1948 they discovered the bi-polar transistors. These early devices were quite challenging to manufacture in large quantities and as such, more compact devices were developed (Moskowitz, 2016).

In 1959 Mohammed and Dawon invented the MOSFET which stands for metal oxide semiconductor field effect transistor. This was the first compact transistor which could easily be produced massively. This device later became the most widely used gadget in the world at that time and thus it greatly transformed the electronics industry. The MOSFET had thus played a pivotal role in electronics development (Williams, 2017). The adaptation of semiconductor technology in the Interplanetary Monitoring Platform and in Apollo's computer aided immensely the Apollo program which set out in the landing of astronauts in the moon. Through the MOS, the microprocessor was invented in 1970 and the first of such was Intel 4004, which was made in 1971. The 4004 which was a 4bit processor was immediately followed by the invention of Intel 8080 which was an 8bit processor and this led to the manufacture of the first personal computer which was the Altair 8800 (Federico, 2009).

Electrical and electronic engineering gave birth to computer engineering in 1939. Computer engineering came to the lime light when John Vincent who was a Physics and Mathematics teacher at Iowa state university and Clifford Berry who was a graduate of physics and electrical engineering, used Mathematics, Physics and electrical engineering and developed the first digital computer. These two scientists within a period of five years completed the making of the Atanasoff-Berry Computer also known as ABC. Researchers later took four years and engaged in an expenditure of $350,000 to build a replica for ABC in 1997 after the original ABC was dismantled in the 1940s. Advancements in semiconductor technology led to the emergence of the first modern personal computer in 1970. These technological advancements in semiconductor technology involves works of proponents such as William Shockey, John Bardeen and Mohamed Atalla amongst others (Lojek, 2007). The Case Western Reserve university of Cleveland Ohio, laid host of the first computer engineering program in the United States of America in 1971.

The above history on each of the engineering fields to be considered in this study gives a deep insight on the inception and evolution of each of these fields. All this is in a bid to understand better the present dynamics pertaining to these various engineering fields and how they could be improved upon in the 21st Century, taking into consideration the new facets which prevail in the 21st Century.

Conceptual Background

Conceptually, the educational system of Cameroon is composed of two sub systems of education, that is, the English sub system and the French sub system of education which they inherited from the British and French respectively and this is according to specifications from the 1998 law on education. Due to the policy of harmonization, the duration of primary education is six years in both sub-systems instead for seven years for anglophone and six years for francophone schools as previously. The duration for secondary education is seven years, that is five years for the first cycle and two years for the second cycle. This currently is practiced only by the English sub-system of education while the French subsystem still operates in the 4-3 system in secondary education, that is four years in the first cycle and three years in the second cycle. This simply implies the fact that though harmonization has taken place in the basic or primary sector in which the seven years in the English subsystem was reduced to six years, the much-expected harmonization at the level of secondary education has not taken place that is for the 4-3 system to be replaced by the 5-2 system. (Tambo, 2003).

At the end of first cycle in both the English and French sub-systems of education, certificate examinations are written conducted by competent examination boards. For the French sub-system, the examination written at the end of the fourth year in the class called troisieme (3e) which marks the end of the first cycle in general education is called Brevete Etudes des Premiere Cycle (BEPC). At this level in the French sub-system, students do not make choices on the subjects to offer. In the English sub-system of education, at the end of the first cycle, students take the GCE Ordinary level exams. In this examination, students are not compelled to take every subject, but they must take the three compulsory subjects which are; French Language, English Language and Mathematics. The students then choose from amongst the other subjects, those they will like to offer, with a maximum to be offered being eleven subjects with Religious studies inclusive. In the end of the second cycle in the Francophone sub-system of education, the students write two exams, that is the Probatoire which is written at the end of the second year of the second cycle and the BACalaureate exams which is written at the end of the third year of the second cycle. In the BACalaurete exams in general education, students choo The BACalaureate is thus the final secondary school examination that paves the way for students into university. In the English sub system of education, the GCE Advanced level is written at the end of the second year in high school. In this examination, the students choose the subjects to study, and with the GCE A/L students could engage with university studies.

These end of course examinations in secondary schools in the English sub-system and French sub-system in Cameroon is organized by the GCE board and BAC board respectively. These examination boards are responsible for carrying out assessment, measurement and evaluation in order to adequately certify the students. These examination boards are therefore in charge of the setting and the designing of the items on the instruments to be used for assessment, giving the prescriptions and implement the rules and conduct in the design of standardized examinations like the GCE exams and the BAC exams, the mode of administration of the exams, the scoring process and evaluation. The GCE examination is written in two phases, the first phase is the practical phase for all the science subjects which is done some few weeks before the theoretical phase which is the second phase. The second phase which is the theoretical phase is done for about two weeks with two sessions daily, that is the morning session and the afternoon session, in each session, a paper in a subject is written and the sequence of writting is governed by the time table from the GCE board. The BAC examination on the other hand is written approximately for a week, and at the end of the writting session the optional practical papers for the sciences are written. The writting sessions are also done as stipulated by the time table designed from the BAC board. The science subjects in the GCE examination are structured in such a way that there is a fixed percentage designated for practicals. Meanwhile the science subjects in the BAC examinations do not have practicals as a compulsory aspect, but they are optionally done and written in the BAC examinations as supplementary courses with additive purposes, as the scores students have in them are added to their final score in the general examinations.

In the test design phase, the examination boards make sure that the item which are to be used for assessment are of appropriate difficulty and discrimination levels, that is the difficulty indices of the questions are appropriate, and the questions also discriminate appropriately with acceptable discrimination indices. Other psychometric properties of the examinations such as reliability and validity are supposed to be ascertained by the examination boards. Since the GCE and BAC exams are standardized exams. Reliability according to Tambo (2012) is the extent to which a test or examination is stable dependable and consistent in measuring what it is supposed to measure. That is before the administration of examination questions, the respective examination boards are supposed to make sure that the examinations are dependable, stable or consistent, this can be done through test retest reliability method, split half method, kuder Richardson or by the use of equivalent forms. In order to ascertain these psychometric properties, the test development process is supposed to be methodologically and scrupulously done.

To Nworgu (2015), in developing the test, there should be a clear outline of the subject matter to be assessed in the test, this is refered to as content analysis. The content could be described in terms of the topics or sub topics which was learned by the learners. Moreover, there should be a deep insight on what the content is all about and on what exact content the test will be based on. With this at hand, the test questions or item will be revolving just around the content of the test. In case where the content of the test is not clearly defined, the test would certainly lack content validity and other psychometric properties. This first step is followed by the review of instructional objectives. The instructional objectives refer to the the changes in behaviouir which a teacher should normally observe in his or her learners at the end of the lesson. Therefore, in developing a test, the test developer should be certain of the instructional objectives because they present the traits which should be measured in the learners. In doing this, the levels of intellectual functions such as knowledge, comprehension, application, analysis, synthesis and evaluation. The third step in test development is developing the test blue print or table of specification. The table of specification is a two-way grid table which states clearly the objectives as they are matched up with the content. The table of specification is like a magical chart which gives the exact number of the of test items per objective and per topic.

When the table of specification has been designed, the test developer then knows the exact number of items to be designed from each topic and for each objective, thus, next step in test development is the writing out of the test items. In writing the items, the test developer has to ascertain the kinds of items that will be in the test, that is whether it will be objective, that is multiple choice, essay type items or short answer items. Moreover, regardless of the type of items to be constructed, certain rules should be adopted in designing the tests, these rules are as follows; more items than required should be constructed so that after doing item analyses, the number of items required would be atleast available to be included in the test or examination, the items should also be written in a way that the task will be absolutely clear to the respondents, in doing this ambiguous and flamboyant words should be avoided. Also, clues to the right answer are not supposed to be given in the test items and the test items constructed should neither be too difficult or too easy. Furthermore, ample time should be allocated to complete the tasks demanded by the test or examination and finally, a good scoring guide which would be adhered to should be developed in order to ensure reliability (Nworgu, 2015).

After the test items have been written, a face validity of the test has to be done, that is determining whether the test actually looks like what it is supposed to be. This is done by experts of measurement and evaluation as well as experts in the subject matter concerned and also by a representative sample of the testees to whom the instrument or test is designed for. Ascertaining the face validity is closely followed by the process of item review. This involves the process of carefully scrutinizing the items in order to choose those which are appropriate. After this stage, the items are then trial tested using an equivalent sample of the group for whom the test is developed. The answer scripts from the trial testing are then used for item analysis. From the item analysis, statistics such as; the item difficulty indices, item discrimination indices as well as the distractor indices will be determined for each item. From the item analysis, items with satisfactory statistical qualities are then selected to be included in the final form of the test. Those items whose statistical qualities were not satisfactory could then be either discarded or modified and tried out again. Test assembly is the next step that follows the selection of the statistical appropriate items. In assemblying the items in the test, items of the same type should be grouped together, all the items should be consecutively numbered from the first to the last, each subdivision of the test should be arranged in a way that easier items come before more difficult one's, and the time allocated for the test as well as directives should be stated. After this phase, the next phase is the final testing or norming phase. This involves administering the test to a fairly large group of students who are similar to the students whom the test is designed for. This testing will give indications of the general performance of the test with respect to the group tested. Data collected from this test are then used to establish norms for the test and this is what is refered to as the standardization phase. The next step involves the writing of a manual to accompany the test. The manual would contain information such as the purpose of the test, the validity, reliability, norms as well as general guidelines for scoring and interpreting the test scores. The final phase of test development involves the final production which involves the printing of the test and manual. At this stage, strict measures should be taken to avoid compromise and leakages (Nworgu, 2015). If any of the stages in the test development process as elaborated above is compromised with, then the test might lack pertinent psychometric properties such as validity and reliability and if this is the case, then the test results would definitely not depict what they are actually supposed to represent or depict.

Validity according to Grunlund (1985) refers to the appropriateness of an instrument to measure what it is supposed to measure. The validity of a test or exam could be seen from various perspectives such as the content validity, the face validity, construct validity and criterion validity which could either be concurrent validity or predictive validity. Content validity refers to the extent to which the test or examination covers the subject matter it was supposed to cover in the assessment. Face validity refers to the extent to which the instrument which could be a test or exam looks to be what it is supposed to be. Construct validity refers to the extent to which an instrument measures the appropriate constructs it is supposed to measure. Criterion validity refers to the extent to which scores on a measure are related to some. Concurrent validity is that type of criterion validity which measures the extent which the score two concurrent measures are related. While predictive validity measures the extent to which scores on a particular predict scores on some other measure in the future.

Brown and Coughin (2007) see predictive validity to mean the ability or potential of an assessment instrument to foretell or predict performances in the future either on the assessment of another construct or in in a similar activity. Also, predictive validity entails comparing test scores with some other future measure (criterion) for particular individuals (Alderson, et al., 1995). Predictive validity in psychometric terms, illustrates the extent to which a scale predicts scores on some criterion measure (Shaw and Bailey, 2017). In relation to survey instruments and psychological tests predictive validity refers to the level of relationship or agreement between scores which are obtained from measurements which could be considered more direct and objective. The correlation coefficient thus obtained from the two sets of measurements from the same target population qualifies the predictive validity. These studies are quite fundamental for to test validation

The prediction of students' academic performance in institutions is very important because it could aid these institutions in strategic planning in how to better improve students' performance in such institutions (Zaidah and Daliela, 2007). Predictions of students' performance could also be meant to reveal to which teachers' instructional objectives have been attained. The selection of students who will probably succeed in future academic endeavors could be done via predictive examinations. These examinations also help prepare students for final examinations (Omirin and Ale, 2008).

Owoyemi (2000) as cited in Atieno (2012), pin pointed that students' future academic performance could conveniently be predicted by students' results in previous academic performance. However, there is upsurge of divergent views on the predictability of some examinations. That is, while some scholars hold that students' academic performance in some examinations could not be significantly predicted by their previous academic performance, other scholars hold strong to the view that students' academic performance in some examinations could conveniently be predicted by their previous academic performances. For example, the findings by Peers and Johnson (1994), confirmed the predictive validity of Scottish Certificate examination to student's academic performance in the first and final year in the university. Also, Gay (1996) found out that high school grades could be used to predict college grades. Contrary to these findings, O' Rouke, Martin, Hurley (1989) found out that the Scholastic Aptitude Test (SAT), did not significantly predict examination performance as the Leaving Certificate Examination (LCE).

The concept of differential predictive validity is often used in studies involving predictive validity because differential predictive validity plays a vital role especially when the predictor over predicts the criterion or when the predictor under predicts the criterion. Several studies have indeed showed that differential predictive validity exists (Zujovic, 2018). The differential predictive validity of standardized examinations is most often determined because the results of these standardized tests are different with respect to particular groups of people, thus in using these scores which are different for different groups for admission purposes is not fair. Consequently, validity studies for the different groups of people provide validity evidences for adequate interpretation and use of the test scores (Kuncel and Hezlett, 2007). Differential predictive validity studies have been carried out in various aspects. In order to easily illucidate the concept of differential predictive validity, lets have a look at this study in which Noble, Crouse (1996) carried out a study on the differential predictive validity of ACT and SAT scores to students' course success in terms of gender and ethnicity and the results of the study revealed that both the ACT and SAT slightly over predicted course success for blacks and males as compared to whites and females. In the above study ACT and SAT scores are used as predictors to studentss' course success and how this prediction is different in terms of gender and ethnicity. In the same light, this study thus makes use of differential predictive validity of GCE A/L and BAC results in sciences in terms of gender, students' motivation and type of high school attended to students' performance in engineering in order to determine whether indeed there is evidence for predictive validity.

Butressing more on the concept of validity, even if a test is valid and reliable, the raw scores from the test or examination is of little or no significance, this is because the interpretation of the scores is what is of more importance. Thiis interpretation is based on the reference point, that is whether it is norm referenced or criterion referenced based (Nworgu, 2015). Amongst these two, norm referencing is what is normally used for most achievement tests. With this testing, a students' performance on a particular test is compared with that of other students. These tests provide information which is used for ranking individual students or group of students. With such tests questions are raised on whether they actually follow the goals and content of the curriculuim, whether they actually measure what has been taught, whether they indicate what a student knows and what he or she does not know in a specific content or what the teacher needs to furnish the students with in order to improve on their performance (Ornstein and Hunkins, 2008) All these is as a result of the fact that in norm referenced tests any interpretation could be given to any score and this will intend depend on the overall performance of the test. In some rare scenarios, politics could even affect the manner in which the norm referencing is done, either to make students over pass for certain political reasons or to reduce the pass rate for some political reasons too. Despite all these, examination boards in charge of certification through the administration of standardized examinations when using norm referenced testing should endevour to make what ever grading is given to a score to reflect the score within the context.

In some cases, in order to avoid the flip flops of the norm reference testing which could be detrimental to societies which have decided to uphold objectivity, and in cases where there is more interest for mastery or performance test, criterion reference testing is applied. The criterion reference test is designed to indicate how a student performs a skill or task or comprehends a concept with respect to a fixed criterion or standard. These standards could be created by state educational agencies as well as state legislators. With the criterion reference testing, the educator could easily determine what the learner knows or does not know, consequently, the score of each item is taken seriously into consideration When these tests are used to determine the learner's mastery, care must be taken to make sure that the items of the test were not very easy or very difficult. The advantages of criterion reference testing are that; they are curriculum specific and with this type of testing new curriculums could easily be evaluated (Ornstein and Hunkins, 2008)

From this study, the predictability of the scores would say a great deal whether the references used for the various examinations are apt or not. This is because norm referencing could easily lump up students of different abilities into a particular grade in a particular subject and consequently since they have different abilities in that subject, the grades accorded might not consistently predict future performance. For example, if in an examination a student scores above 80% in which the cut off mark for an A grade was supposed to be 80%, but because of a dismal performance the cut off for an A grade is brought down to 60%, one would clearly see that students of different abilities are being grouped together by allocating them the same grade that is the A grade.

Looking at the concept of Engineering, it is a branch of applied science that embodies the application of Mathematics, basic sciences such as Physics, Chemistry, Geology, Biology to some extent and some other scientific orientations in order to invent, innovate, design, build, maintain, research, and improve structures, machines, tools, systems, components, materials and processes (Liberty, Aida and Dulog, 2015). There are many branches of engineering such as; Electrical engineering, computer engineering, mechanical engineering, Mining and Mineral engineering, Petroleum engineering and civil engineering. Electrical engineers work in a variety of spheres from tiny micro-chips to huge power station generators Electrical; engineering is amongst the newest branches of engineering and dates as far back the 19^{th} Century. It is that branch of engineering which deals with the technology of electricity. Computer engineering refers to that branch of engineering that integrates several fields of electronic engineering and computer sciences, in order to develop computer soft-ware and hard ware. Civil engineering on the other hand is quite a professional engineering discipline which deals with the construction, design and maintenance of physical and naturally built environment. This include public works such as bridges, roads, canals, dams, airports, sewage systems, pipelines, structural components of building and rail ways. Mechanical engineering on its own part is one of the oldest and broadest of the engineering disciplines refers to that field of study that applies engineering physics engineering, engineering mathematics alongside material science principles to design, analyze, manufacture and carryout the maintenance of mechanical systems. Petroleum engineering is that branch of engineering which deals with the production of hydrocarbons which could be crude oil or natural gas. The upstream sector of oil and natural gas thus lays host of the exploration and production. Closely related to petroleum engineering is mining engineering which is that engineering discipline which applies science and technology to the extraction of minerals from the earth. Mining engineering is associated with other disciplines such as exploration, excavation, mineral processing, geology, metallurgy, geotechnical engineering and surveying (Wikipedia, 2019).

Summarily, the major concepts of this study evolve around assessing the predictability of GCE A/L and BAC examination results sciences on students' performance in various branches of engineering. Therefore, the study looks into concepts pertaining to the psychometric properties of tests and examinations and the place of these psychometric properties in predicting future performances.

Theoretical Background

This study makes use of psychometric theories such as; the Classical test theory, the Item Response theory, the Generalizability theory and other theories such as the attribution theory and the Expectancy value theory and the theory constructivism by Lev Vygotsky.

The Classical test theory is that theory which dwells on the effects which measurement errors could cause on observed scores. The classical test theory was born out of the process of measuring people's individual differences in the 20th Century. This theory emerged from three achievements which were conceptualized. The first of these fundamental concepts was recognizing the presence of errors in measurements, that is accepting the assertion that measurements could be done with errors and trying to identify these errors. The second fact is considering the error as a random variable, that is, assuming the error occurs randomly and uncontrollably. Thirdly was the idea of ascertaining the correlation of scores which might have been affected by errors and hypothetical scores and how to get the reliability index of coefficient of scores on a particular measurement (Schumacker, 2010). The method on how to correct the correlation coefficient due to measurement errors and how to accurately get the reliability coefficient which would be used to make the correction due to the measurement error was discovered by Charles Spearman in 1904. These pertinent discoveries were used as the bases on which the Classical test theory was built. Other prominent scholars such as George Udny Yule, Louis Guttman, and Truman Lee Kelley who were involved in the development of the Kuder Richardson's formula also played great roles in the development of the classical test theory (Allen and Yen, 1979).

The classical test theory has considerably been used over decades in order to ascertain the reliability as well as other characteristics such as validity of measurement instruments (Bichi, 2016). The classical test theory simply dwells on the fact that the score earned is equal to a hypothetical true score and an error margin. Therefore, through this theory, one could comfortably tell in this study whether the scores or grades students score in the GCE or BAC examinations are close to their true scores and this will show clearly if they relate perfectly to the students' scores in engineering at university.

Another theory used in this study is the generalizability theory. The generalizability theory is a statistical framework which explains the consistency, dependency or reliability of measurements. This theory determines the reliability of measures under specified conditions. It is most often used to ascertain the reliability of performance assessment. The generalizability theory assesses the measurement error by having a wide view on various potential sources of this error. The generalizability theory was developed by Cronbach between 1950 and 1960 as he worked on reliability. Cronbach criticized the concept of taking the observed score to constitute of both the true score and the error as he emphasized that even the true score is also error bound. The theory also dwells on the fact that test takers performance in a particular test can be influenced by the diverse aspects involved in the test administration and this will come as backdrop of questioning the consistency of students' performance over time (Kupermintz, 2003).

The generalizability theory became further broadened when Cronbach noticed that systematic variations which could potentially affect test performance is covered up by the error term which is undifferentiated, that is the error term not being specific in pinpointing the source of the error poses a problem. In order to get plausible solutions to this, he into a working collaboration with two other people and thus came out with a 'random model' which resolved the complexities of the error variance. This random model is what is called the generalizability theory which is a comprehensive statistical framework which could be used to identify measurement error, and which is built on both mathematical and psychological bases (Shavelson, 2003).

In line with this study, the generalizability theory makes it clear that errors in the scores or grades students' score in the standardized examinations such as the GCE or BAC examinations or semester examinations in the engineering school could be due to errors from sources such as the various aspects involved in test administration, or test construction amongst others. Therefore, from this theory, the predictability of students' academic performance in engineering by their high school results could be affected by measurement errors which could be brought about by some aspects involved in test construction, test administration or even at the scoring stage. This theory therefore has the proficiency of pinpointing the sources of various errors so that amendments could be made to ameliorate reliability. The different examination boards have their own different modus operandi of administering their examinations and thus, a difference in the level of predictability of the examinations from these two different examination boards could be due errors streaming from different sources.

The Item Response Theory (IRT) is another theory used in this research work. This theory is also called the modern test theory. Unlike the classical test theory and the generalizability theory which focus on the evaluation of the quality of observed test score, the item response theory focuses on estimating the score of the latent trait (Suen and Lei, 2007). The concept of Item response functioning came into existence before the 1950. The pioneers who fostered the development of the item response theory between 1950 and 1960 were; Frederick Lord who was a psychometrician in the Educational Testing Service, Georg Rasch who was Danish Mathematician and Paul Lazarsfeld who was an Austrian sociologist. The research works on the IRT were further pushed forward by David Andrich and Benjamin Wright. The IRT only became widely used in in the 70's and 80's when it was widely realized that with the computer the IRT could be easily used and when the importance of the IRT was widely felt. The main focus of the IRT is to assess the efficiency of each item in assessments and the overall role they play in the assessment. Psychometricians make efficient use of the IRT in designing exams and even preparing question banks which could be used in future exams. Through the IRT, the psychometricians would be able to know the difficulty level of each item and the level to which each item discriminates, so that equivalent forms of exams could be prepared with relatively equal levels of difficulty which could subsequently be used for future examinations. This thus lays the bases for standardized examinations where results of various sessions could be compared upon (Hambleton et al, 1991).

The IRT principally provides information pertaining to the difficulty level of each item in a test via the item difficulty index and the extent to which each item in a test discriminates, which is measured via the item discrimination index. This theory strongly finds a place in this work because if the grade a student scores in the GCE or BAC examination comes as backdrop of an examination with inappropriate difficulty or discrimination indices, then that particular grade certainly lacks reliability and consequently validity and might not predict appropriately students' future performances.

The theory of attribution of Weiner is another theory which finds a place in this study. This theory focuses on how individuals perceive happenings and how this affects their general thinking pattern and behavior in general. This theory which is considered a paradigm for research in psychology and related fields was developed by Weiner and his colleagues. Weiner's focus was on attribution to achievement. He clearly stated that the difficulty level of tasks, effort, ability and luck as the principal factors which influence attribution to achievement. Weiner used three dimensions to classify attributions which were; locus of control, stability and controllability. That is, in general the inner drive a person has in relation to him or her being in control of a particular situation, whether he or she considers the aspect under consideration as permanent or not and whether the person has the believe that he or she is in control of situations under consideration (Weiner, 1974).

In relation to this study, if students of engineering at university attribute their success in the GCE or BAC examinations to aspects which are under their control and which they know such aspects could be determined from within, and when they also know that undesirable aspects linked to their high school results are not stable, they will eventually know how well to carry out their academic activities in order to have desired results. That is, in realistic terms, when engineering students attribute their success in high school to factors like hard work, they will eventually know that working hard at engineering school will give them success, but if they attribute their success in high school to factors which are not stable and which are not under their control like gifts, when those things will not be available in the engineering school, they might not perform as well as they did in high school and consequently their performances in engineering school might not be a reflection of their academic performance in high school.

The theory of constructivism by Lev Vygotsky (1896-1934) is one of the theories used for this study. The theory of constructivism in general is rooted in epistemology. According to this theory, cultural and social environment strongly affect the knowledge and experiences of learners. Learners therefore construct their own knowledge out of their experiences and interaction with the environment. This theory lays emphasize on sociocultural learning. That is how through the interaction with teachers per say, intellectually more apt peers, and cognitive tools could help the learner cross the zone of proximal development by internalizing and forming mental constructs. The concept of instructional scaffolding was later brought up as a follow up by Jerome Bruner and other psychologists. The concept of scaffolding just goes further to buttress the importance of the informal learning environment which aids, supports or scaffolds learning that are withdrawn in piece meal as they become internalized (Seifert and Sutton, 2009).

In relation to this study, if in high school a student had a relatively favourable social learning environment that helped him or her to easily internalize in order to easily cross the zone of proximal development and if at engineering school he or she doesn't have a favourable social learning environment, the high school results might not predict to a high extent the students' performance in engineering.

The expectancy value theory is also used in this study. This theory was created with the rational of explaining and predicting people's attitudes towards objects and actions. This theory was developed by John Atkinson in a bid to understanding the extent to which individual's achievements are tied to their motivation (Ecles, 1983). From this theory, students' achievement and their choice of activities gearing towards achievement is primarily based on two factors which are their expectancies for success and the values they attribute to success. Expectancy here refers to the confidence possessed by an individual in carrying out a particular task while value here is a measure of how important, useful or enjoyable a person interprets a task. From theoretical and empirical research works done, pertinent outcomes such as academic achievement, and continuing interest could be predicted by expectancies and values (Trautwein et al., 2012).

In line with this study, if a student in high school had confidence in passing his or her GCE A/L or BAC examinations brilliantly, that self-belief would have certainly propelled the student to academic excellence and if in the engineering school at university, he or she does not have confidence in performing well in engineering, then the results from the engineering school may not be as brilliant as that scored in high school. Consequently, the high school results may not adequately predict performance in the school of engineering.

Furthermore, another theory used in this study is the social cognitive career theory. This theory was bought to the lime light by Lent, Brown and Hackett in 1994. This theory emanated from Bandura's social cognitive theory in which he hypothesized that a person's self efficacy is found between their self belief of carrying out a particular task and their ability of actually carrying out that particular task, he also postulated that a person's self efficacy could be brough about by their previous performances, by observation, through being persuaded by others, and from physiological states and arousals. Bandura further emphasized that self efficacy is different from outcome expectations as a person could strongly believe on a particular behavioural outcome but the outcome is not finally brought to actualization because he or she did not have the self efficacy to accomplish the tasks (Fouad, 2014). Hackett and Betz (1981) first applied Bandura's social cognitive theory by examining the effect of self efficacy to career choice. In their study, they postulated that the limited career choices which women have could be due to their low self efficacy. From their study on seff efficacy and career orientations, together with outcome expectations, a more wholistic theory was then developed which embodied self efficacy and outcome expectations with respect to career orientations. This theory is what is called the social cognitive career theory and was developed by Lent, Brown and Hackett in 1994.

The social cognitive career theory explains the effectiveness of a students' self efficacy, interests, outcome expectations, social supports and barriers on students' decision on following various career paths. In line with this research work, student's motivation for engineering studies should definitely come from their self efficacy towards engineering, interests towards engineering, their outcome expectations upon offering the engineering program at university, and social support from family, friends, peers and mentors.

Contextual Background

In Cameroon today, all hands are being put on deck to make sure that the country emerges by the year 2035. Appropriate stakeholders thus are trying to make sure the technological growth of the country tremendously increases. The emphases on science and technology in Cameroon became more prominent in the era of the new deal government when the president of the Republic of Cameroon in 1984 emphasized that priority should be given to the mastery of science and technology in order to ensure the independence and progress of Cameroon in the modern world (Biya, 1984). This view was further reiterated by Ndam (1995) as cited in Tambo (2003) that in a modern world which is ever changing and highly competitive there is need for technological competence to be able to compete. Part III section 25 of Law No. 98/ 004/ of 14 April 1998 laying down guidelines for education in Cameroon further reiterated this assertion by stating that the education provided in schools shall take into account scientific and technological advancements and shall be tailored in terms of content and method to national and international economic, scientific, technological, social and cultural trends (Cameroon, 1998).

With the advent and usage of the computer and its accessories like the internet in the in the 21st century, technological advancements worldwide took a different turn and a third world country like Cameroon could not be indifferent to such a global change. In order to foster 21st century scientific and technological growth, Cameroon in recent years has seen the birth of more technical secondary and high schools and the promotion of the teaching of STEM subjects, that is subjects related to Science Technology, Engineering and Mathematics in secondary, High schools, and universities, and the introduction of new subjects into the school curriculum like Computer science and ICT. According to the Education and Training Sector Paper (2013-2020), secondary general education should be tailored in such a way that students' access into science and technology fields should be increased, young girl's access to science and technology streams should also be increased, the paper also laid emphasize on the strengthening of the teaching of science by creating and operationalizing ten science high schools by 2020, and strengthening Cameroon's school system while building on the practices of the two sub-systems (Cameroon, 2013).

Cameroon started with just one Engineering school, that is, the Advanced school of Engineering of the university of Yaounde 1 created in 1971. Today there are a good number of Engineering schools in Cameroon. In to foster the attainment of the millennium development goals via technological development, these Faculties (schools) of engineering are created in view of fostering technological, growth and to solve pertinent societal issues. Amongst these Faculties (schools) of engineering are: the Faculty of Engineering and Technology of the University of Buea with two engineering departments which are; the departments of computer engineering, and the department of Electrical and Electronic Engineering, the National school of Engineering in the University of Maroua which was born out of the Institute of Sahel in 2017 to solve the problems of the Sahelian populace of the Northern part of the country and Neighboring countries like Chad and Nigeria. The National Higher Polytechnique Institute (School of Engineering) of the University of Bamenda, The Faculty of Agriculture and Agronomy of the university of Dschang which trains Agricultural engineers, the Faculty of Engineering of the Catholic university in Bamenda, and the Faculty of Engineering of the Protestant of the protestant university in Bali. Apart from these classical Faculties of Engineering, there are other institutes and Colleges which offer Engineering technology related programs throughout the National territory. such as: the school of

Post and Telecommunications in Yaounde, the National Advanced school of Public works in Yaounde with the Annex campus in Buea. The University institute of technology (IUT) in Douala, the University Institute of Technology (IUT) of the university of Ngaoundere, the University Institute of technology (IUT) Bandjoun, the University institute of technology(IUT) Mbalmayo, the college of technology (COLTECH) of the university of Bamenda, the college of technology (COLTECH) of the university of Buea and the Ecole National Superieur d'Agronomy Industriel (ENSAI) of the University of Ngaoundere.

The above highlighted institutions are either Public institutions, that is, owned and managed by the state, or are private higher education institutes which are either owned by private individuals or are conventional, that is owned by a missionary body. Being either a public higher education institute or a private higher education institute, they are all out for the promotion of science, culture and social progress as well as other pertinent objectives of higher education as stipulated by Law No.005 of 16th April 2001 to guide higher education in Cameroon (Cameroon, 2001).

In Cameroon students are admitted into schools of engineering at two levels, that is either into the first cycle with high school certificate or into the second cycle with a Bachelor's degree. Students admitted into the first cycle could either be from the GCE A/L background or the BAC background. Students liable for admission could have either studied technical education in secondary and high school in which case they will be admitted with the GCE A/L technical certificate or could have studied general sciences in the secondary and high school, in which case they would be admitted with either a GCE A/L certificate in general sciences or the BAC certificate in general sciences. Consequently, those with technical industrial background get into departments of the specialties they did in the technical high school which could either be BAF1 (mechanical fabrication), BAF2 (Electronics), BAF3 (Electrotechnics), BAF4-BA(Civil engineering with Building construction as option) BAF4-BE(Civil engineering with office study as option), BAF4-TP(Civil engineering with option as Public works) BAF5 (Refrigeration) or BA MAV in the case of BAC exams and GCE technical in the various fields in the case of GCE exams. While students who did the general sciences be it in the BAC exams in which case they could have offered either BAC (Mathematics and Physical sciences), BAD (Mathematics, earth and life sciences), BAE

(Mathematics and Technology) or BATI (Information Technologies) (OBC, 2018). Practicals of subjects such as SVT, Infomatique and Chimie are optioanal alongside drawing. Being the GCE exams the students could have offered either S1 (Physics, Chemistry and Pure Mathematics), S2 (Biology, Chemistry, Physics), S3 (Biology, Chemistry and Pure Mathematics), S4 (Biology, Chemistry, Geology), S6 (Chemistry, Physics, Mathematics and Further Mathematics), S7 (Chemistry, Biology, Physics and Mathematics) and S8 (Chemistry, Biology, Physics, Mathematics and Further Mathematics) (C.O.S.U.P, 2019) other subjects such Information and Communication technology, Computer science or Religious studies could be chosen by the students as additional subjects, with the maximum of five subjects which could be offered. The students from the technical background already have an engineering specialty from high school which they will follow suit in the school of engineering at university but students from the general education background are caught at a junction where they are to choose the branch of engineering to embark on. Thus, posing a problem, which has to do with placements of students from the general science background into various departments of engineering. Moreover, nowadays, most students who find themselves in choosing what to study at university after completing high school are teenagers, and some of them wonder what life is all about and some are even confused what kind of people they would like to become or what kind of goals and objectives they should embrace (Nsamenang, 2016). This therefore means that most of the students especially from the general science background would not actually know what branch of engineering to embark on taking into cognisanze this additional psychological effect. Thus, the use of placement guides which will make use of their high school results which are empirical evidences will be quite fundamental in placing students into the various branches of engineering.

The selection of students into schools of engineering particularly those of state universities or those managed by the state is through a competitive entrance examination in which mostly Mathematics and Physics are written, and a study of academic file is together with the scores of the written subjects are used to select the students for engineering.

The National Higher Polytechnic Institute (NAHPI) of the university of Bamenda which is one of the institutions where this study was be carried out was created by decree No

2017/582 of 24 November 2017. The departments created at the inception were geared at meeting the socioeconomic needs of Cameroonians. The departments of this school of engineering are; Civil engineering and Architecture, Electrical and Electronics engineering, Mechanical and Industrial engineering, Mining and Mineral engineering, and Petroleum engineering and the recently created department of Bio-medical engineering which went operational in 2020. The school runs B. Eng program for four years, a M. Eng program and a PhD in engineering sciences. Admission in this school of engineering is open at all the three levels. In the admission of students into the B. Eng program, is open to all students who atleast have a pass in two A/L or BAC science subjects. Therefore, students with such criteria are fit to sit for the competitive entrance examination.

The Faculty of Engineering and Technology (FET) of the university of Buea is also one of the engineering schools where this research work was carried out. The FET saw the light of the day in 2010 with the creation of two departments which are the department of Electrical and Electronic engineering and the department of Computer science. Three other engineering departments were created in the year 2020, which were the departments of Civil and Architectural Engineering, the department of mechanical and industrial engineering and the department of chemical and petroleum engineering. The Faculty was created with the mission of training engineers who will contribute to the technological as well as industrial advancement of Cameroon. This mission was streamlined into three sub goals, which were; to develop in the engineering students' skills which are of great importance in the industrial sector in the CEMAC zone, to build capacity for job creation in Cameroon and CEMAC at-large, and to produce the man power necessary to realize the Government's vision which is currently gearing towards emergence come 2035. At the inception, students were selected based on the study of their academic files, but as from 2016, the selection of students was based on a competitive entrance examination. The FET of the University of Buea runs undergraduate programs, Master of Engineering programs (M. Eng) as well as PhD programs.

The National Advanced school of public works in Yaounde which is one of the oldest engineering schools in Cameroon was one of the engineering schools used for this study. It was created in 1982 with the mission of training engineers and technicians who will be in charge of public works throughout the national territory. The school runs a higher technician cycle with an annex campus in Buea in the South West region, and through their public works centers in Akonolinga and Garoua Bachelor of Engineering program (B. Eng) and Master of Engineering programs (M. Eng). The school runs programs around civil engineering and Architecture, rural engineering, town planning, energy and environmental engineering, land survey. The engineering school of the Catholic University of Cameroon at Baham which is found in the West region of Cameroon was also used for the study. The engineering school of CATUC in Baham went operational in November 2019. (Catuc, 2020). The engineering school runs departments such as; the department of chemical engineering, the department of civil engineering, the engineering of mining and petroleum engineering and the department of electrical and electronics engineering. The school admits students both from the GCE and BACalaureat backgrounds and the main rout of getting admission is through competitive entrance examinations. The engineering school of the Catholic University Institute of Buea (CUIB) is also one of the institutions which was used for this study. The institution offers B. Sc in the following engineering department: Chemical engineering, Civil and environmental engineering, Electrical and computer engineering as well as mechanical engineering. The institute operates on two campuses, one in Molyko Buea and the other in Bonamoussadi Douala. This study made use of students from the both campuses.

Given the array of engineering departments in the various engineering schools, students are bound to make choices on what particular branch of engineering to embark on. Moreover, the GCE and BAC results could conveniently be used to place the students into the various department, but it is crucial to determine the extent to which GCE A/L and BAC results predict students' performance in various departments of engineering and wether they predict students' academic performaance differently in terms of other aspects such as; students' gender, motivation for engineering and type of high school attended.Thus, determining the predictive validity and differential predictive validity of GCE A/L and BAC results in general sciences will enable stakeholders to know how appropriate the GCE and BAC exams are and will be able to define clearly what particular subject or subjects could best place students into the various branches of engineering.

Statement of the Problem

Industrialization and technological development is what most nations of the world today are striving to foster. Most Western and Asian countries have already gone far ahead in terms of technological development, maintenance and industrialization. There is a saying in China that if you want to be rich, you need to build a road and a bridge. Which is true, as the infrastructural facilities China has built over four decades of reform and opening up have boosted its economic growth and helped it lift more than 800 million people out of poverty (Guimey, 2008). Thus, infrastructure is considered a double-edged sword that can assist rapid economic development. In such countries, Education is not mainly meant for certification but to equip learners with adequate technological skills which could help in the industrialization and economic development of the country in one way or the other. A clear example of such are micro-electronic gadgets like watches, clocks and calculators which are being made by students in countries like China and Japan and in which employment rate of high school graduates in sciences and engineering graduates stand at 95.9% and 91.5% respectively.

In Cameroon, Most science students in secondary and high school are placed in a situation where the mastery of facts seems to be primordial as most of the graduates of high school in the general sciences are not creative enough in the application of science knowledge acquired in high school in the provision of 'petit' jobs for themselves or in the making of micro technological gadgets like their counterparts from technical high schools.

Moreover, some graduates from schools of Engineering in Cameroon are not prolific in applying what they have learnt in order to create jobs for themselves so as to contribute to the technological growth of the country and to the GDP. This is thus a call for concern especially as Cameroon gears towards emergence come 2035

Despite these ought, the government together with appropriate stakeholders have been putting measures in place in order to overcome this debacle. Amongst which are; subsection II of section 3.3.2 of the G.E.S.P(2009), the E.T.S.P (2013) and subsection II of section I of the second pillar of the recently adopted N.D.S.P(2020). These strides were all geared towards the structural transformation of the economy, alleviating poverty and reducing unemployment by making sure that general education is tailored in such a way that students' access into science, engineering and fields of technology should be increased, as well as young girl's access to such fields of study should be increased.

Nevertheless, unemployment still stands at 13% and the youth unemployment rate has instead increased from 4.56% in 2007 to 5.96% in 2016, 5.87% in 2017, 5.79 in 2018 and 5.73% in 2019 (I.L.O, 2019) which is not pleasant

One thus wonders if the curriculum of the general sciences actually prepare students for fields of engineering and technology. Moreover, results of standardized examinations could be used to determine how well a curriculum prepares students for future academic endeavours. Thus, it was quite pertinent to determine the extent to which the curriculum in the sciences prepare students for engineering and fields of technology as stipulated by ascertaining the extend to which the grades students score in the science subjects at the GCE A/L and in the BAC examinations actually predict their performance in engineering given that most of them are not creative enough in the application of science knowledge acquired in high school in the provision of 'petit' jobs for themselves or in the making of micro technological gadgets like their counterparts from technical high schools.

It is against these backdrops that the researcher set out to ascertain the predictive validity and differential predictive validity of high school results in sciences to students' performance in Engineering

Objectives of the Study

General Objective

To determine the extent to which high school results in sciences predict students' performance in engineering and the extent to which these high school results in sciences predict students' performance in engineering differently in terms of gender, degree of motivation and type of high school attended.

Specific Objectives

1) To assess the extent to which GCE A/L results in sciences predict students' academic performance in Engineering

2) To assess the extent to which BAC results in the sciences predict students' academic performance in engineering

3) To determine the extent to which students' high school results in sciences predict their academic performance in engineering differently in terms of gender.

4)To find out the extent to which students' high school results in sciences predict their academic performance in Engineering differently in terms of their motivation for engineering studies.

5) To determine the extent to which students' high school results in sciences predict their academic performance differently in terms of the type of high school they attended

6) To develop regression models for the prediction of students' academic performance in various fields of engineering by high school results

Research Questions

General Research Question

To what extent do students' high school results in sciences predict their academic performance in engineering, and do these high school results predict students' academic performance in engineering differently in terms of gender, degree of motivation and type of high school attended?

Specific Research Questions

1) To what extent does the GCE A/L results in sciences predict students' academic performance in Engineering?

2) To what extent does the BAC results in sciences predict students' academic performance in Engineering?

3) Do students' high school results in sciences predict their academic performance in Engineering differently in terms of gender?

4) Do students' high school results in sciences predict their academic performance in Engineering differently in terms of their motivation for engineering studies?

5) To what extent do students' high school results in the sciences predict their academic performance in engineering differently in terms of the type of high school they attended?

6) What regression models could be used in the prediction of students' academic performance in various fields of engineering by their high school results?

Research Hypotheses

Ho_1: GCE A/L results in sciences do not significantly predict students' academic performance in Engineering.

Ha_1: GCE A/L results in sciences significantly predict students' academic performance in Engineering

Ho_2: BAC examination results in sciences do not significantly predict students' academic performance in schools of Engineering in Cameroon.

Ha_2: BAC examination results in sciences significantly predict students' academic performance in Engineering

Ho_3: High School results in sciences do not significantly predict students' academic performance in engineering differently in terms of gender

Ha_3: High School results in sciences significantly predict students' academic performance in engineering differently in terms of gender.

Ho4: High school results in sciences do not significantly predict students' academic performance in engineering differently in terms of their motivation for engineering studies

Ha4: High school results in sciences significantly predict students' academic performance in engineering differently in terms of their motivation for engineering studies.

Ho5: High school results in sciences do not significantly predict students' academic performance differently in terms of the type of high school they attended

Ha5: High school results in sciences predict students' academic performance in engineering differently in terms of the type of high school they attended.

Justification for the Study

This study was carried out firstly, to find out whether the curriculum of the science subjects in both the English and French subsystems of education adequately prepare students for engineering studies in Cameroon. This is determined through standardized achievement examinations organized for each of the sub systems, which is the GCE A/L for the English subsystem of education and the BAC examinations for the French subsystem of education, and this is in accordance with Schiro (2008) who affirmed that standardized achievement tests determine how well a curriculum prepares students for further academic endevours Consequently, from the findings of this study necessary modifications will be made in adjusting and fine-tuning the curriculum of science subjects in either of the subsystems of education in Cameroon in order to lay better preparatory basis for engineering studies in schools of Engineering in Cameroon.

Also, from this study, clarifications will be made on which of the sub systems of education in Cameroon better prepare students for Engineering studies and what each of the sub systems can copy from each other in order to make science education uniformly taught in all schools. The new dispensations may help children from primary schools to change their negative thoughts about the sciences. Such a shift may make more children to develop interest in technical education which is very pragmatic and the gate way to engineering studies.

Moreover, the non-prolificity of some engineering graduates could be linked to the fact that in Cameroon, students do not really know what particular branch of engineering to embark on in relation to their high school results. Knowing specifically what branch of engineering to embark on basing on aptitudes, attitudes, skills and aspirations could go a long way to improve upon the performance of engineering students and on their output upon graduation. Therefore, this research work will spell out clearly what particular branch of engineering students from high school can embark on in relation to their high school results and consequently the study will provide a placement guide to schools of Engineering for the criteria for selection of students into various branches of Engineering into schools of Engineering in throughout the national territory. These placements will also take into consideration students' gender, their level of motivation for engineering and the type of high school they attended.

Furthermore, this study attempts to ascertain the worthwhileness of the assessment, measurement and evaluation practices of the GCE board and BAC board in relation to the examinations, that is the GCE A/L and the BAC exams organized by the respective examination boards. This is elaborated in this study by examining the psychometric property of predictive validity which is a kind of criterion validity of these examinations. Thus, if there is no adequate predictive validity of the GCE examinations or the BAC examinations in the sciences, then other psychometric properties of the exams such as the reliability, content validity, concurrent validity and even the face validity have to be looked into. All this will lead to the fine-tuning of the processes of assessment, measurement and evaluation as well as the setting and vetting of these respective examinations if need be.

Also, in the USA and in other Western countries, almost all universities and colleges select applicants for admission through standardized tests. For example, in the USA, the SAT is commonly used as a standardized test for the selection of undergraduate students while the GRE is used as a standardized test for the selection and admission of Post graduate students (Lydia, 2005). In Cameroon standardized tests are not principally used for the selection of students into the undergraduate programs into schools of engineering. Therefore, coming up with a framework in this study where students could be placed into various engineering programs with the use of the GCE A/L and BAC results, the aforementioned examination results could then be hitherto used for the selection and admission of students into engineering schools since the GCE and BAC examinations are standardized examinations.

Significance of the Study

Knowing the students who will suit for engineering studies with respect to their high school results beyond other aspects is quite pertinent for the educational and technological growth of every nation. This study which is aimed at determining the predictive validity of two high school end of course examination results in sciences which are the GCE A/L and BAC results in sciences to students' performance in engineering is highly significant to students, parents, policy makers, the examination boards, which are the GCE and BAC boards, the administration of engineering schools, and the society at large.

Significance to Students

This study will guide and orientate the students on what subjects to study in the high school or what particular science series to offer with respect to what particular branch of engineering they have passion for or wish to study in the engineering school. Moreover, the study will also help students to know whether to take their studies in high school seriously or not, since the high school could serve as a preparatory base for engineering studies.

Significance to Policy Makers

From this study, policy makers will be able to better fine tune strategies to be used for the selection of students into various branches of engineering. It will also bring to cognisance to the policy makers and make them better identify students who could be potential high academic achievers in engineering studies in relation to their high school results in sciences and those who will potentially not make use of the admission offered them through relatively low performances in engineering studies. Consequently, policies for the recruitment of students into schools of engineering could be reformulated.

Significance to Parents

This study will also provide sufficient information to parents which will aid them better guide and orientate their children on what particular branch of engineering to embark on with respect to their high school results and will also help them know what particular subjects at high school they have to aid their children more in by providing for them adequate text and work books and other learning aids which will adequately suit the particular branch of engineering which they want them to embark on. Furthermore, from this study, parents will be able to decide on which of the subsystems of education they will want to enrol their children to with regards to the predictive nature of the GCE examinations from the English sub system of education and the BAC exams from the French subsystem of education.

Significance to the GCE Board and the BAC Board

This study will provide pertinent information to both the GCE board and the BAC boards on how the final results derived from examinations they organize could be valid in predicting future performances. From these, the respective examination boards will be able to know if the grades they allocate in end of course examinations predict as they ought to, that is if they have adequate predictive validity. Therefore, if the predictive validity is questionable, the respective boards have to consider other psychometric parameters such as, the reliability of the exams, the content validity of the respective examinations and even the methods used in assessing candidates, methods employed in the marking of scripts and also the extents to which deliberations are made in order to pass valued judgements (evaluation), in the respective examinations

Significance to the Engineering School Administration

The findings of this study will give precise guidelines to the administration of engineering schools on how to select students into the various branches of engineering with respect to the results students scored in end of course high school examinations. It will also help them easily orientate students on what branch of engineering to embark on with respect to their respective high school results in science subjects.

Significance to the Society

Societies nowadays are custom to rapid technological changes and innovations therefore educational aspects like science, technology, engineering and mathematics which could lead to rapid technological growth will be highly applauded and welcome by the society. The study will also help the society to be able to know how much importance it has to place on end of course examinations like GCE and BAC examinations in relation to the predictive power of their results to institutions of higher learning like the engineering schools.

Scope of the Study

The geographical scope of the study is Cameroon and specifically five Regions within the Republic of Cameroon which lay host of engineering schools used for the study. These Regions are the North-West Region, the West Region, the South West Region, the Littoral Region and the Centre Region.

Conceptually, the scope of the study embodies students' academic performance in the GCE Advanced level in Physics, Chemistry, Mathematics, Further Mathematics, Geology and Computer science and BAC examinations in Physique, Chimie, Mathematique, SVT, and Informatique and how they predict students' academic performance in the 1st and 2nd years in schools of Engineering, that is assessing the predictive validity of the GCE and BAC exams. The study also makes use of the concept of differential predictive validity. That is, it evaluates the differential predictive validity of GCE and BAC results in terms of gender, high school type and the effect of motivation on the predictability of students' performance in engineering by high school results. Generally, this research work dwells on concepts such as: assessments, tests and test practices, measurements, Evaluation, validity of tests, laying emphases on predictive validity and differential predictive validity, reliability of tests, Cameroon GCE examinations, Cameroon BAC examination, motivation, Engineering education, technological development and academic performance in engineering which will be limited to six branches of engineering namely; Civil engineering and Architecture, Computer engineering, Electrical and Electronics engineering, Mechanical and Industrial engineering, Mining and mineral engineering, as well as Petroleum and chemical engineering.

The theoretical scope of the study revolves around the following theories; the classical test theory, the item response theory, the attribution theory, the theory constructivism theory by Lev Vygotsky, the value Expectancy theory and the social cognitive career theory.

Operational Definition of Terms

High School Results

Students' academic performance in the GCE A/L and BAC examinations, expressed in the grades they score at the GCE exams and the mark scored or 'mention' in the case of the BAC exams.

Validity

Refers to what is assessed and how well this corresponds with the behaviour or construct that it is intended to test (Harlen, 2005).
It simply refers to the appropriateness of an instrument to measure what it is supposed to measure

Predictive validity

It refers to the relationship between test scores and later performance on ability, skill, or knowledge (DeVellis, 2011). It could also be seen as the ability of an assessment tool to predict future performance either in the same activity or on another assessment on the same construct
It refers to the extent to which a measure or score predicts future performances (Brown and Coughlin, 2007). In this study, it refers to the extent to which GCE A/L results and BAC results in sciences predict students' academic performance in engineering schools.

Predictor

It is an independent variable which is used to forecast a dependent variable called the criterion variable. Example, in this study, the high school results which are depicted by the grades are the predictors which intend predict students' GPA in engineering

Criterion

This refers to what the predictor predicts or foretells, thus it is the dependent variable in predictive validity studies.

Differential Prediction

To Linn (1978) differential prediction arises when there are differences in the lines of best fits of regression equations or as a result of differences in standard errors of estimate found between the various groups of test takers.

This is a situation which arises when even the best prediction equations, that is equations linking the predictor variables to the criterion for the different groups within the population are different and when there is significant difference the standard error of estimates for different groups of examinees.

Differential Validity

This is when the calculated validity coefficients are different for different groups of examinees. Example, if the validity coefficient for male students are different from those of the female students, then differential validity exists

Differential Predictive Validity

It is the measure of the extent to which a test is predictive for all groups but to different degrees. That is, it represents the predictive validity for the different sub groups within the population.

Differential Prediction

It is the existence of findings where the best prediction equation and or the standard errors of estimate (SEE) are significantly different for the different groups of examinees (Young and Kobrin, 2001). In this study, differential prediction refers to the existence of prediction equations or models or Standard errors of estimates which are different for different groups in the study, that is, there could be significantly different SEE for the prediction of students' academic performance in engineering by their high school results for students with varryng degrees of motivation, or for the different categories of gender which are male and female or for the different types of high school attended, be it Public, mission or lay private

Regression Model

It is a prediction equation derived from regression analyses which links the predictor variables to the criterion. Example, an equation showing the relationship between test scores and final GPA

Over Prediction and under Prediction

These concepts are talked of when after comparative findings, the use of common prediction equations or models yields significantly different results for different groups of examinees. Over prediction is said to occur when the residuals computed from the regression model is negative while under prediction is said to occur when the residuals are positive.

School of Engineering

A school or Faculty specialised in the training of engineers in various engineering fields and whose graduates are certified at the end of their training with a Bachelor of Engineering degree (B. Eng), a Master of Engineering degree (M.Eng) or a Ph.D in Engineering.

Motivation

In this study, it refers to a measure of students' interest and likeness to study engineering. It also refers to the process by which students' interest to study Engineering could be aroused, sustained and regulated. In this study the degree of motivation for engineering studies is classified into three categories which are; highly motivated, moderately motivated and lowly motivated for engineering studies

Academic Performance in Engineering

It is the outcome of education. It measures the extent to which a student or institution has achieved its pre-determined educational goals. In this study, it is measured in terms of the GPA students score in the 1^{st} and 2^{nd} years in Engineering.

Test: It is a task or set of tasks or questions intended to elicit a particular behaviour when presented to learners under standard conditions.

Examination: A set of questions or exercises to gauge understanding on knowledge, or skill or ability.

Standardized test: Refers to a test that is administered and scored in a consistent manner to ensure legal defensibility (Popham, 2001).

Type of High school: In this study, type of high school refers whether the high school is owned by the government, that is a public school, or is privately owned which in this case would either be a lay private or a mission schoo

CHAPTER TWO

REVIEW OF RELATED LITERATURE

Introduction

This chapter focuses on some key concepts, relevant theories and empirical studies. The chapter is therefore divided into four rubrics indicated below:

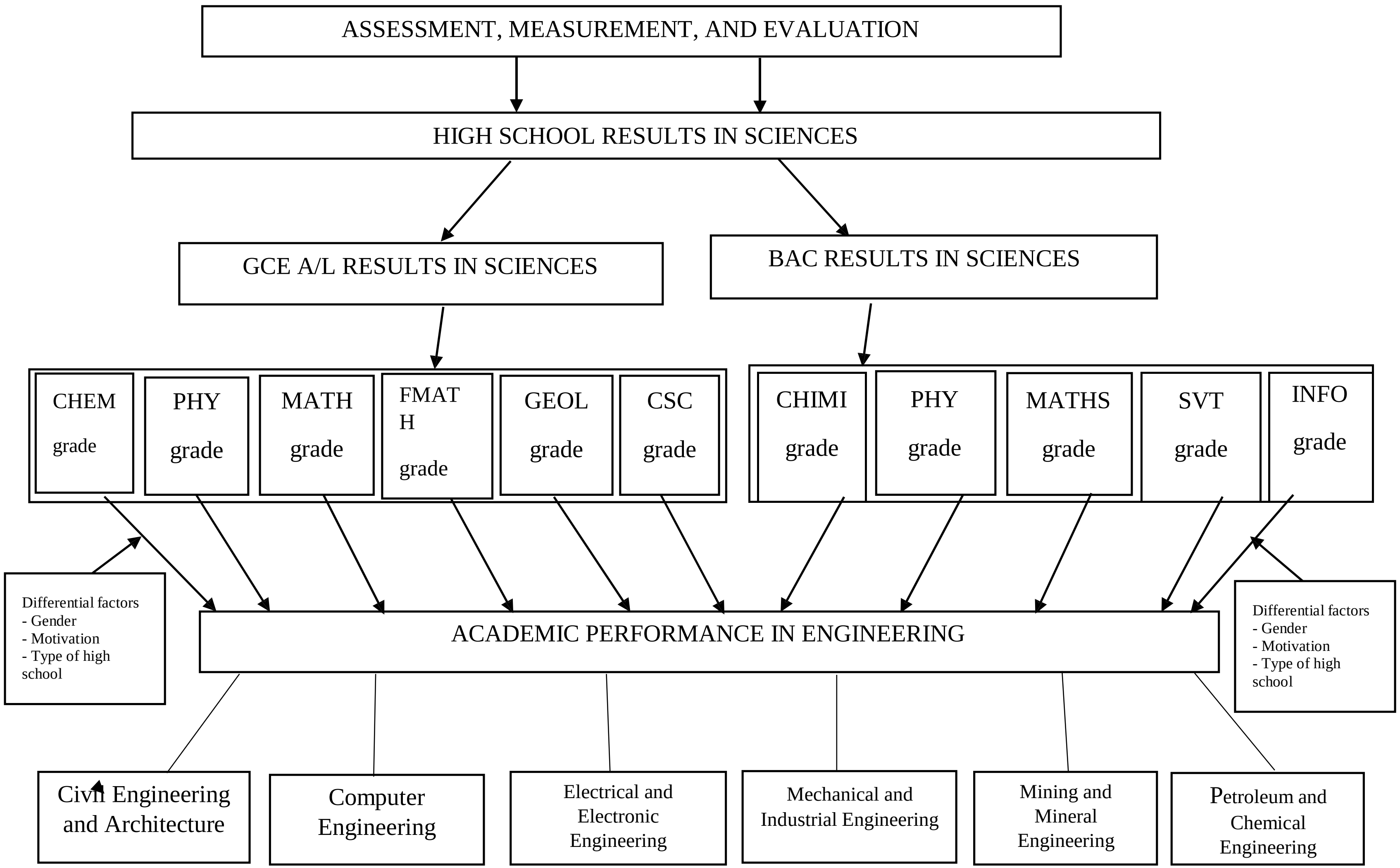
- The Conceptual review
- The Theoretical Framework
- Empirical Review
- Appraisal of Literature

Conceptual Review

When students are getting into high school, they choose subjects that will pave the way into their future dream careers. Students of general education who aim at engaging into engineering studies in the university engage in the offering of science and Mathematical oriented subjects such as Physics, Chemistry, Mathematics, Computer Science amongst others. Before students get admission into Engineering schools, they must have been certified by the GCE board to have had the GCE A/L or the BAC board to have had the BACalaureate. The grades students score in these examinations come as a product of the processes of assessment, measurement and evaluation. This study which is out to determine the predictive validity of these grades to students' performance in various branches of engineering, use these grades as predictors to student's academic performance in engineering which is the criterion or dependent variable. In order to better elucidate the predictive validity of these high school results, the differential predictive validity of these high school results was also assessed in relation to gender which is a background variable and students' motivation for engineering studies and the type of high school the students attended.

Figure 1

CONCEPTUAL FRAMEWORK



The following concepts will be elaborated upon in the work

The concept of Assessment

- The concepts of tests and testing practices
- The Cameroon GCE examinations
- The Cameroon BAC examinations
- Characteristics of effective assessment instruments; Validity, Reliability and Usability
- The concept of measurement
- The concept of Evaluation
- The concepts of motivation
- Engineering Education
- The concept of Academic performance

The Concept of Assessment

According to Reynolds and Kamphaus (2003), Since the beginning of recorded history, the assessment of human characteristics has been part and parcel of the educational enterprise. Oral questioning at response at the time was what was used in ancient Greece and Rome in order to measure intellectual capabilities. This is because until the late 1800s, writing materials were not very widely available for usage, thus oral questioning is what was widely used. Until 1900, pencils and papers were rare commodities. Therefore, before this period it was not possible to use written tests as assessment strategies to assess performance (Hogan, 2007). Hogan opined that the assessment curriculum content was simply done by oral quizzing. With the passage of time, oral quizzing was brought to the lime light for scrutiny and it was observed that it was just a suitable way of assessing learners in elementary schools. It was further argued that oral examination was not well developed and fell short of some basic assessment requirements like the usage of assessment to adjust the curriculum (Hogan, 2007).

Assessment in the educational cycle especially in American public schools experienced a marked development in the 1900's. During this period, the curriculum was shaped by the economic needs of the society, consequently, the curriculum was designed in such a way that people would be taught specific skills which were needed in the society (Shepard, 2000). Therefore, the curriculum used at that time in schools was the society based curriculum. With regards to this, there was then the need to test and assess skills and knowledge in order to ascertain the extent to which learning is or has taken place with the use of precise standard measurements. This thus led to the development of objective tests by Thorndike and his students. These tests were quite dominant and were regarded as a very striking feature of achievement testing in the USA (Reynolds *et al*, 2003).

More than 2000 years ago, the term assessor was ascribed to the lawyer who sat beside the magistrate and gave instructions on administrative laws in the Roman Province. Today, concept of assessment is also used in the educational milieu, and it means sitting beside the learner in order to teach and describe to him or her, observe his or her behavior, collecting and recording information pertaining to his or her learning progress, scoring and interpreting information about learner's performance (Dreyer, 2008). That is why for a plethora of people, the word assessment brings to their minds images of learners taking tests with the use of paper and pencil, and grades being assigned by the educators to the students after scoring the tests (Airasian, 1994). Though the main assessment tools used are the tests and examinations, some schools of thought still hold strong to the assertion that there is more to classroom assessments than giving tests in order to evaluate students' performance (Marce and Fraser, 2004).

Assessment as used today is seen generally as the process of systematically gathering information. It is a very important element in the teaching-learning process which gives teachers the opportunity to evaluate their teaching methods and equips them with the necessary information pertaining to learner's progress (Alahmadi, Alrahaili, and Alshraideh, 2019). Assessment could also be seen as the process of using tests to collect and analyze information for the purpose of determining how much pupils have learned about a given subject or the skills they have acquired for performing certain tasks (Snowman and Brehler, 2000). Johnson (2009) defines assessment as the use of various procedures to collect information about learning and instruction. Also, according to Dreyer (2008), assessment refers to process through which educators collect information concerning students' learning in order to understand better the learners, monitor and follow up their performances and to make a viable classroom environment.

To Tchombe (2019), assessment is an activity carried out in order to get facts concerning conditions that exist within a particular time. Pertaining to educational settings, she sees assessment as the process of determining the extent to which students have made progress in attaining stipulated goals and in the classroom context in particular, it refers to the processes and products which could be used to ascertain the extent to which students have learned with respect to the objectives of instruction

Nowadays the objective is to move from summative assessment to formative assessment modes. This simply means that the goal of assessment is gradually shifting from just getting information about students' achievement to bringing forth information about students' learning in order to improve, modify and direct the teaching, learning process. This implies a paradigm shift from predicting and controlling to a new ground where meaning and understanding is at the center of the instructional process, thus, shifting away from teacher centered instructional designs and the disposition of students to memorization, (Dreyer, 2008). This shift therefore takes assessment to current trends which emphasize assessment which is learner centered, ongoing and promotes critical thinking (Hogan, 2007). This shift also makes assessment more dynamic, as it shifts it from a one-dimensional position which is focused only on knowledge to assessment which also dwells on measuring learner's attitudes and values (Marce and Fracer, 2004).

Nworgu (2015) opines that assessment is a systematic process of gathering data from a variety of sources in order to understand, describe and improve learning. This conception of educational assessment implies that it:

- Encompasses both measurement and evaluation
- Decisions or judgments are made based not only on one single measurement or source of data but on multiple measurement sources of data. In that sense, assessment is broader than either measurement or testing.
- It has two major purposes namely; to understand and describe or summarize learning and to improve learning.

Moreover, there are aspects which could affect assessment negatively, that is, because of these aspects, assessment may not be as reliable as it ought to be. The first of these aspects is the obsessive focus on competition. This implies that when those to be assessed are too focused on competition, they might be put under unnecessary pressure and might not be at their best at the time of assessment. The next aspect is the fear of failure on the part of the low academic achievers. This will definitely negatively affect assessment because those to be assessed will not be psychologically balanced at the time of assessment (Black and William, 1998)

Building from all the above illustrations, assessment could be seen as the process of determining the extent to which a given task has been accomplished. In educational contexts, objectives are set at the beginning of the teaching- learning process, therefore, determining the extent of accomplishment of the educational objectives is what is referred to as assessment. This is done with the use of assessment tools such as tests. Determining the extent to which educational objectives have been attained could be done in short intervals or could be done after longer periods. Assessments generally carried out in very short intervals are aimed at aiding the learning process, while those carried out after longer periods are aimed at determining how efficiently learning has taken place. Therefore, assessment could be summative or formative

a. Formative Assessment

Formative assessment or assessment for learning is that assessment undertaken while a lesson, course or program is still in progress or on-going in order to collect relevant data and using the feedback to improve learning, course or program. According to the FAST (Formative Assessment for Students and Teachers), SCASS (State Collaboration on Assessment and Student Standard) group, it is a "process used by teachers and students during instruction that provides feedback to adjust on-going teaching and learning to improve students' achievement of intended instrumental outcomes" (Nworgu, 2015). Also, Tahir et al (2012) define formative assessment as that diagnostic assessment used with the aim of providing feedback to both teachers and students during instruction. According to Tahir *et al* (2012) formative assessment takes place in the course of instruction while summative assessment takes place at the end of instruction.

Marsh (2007) opines that formative testing refers to a collection of strategies designed and used in order to identify students' learning difficulties so as to make the necessary remediation in order to make improvements in majority of the students' performance. In the same light, Kathy (2013) purports that formative assessment or testing aims at improving students' academic achievement by analyzing their learning difficulties. Formative assessment focuses on the monitoring of students' responses and their learning progress with respect to instruction, it is also a source of immediate feedback to both the teacher and the learner with regards to the teaching-learning process (Olagunju, 2015). Moreover, a successful formative assessment could be achieved through the use of quality assessment tools and the subsequent and effective use of information derived from these assessments in order to make better teaching and learning (Christiana *et al*, 2015)

According to Karimi (2014), formative assessment is one of the vital ways through which the processes of teaching and learning could be improved. It is carried out to assess students' learning needs, to follow up their progress and to assess their understanding in relation to what they have been taught, so that concrete and adequate remediation could be made.) Also, formative assessment helps the teacher to identify the particular areas where students have not yet mastered or where they are facing challenges which could impede their acquisition of the required competencies (Newton, 2007). Formative assessment thus gives feedback to the students and teachers in relation to the instructional process, so that the gaps between the learning process and the desired learning outcome could be narrowed. In another dimension, formative assessment could be seen as that avenue which gives the teacher the opportunity to make relevant judgements pertaining to students' ability and subsequently decide what adjustments and improvements should be done in order to take the students' learning achievement to the highest standard (Widiastuti, 2017).

This falls in line with the ideas of Filsecker and Kerres (2012), who see formative assessment as the major means of collecting detailed information about the teaching and learning processes which could further be used to Improve upon instruction and to pave the way for students to attain the highest learning standards which could help them in their future learning. Formative assessment is therefore a limelight for instructional modification with the sole aim of easing the teaching- learning process so that instructional objectives would easily be attained. It could thus be seen as a methodological piece meal evaluative process aimed at the accomplishment of learning objectives.

Judging the effectiveness of formative assessment from a theoretical perspective, teachers are supposed to be proactive in the classroom in order to give students the necessary support they need while learning new things, so that they will stand a better chance of independently using the knowledge (scaffolding) (Vygotsky, 1978). Also, students ought to be given thoughtful and reasonable feedback on both correct and incorrect responses. The feedback coming from the environment will have an effect on the students' person which will in turn affect his or her behavior. Thus, there will be a continuous reciprocal interaction between the environment, personal factors and behavior (reciprocal determinism), (Bandura, 1986). Such effective interaction will in turn foster learning. Students also need to reflect on the feedback given them by the teachers and on their performances, so, they have to be given more time to reflect (metacognition) then after, work with the teacher so as to become more competent in performance (scaffolding)

Gronlund and Linn (1990), consider formative assessment to serve three significant purposes which are: to plan corrective strategies of overcoming learning deficiencies, to motivate learners and to improve upon retention and subsequently transfer of learning. They see the implications of formative assessment to have an effect on both the learner and the teacher. That is through formative assessment, the teacher will fine-tune his pedagogic techniques as corrective strategies of overcoming students' learning difficulties. Also, the formative assessment scores will motivate learners especially those who doubted their capabilities, but, their scores made them see they indeed have a worth and will also make those who were asleep in relation to their academic work to sit up especially when they see their low scores in relation to the scores of their mates. Moreover, formative assessment will also greatly improve on students' retention power and putting into practice what they have studied as they will be called up now and then to prepare and write tests.

Also, according to Jacob and Isaac (2005), an important aspect of formative assessment is feedback. They stipulated three aspects which should be looked into in order to make efficient use of feedback, these aspects; recognition of the desired goal, evidence about the present situation and closing the gap between the desired goal and the present situation. That is before deciding on what to do next after haven gotten feedback, the assessor needs to first of all reflect on the goals and then relate the goals to the situation at hand before striving to close the gap in order to make the goals a reality.

The following features could be attributed to formative assessment

- Formative assessment is a process, not any particular test
- It is used not just by teachers but by both teachers and students
- Formative assessment takes place during instruction
- It provides assessment based feedback to teachers and students
- The function of this feedback is to help teachers and students make adjustments that will improve students' achievement of intended curricular aims
- It is of two types- Assessment for Learning (AFL) and Assessment as Learning (AAL).

b. Summative Assessment

Summative assessment according to Atkin, Black and Coffey (2005) is that assessment given at the end of a particular learning period in order to measure the extent to which learning has taken place, and this measure is often denoted by a score which is a quantitative representation of how much the learner knows in relation to the subject matter. Kibble (2017) defines summative assessment as that which is usually applied at the end of instruction in order to evaluate students' learning. He considers summative assessment as high stakes for all those concerned especially the learners whose performances are judged, the data from summative assessment may also be used to drive course improvement, to assess the effectiveness of teaching, and for program-level assessment such as accreditation. Also, Black, Harrison, Lee, Marshall, William, (2003), see summative assessment as that periodic assessment used at particular time periods in order to determine what students know and what they do not know. Their view limits summative assessment to only identifying what learners know or not at the end of a particular time period, consequently their definition does not really make clear the difference between summative and formative assessment. According to shepard (2006), summative assessment amongst other obligations should fulfill its principal purpose of documenting what students could be able to learn or what they know at the time of assessment and what they don't know and if explicitly done should also meet a secondary purpose of support for learning. This secondary purpose re-iterates the fact that summative assessments could have aspects of formative assessment. This falls in line with ideas of Kibble (2017) who buttress the fact that assessment falls somewhere between pure summative assessment and formative assessment. He emphasized that there exists a continuum between the two forms of assessment depending on the main purpose of the assessment, but bringing to cognizance the fact that feedback to learners in relation to the assessment should be a feature common to both types.

Generally, summative assessment or assessment of learning is that assessment carried out to determine what students have been able to learn after the end of a given lesson, unit, program or period. Examples are the GCE and BAC examination which is written at the end of secondary and high school in the Cameroonian context.

Summative assessment has the following uses;

- To measure what students have learnt at the end of a unit
- To promote students
- To ensure that they have met the required standards to enter certain occupations
- Select students for entry into further education

Feedback from this form of assessment is generated at the end of a program where it is no longer feasible to use it to affect any modifications (Nworgu, 1992)

Tests or Examination

A test is a task, a set of tasks or questions intended to elicit a particular behavior when presented to learners under standard conditions (Powell,2010). A test or examination (informally, exam or evaluation) could also be seen as an assessment intended to measure a test takers knowledge, skill, aptitude and physical fitness or classification in many other topics e.g. beliefs. Moreover, according to Achankeng (2011), a test can be defined as a series of questions, problems or physical responses designed to determine knowledge, intelligence, or ability. It is a basis for evaluation or judgement. She also sees a test to be any standardized procedure for measuring sensitivity, memeory, intelligence, aptitude or personality. A test may be administered verbally, on paper, on a computer or in a confined area that requires a test taker to physically perform a set of skills. Tests vary in style, rigor and requirements. For example, in a closed book test, a test taker may use one or more supplementary tools such as a reference book or a calculator when responding to an item. A test may be administered formally or informally. An example of an informal test would be a reading test administered by a parent to a child. An example of a formal test would be a final examination administered by a teacher in a classroom or an IQ test administered by psychologist in a clinic. Formal testing often results in a grade or a test score (Thissen &Wainer, 2001).

A test score may be interpreted with regards to a norm or criterion, or occasionally both. The norm may be established independently or by statistical analysis of a large number of participants. An exam is meant to test a child's knowledge or willingness to give time to manipulate that subject. Tests could be standardized, or non-standardized (teacher made) tests.

Standardized Tests

These are tests whose administration and scoring are in a standard or consistent manner. That is, the designing, conditions of administration, scoring procedures and interpretation of scores are predetermined and standard (Popham, 1999). A standardized test is any test that is administered and scored in a consistent manner to ensure legal defensibility (NCREL.org). Standardized test could also be defined as a testing format in which all the test takers either answer the same questions or aswer questions from the same item bank in the same manner (Brandon, 2018). Moreover, standardized testing can be applied to an array of testing or assessment programs, but the term is preferably used when talking about large scale tests administered within schools of a large geographical area or a nation. These tests are taken in fixed stipulated levels (Brandon,2018). A non-standardized test is usually flexible in scope and format, variable in difficulty and significance. Since the tests are usually developed by individual instructors, the format and difficulty of these tests may not be widely adopted or used by other instructors or institutions. A non-standardized test may be used to determine the proficiency level of students, to motivate students to study and to provide feedback to students. In instances, a teacher may develop non-standardized tests in scope, format and difficulty for the purpose of preparing their students for an upcoming standardized test (Groswami, 1991).

Finally, the frequency and setting by which a non-standardized test is administered are highly variable to and are usually constrained by the duration of the class period. A class instructor may for example, administer a test on a weekly basis or just twice a semester depending on the policy of the instructor or institution, the duration of each test itself may last for only five minutes to an entire class period.

In contrast to a non-standardized test, standardized tests are widely used, fitted in terms of scope, difficulty and format and are usually significant in consequences. Standardized tests are usually held on fixed dates as determined by the test developer, educational institution or governing body, which may or may not be administered by the instructor, held within the classroom or constrained by the classroom period. Although there is little variability between different types of the same type of standardized test e.g. SAT or CRES, there is variability between different types of standardized tests. Any test with important consequences for the individual test taker is referred to as a high-stake test.

A test may be developed and administered by an instructor, a clinician or a governing body or a test provider. In some instances, the developer of the test may not be directly responsible for its administration. For example, educational testing service (ETS), a non-profit educational testing and assessment organisation develops standardized tests such as the SAT but may not directly be involved in the administration or proctoring of these tests. As with the development and administration of educational tests, the format and level of difficulty of the tests themselves are highly variable and there is no general consensus or variable standard for test formats and difficulty. In general, tests developed and administered by individual instructors are non-standardised whereas tests developed by testing organisations like the GCE Board are standardised.

Grades or test scores from standardised tests may also be used by universities to determine if a student applicant should be admitted into year one of its academic or professional programs. For example, universities in the United Kingdom admit applicants into their undergraduate programs based primarily or solely on an applicant's grades on pre-university qualification such as the GCE A-Level or Cambridge Pre-U. Standardised tests are sometimes used to compare proficiencies of students from different institutions or countries. For example, the organization for economic cooperation and development (OECD) uses program for international student assessment (PISA) to evaluate certain skills and knowledge of students from different countries participating countries.

Construction of Standardized Tests

Specifying the construct to be measured is the first step to be considered when constructing a standardized test. Since the goal of the standardized test is to be widely accepted and used as possible, the task of specifying the constructs to be measured would be more daunting. In doing this, test developers could develop the test which would be used to measure attainment by chosing a content area in the particular grade level deemed for assessment, and within the content area, identify concepts which are taught nation wide which would be used to subsequently develop the items for the assessment. Moreover, test developers in order to ensure content validity should collect the various instructional materials, curriculum guides and widely used text books which would be used by measurement experts in test construction. From all these perspectives, the most popular instructional outcome will constitute the content domain of the test (Kennedy, 2003)

After deciding on the content area for assessment, the second step in constructing standardized tests involves the designing of test items by experts in test development which will match the domain of interest and which will also be inline with the instructional objectives in order to avoid ambiguity. The items which have been set are the further reviewed and vetted by other experts in order to ascertain the appropriateness of the items. The third step in test construction involves the actual administration of the test in order to evaluate the quality of the test. Through administering the test to sample populations, the quality of the test would be determined from the difficulty and discrimination indices of. the items. The difficulty index is a measure of the difficulty level of the item and it is derived by taking the proportion of test takers who get a particular item correct and the discrimination index is derived from the difference between the proportion of top achievers who get the particular item correct and the proportion of bottom achiever (Kennedy, 2003).

Once the test items have been assembled, the quality of the whole test has to be ascertained. This is done by verifying the reliability and validity of the test. Reliability refers to the extent to which the test is consistent in measuring what it is supposed to measure while validity refers to the appropriateness of an instrument to measure what it supposed to measure. Reliability could be measured by various methods, depending on the precise purpose for determining the reliability. The test retest reliability method of determining reliability could be used if the essence is to determine the extent to which the test is stable over time, but if the essence is to determine the equivalence of tests, equivalent forms method could be used and if the essence is to determine internal consistency, either the split half method, the Kuder Richardson formula's or Cronbach alpha could be used. In determining the validity of a test, various aspects of the test could be put under consideration. Example, determining the content validity of the test. The content validity assesses the extent to which the test covers the subject matter on which the assessment was based. Validity could also be measured by determining the construct validity, the construct validity coefficient determined will therefore represent the measure of the appropriateness of the test to measure the desired constructs. By determining the criterion validity of the test, the validity of the test could also be ascertained to some extent. The criterion validity refers to the extent to which test scores are related to an external criterion. Criterion validity could be concurrent or predictive. Concurrent is talked of when the criterion under consideration is being measured the same time the test is being used for assessment while predictive validity is that kind of criterion related validity which determines the extent to which test scores can predict future performances. The validity of the test could also be determined from the face validity of the test. The face validity refers to the extent to which the test looks from face view to be what it is actually supposed to be (Kennedy, 2003)

When the test has been ascertained for validity and reliability, the next step is the standardization of the test results by norm referencing. Norm referencing refers the concept of evaluating a student performance with respect to to the performance of all the test takers. That is comparisms of students' test scores are made in relation to percentiles or normalized scores. Percentiles measure a person's performance in relation to the performance of the entire test takers. For example, a student could score 40% in examination which is normally a fail mark but because it is in the 5^{th} percentile, it is considered a pass. Normalised scores on the other hand are scores (means and standard deviations) which are derived from raw scores through mathematical transformations and are used as a standard for comparing scores within a group (Kennedy, 2003).

Advantages and Challenges to Standardized Testing

Standardized tests which are test administered and scored in a consistent manner and under standard conditions with specifications of where the test will be written, how it would be written, by whom and the duration for writing, it therefore means its got somany advantages, and despite these advantages, there are draw backs linked to standardized testing.

Firstly, it is a means of educating the learners on priorities, that is through standardized testing, the subjects which students might not pay attention on such as arithmetic, reading and writing because they might consider them as boring in contrast to subjects such music and physical education, are all brought to the lime light and all evaluated to see the extent to which students have learned. By so doing, the students will then see the importance of such subjects and could start prioritizing them. The students will thus see for them selves that the subjects which they don’t really like are also very pertinent through which they could be successful in life like the subjects which they like. Through this, students will be able to demonstrate how much they have learned. Secondly, through standardized tests, the best which teachers could offer is brought out that is by schools offering prices to teachers basing on students’ performance in their respective subjects in the standardized tests teachers are encouraged to do their best in terms of teaching and preparing the students for the standardized examinations in a bid to be credited with prices (Brandon, 2018).

Through standardized tests also, comparisons could be made in relation to students’ performances in particular subject areas by making references to the performances of other students of the same age group and level of education at the national platform. Schools as well as various administrative units could also be classified based on their performances in the standardized examinations. Therefore, from the results of the standardized examinations, outstanding schools would be easily identified, as well as thoso lacking behind in terms of academic performance. These records may then serve as a guide for parents who intend enrolling their kids into schools with particular educational standards. Also by laying emphases on specific learning outcomes, and helping teachers to identify target areas help fine tune the educational system and improves on time management (Kaukab and Mehrunnisa, 2016).

Moreover, standardized tests create a positive school environment for students. Though undertaking tests is stressful, when results of the standardized tests are released, they exonerate positive energy that leads to a positively shaped school environment. The self esteem of most students who have taken the standardized test is elevated without taking into consideration their outcome, as even those who failed and knew they did their best will bost of haven sat for the examinations. This test therefore makes students know that their hard work has paid off. Also, standardized testing creates equity in the social environment. The same examinations are taken by all and sundry within the society and as a prelude, social stratification is broken as the children of parents of high socio-economic status take the same examination with the children of parents of low socio-economic status. This helps break down social barriers in the society and fosters social equity (Brandon, 2018).

Standardized testing also helps in identifying hidden learning deficiencies in learners. Within the ambits of the classroom teacher, learning deficiencies such as dyslexia and dyscalculia could easily be identified, but there are some deficiencies in subjects that teachers cannot esily identify. But with the aid of standardized testing, such learning gaps could be identified and remmediations could then be made by placing the students into individualized programs where the learning deficiencies could be accommodated or corrected in order to ease students' learning. In addition to identifying learner's learning deficiencies, standardized tests make allocations for students with disabilities to take part in the testing exercise, so as to have the same experience which the other students who are not disabled are having (Brandon, 2018).

According to Maegan (2019) as cited by the US Congrss (1992), there are enumerated limitations of standardized tests especially those concerned with its usage in modern education settings. This becomes more pronounced when the out put of standardized testing are used solely for decision making. Firstly, standardized tests to an extent lead to the narrowing down of the curriculum which could consequently limit students' learning. This is simply because of the so much importance placed on the standardized test, teachers would prefer to narrow down their teaching and focus more on areas where they are certain questions in the examinations will come from. In line with this, it was revealed that following the initiative of 'no child left behinh', between the years 2002 and 2009, there have been a 40% reduction in time spent in the teaching of social studies, music, science and art with Mathematics and reading gaining about two hours additional weekly. This thus tilts the curriculum in such a way that the curriculum no longer balanced because amongst the students, there are students who are more inclined to social studies while others are more inclined to the music therefore, tilting the curriculum will complicate the accommodation of students whose interest is on the subjects whose teaching hours are reduced in preference to subjects which attract more focus because of their dominance in the standardized tests (Kaukab and Mehrunnisa, 2016).

Also, the standardized tests do not take into consideration other factors which might affect the students during the examination such as anxiety, or sickness, so, in the case where the test tsker is not in good shape to take the examination, must still take the examinations. Also, the standardized tests do not take the students' past performance into consideration, do not exhibit the academic progress made by students and they do not also take into consideration the efforts put in by the teachers and students (Kaukab and Mehrunnisa, 2016).

Types of Test

Tests can be grouped into 3 categories which are; written tests, performance tests and oral tests.

1) **Written Tests**

Tambo (2012) opines that written tests, sometimes called paper and pencil tests are used when the teacher wants to find out if the student knows something. For example, that a gas expands when heated, that the body needs vitamins to function well. In other words, written tests are used to assess the range and accuracy of students' knowledge about a given subject or area of knowledge. There are two main categories of written tests which are the objective tests and essay tests

a) **Objective Tests**

An objective test is a psychological test that measures an individual's characteristics independent of rater bias or the examiner's own beliefs. It is objective in the sense that the marker does not have to make any judgment as he or she assigns a mark to a given answer. Since there is no judgment involved, a pupil will obtain the same mark irrespective of who marks his/her paper (Tambo, 2012). An objective test could also be seen to mean a test that requires just a single word asnswer or a simple statement which would require a recall. These tests are free from all soughts of subjective bias (Tchombe, 2019).

An objective test is built by following a rigorous protocol which includes the following steps;

- Making decisions on nature, goal, target population, power
- Creating a bank of questions
- Estimating the validity of the questions by means of statistical procedures (or judgment of experts in the field)
- Designing a format of application (a clear, easy-to-answer questionnaire or an intensity etc.)
- Detecting which questions are better in terms of discrimination, clarity, ease of response upon application on a part of sample
- Applying a revised questionnaire or interview to a sample
- Using appropriate statistical procedures to establish norms for the test

There are two main types of objective tests:

The supply type and the selection type

i. The supply Type

It requires the examinee to supply words, numbers or symbols. Answers are not listed as part of the question. An example of the supply type of objective test is the short answer question and the completion test items.

Advantages of Supply Test Questions

- It reduces guessing because no answers are suggested and
- Supply test items are relatively easy to construct

Disadvantages of Supply Test Questions

- Supply test questions are more difficult to mark than other types of objective test questions because pupils may provide other answers that are totally or partially correct.

- Supply test questions are suitable mainly for measuring recall of information. They are not considered suitable for measuring more complex learning outcomes such as the application of principles, analysis, synthesis or evaluation as described in the Bloom's Taxonomy of educational objectives (Tambo, 2012).

ii) The Selection Type of Questions

1. **True-False Questions**

The true-false test question is sometimes referred to as the alternate response form. It consists of a statement to which the test taker is required to respond in one or two ways i.e. true or false. The question could also be framed in such a way that the response options are "yes" or "no". The "Yes-No" form is often used with pupils in lower classes because it seems easier for them.

2. **Matching Test Type**

This consist of two parallel columns, one containing a list of words, numbers, symbols or other stimuli to match to the word, sentence, phrase or other possible answer from the column (responses list).

The matching format is an effective way to test learners' ability to recognize relationship between words and definitions, events and dates, categories and examples amongst others.

3. **Arrangement Type**

This is similar to the matching type where emphasis is on the learners' ability to recognize relationship and do the arrangement.

4. **The Multiple Choice Question**

Multiple choice test questions are considered to be the best form of objective test items because of their flexibility and adaptability in measuring different types of educational objectives. In this type of test, a direct question or incomplete statement is presented, and a number of possible responses are given. The test takers are asked to choose for each item the one correct or best answer from several suggested alternatives. To

Tchombe (2019), only one word or statement distinguishes the key answers to the distracters.

The multiple-choice test items are more complex in structure than other forms of objective test items. The multiple-choice items provide the most useful format for measuring achievement at various levels of learning. Thus, multiple choice items are the most commercially developed and standardize achievement and aptitude tests.

In Cameroon, the GCE board started using the multiple choice in June 2009, but this is not yet applicable in the case of BACalaureat exams.

Advantages of Multiple Choice Test Items

- Learning outcomes from simple to complex can be measured
- Highly structured and clear tasks are provided
- A broad sample of achievement can be measured
- Correct alternatives provide diagnostic information
- Scoring is easy, objective and reliable
- Performance can be compared from class to class and year to year
- Can cover a lot of material very efficiently (about one item per minute of testing time).

Disadvantages of Multiple Choice Items

- Constructing good items is time consuming
- It is frequently difficult to find plausible distractors
- Scores can be influenced by reading ability
- Learners can sometimes read more into the question than was intended
- Sometimes there is more than one defensible correct answer
- May encourage guessing
- Does not provide a measure of writing ability

b) Essay Tests

The extended or free response (Essay) tests are test items designed to judge the learner's ability to organize, integrate, interpret material and express themselves freely in their own words.

According to Tambo (2012), an essay test is a type of examination that requires a test taker to write for a specific length on a given topic or subject.

The test taker is asked to produce his or her answer in continuous prose writing rather than orally. Essay tests can be classified according to the freedom of response. On this basis, 2 main types of essay tests can be identified which are;

- The extended response and
- Restricted response types

The extended response items cover an extended amount of subject matter. It allows the test taker a lot of freedom in organizing and expressing the answer according to his or her own point of view and the breadth and scope of his or her knowledge in that field.

The restricted response essay question is much more limited in scope than the extended type. This type of question requires pupil's response to be within certain defined restrictions.

Advantages of the Essay Test Types

- It measures complex learning outcomes that cannot be measured by other means
- It also enables the measurement of organisational and divergent thinking skills.
- It is very applicable for measuring learning outcomes at the higher levels of education objectives such as application, analysis, synthesis and evaluation of levels of the cognitive domain.
- It is easy and economical to administer
- It can be used to measure in-depth knowledge
- It does not encourage guessing

Disadvantages of Essay Test Types

It is inadequate in sampling subject matter content and course objective since it provides limited sampling

The reliability of test as an instrument is compromised by essay type test as evaluating the answers to poorly developed questions tend to be difficult.

Not east to perform item analysis with essay type items.

2) Performance Tests

While a written test assesses how much students know, performance test assesses what students can do with what they know (Snowman and Brehler, 2000). The four main kinds of performance assessment tests commonly used are;

- Direct writing
- Observations of performance on the job
- Simulations
- Portfolios

In Cameroon, the GCE examinations in the science subjects like Biology, Chemistry and Physics makes use of portfolio in the practical papers of these subjects.

3) Oral Tests

These are tests in which both the questions and the answers are spoken rather than written. This kind of assessment is often used to evaluate young learners. Although in Cameroon, oral examinations are used extensively in public service competitive examinations (Tambo, 2012). The oral test had been used as an additional criterion in the selection of students into medical schools in Cameroon, but in the recent years this selection criterion has been wiped out and replaced with a paper on general knowledge.

The GCE Examinations

The General Certificate of Education (GCE) is a subject specific family of academic qualifications that awarding bodies in England, Wales, Northern Ireland, Crown dependencies and a few commonwealth countries

The GCE generally is composed of 3 levels in increasing order of difficulty. They are;

- The ordinary level
- The advanced subsidiary level (A1 level or As level) which is higher than the O-level, serving as a level in its own right and functioning as a precursor to the full Advanced level and
- The Advanced level (A-Level)

The General Certificate of Education Advanced levels (GCE A-Levels) is an entry qualification for universities in the United Kingdom and worldwide. The US equivalent for that purpose would be the High School Diploma. However, in England and Wales, the high school diploma is considered to be at the level of the General Certificate of Secondary Education (GCSE) which is awarded at year 11 (info for us families, 2017). For college and university admissions, the high school diploma may be accepted in lieu of the GCSE if an average grade of C is obtained in subjects with GCSE counterpart of C. As the more academically rigorous A-Levels awarded at year 13 are expected for university admissions, the high school diploma alone is generally not considered to meet university requirements.

The GCE was first examined in England, Wales and Northern Ireland. It was intended to carter for the increased range of subjects available to pupils since the raising of the school age from 14 to 15. The examinations were graded into ordinary levels for the top 25% academically of the 16-year old. A-levels were the subsequent examinations for those who studied for further two years after O-levels. These were often in addition to O-levels in subjects that the student was particularly adept at.

Letter grades are used with A, B, C, D and E representing a pass and U (unclassified) representing a fail. After leading British universities had expressed concerns that the A grade alone would no longer be enough to seek out the most capable candidates. The A grade was introduced for students who achieve 80% and above the overall A- level qualification.

GCE Examinations in Cameroon

In Cameroon, the GCE examinations are organized by the Cameroon GCE board. The Cameroon GCE board is a para-public establishment of an administrative nature which was created by presidential Decree N^0 93/173 of 1st July 1993 as amended by presidential decree N^0 07/45 of 5th March 1997. The board is placed under the tutelage of the minister of secondary education and the day to daily administrative affairs of the board are run by a registrar.

The missions of the GCE board are provided in Article 3 of Decree N^0 93/172 as amended by decree N^0 07/45 and completed by Prime Minister's order N^0 112/CAB/PM of 12th October 1993. In brief, the mission is to organize the following examinations

- The General Certificate of Education, (general subjects) of the Ordinary Levels;
- The General Certificate of Education, (general subjects) of the Advanced Levels;
- The General Certificate of Education, (technical subjects) of
- the Ordinary Levels;
- The General Certificate of Education, (technical subjects) of the Advanced Levels;
- Foreign Examinations

Examinations in English for the award of

- BACalaureat Technique
- The Brevet de Technicien
- The Brevet D'etudesProfessionelles
- The Brevet professionnel

For the purpose of carrying out its objectives as specified in the prime ministerial Order N^0. 112/CAB/P.M of 12th October 1993, the board shall

- Organize examinations for the award of certificates and other distinctions to persons who qualify
- Offer technical advice on the design of learning programmes responsible for similar examinations in Cameroon and elsewhere
- Conduct and contract research and studies on examinations and other aspects of education

- Demand and receive from any candidates sitting examinations fees such as shall, from time to time be determined by the Board and approved by the minister in charge of national education.
- Enter into contracts, establish trust act as trustees solely or jointly with any other persons and employ and act through agents in accordance with regulations in force.
- Accept gifts, legacies and donations but without obligations to accept same for a particular purpose, when it approves the terms and conditions attached thereto.
- Undertake publishing and book selling as approved by the minister of national education

Processes carried out by the CGCE Board in Test Construction, Administration and Scoring

For the GCE board to organize valid and reliable examinations, it ensures the follow up and accomplishment of certain practices which span from the test design phase, item settings, moderation exercise, pre-testing, administration of the examination and scoring of examination.

i) Test Design Phase

The GCE Board lays particular emphasis on the fact that the quality of its examination should be based on the quality of the test items. As such, the Board puts in place various mechanisms and scientific procedures through which questions have to undergo so that the final output should meet the desired objectives.

ii) Items Settings

Every year, each examiner when going for the marking exercise, goes along with proposed examination questions. These examination questions are then scrutinized by selected members of each subject panel headed by the Chief examiners. They then choose from the pack of questions those which are of certain standards as warrants the examination in view.

iii) Moderation Exercise

During the moderation exercise, the panel's task is to secure the consistent application of the principles of standardisation of questions, parity in the wholesome consideration of the topic, in the syllabus, the aims, assessment objectives, the abilities tested, the level of difficulty of each item and the balance of each paper. After which the provisional marking scheme is prepared.

iv) Pre-testing

The moderated questions are then protested to ascertain the reliability of the test items. Usually about six schools are selected for pre-testing, taking in to account those schools that will normally complete their syllabus in April and is administered to students who are candidates for the upcoming GCE examinations.

After the pre-testing exercise, the test item analysis is done to find out the difficulty index, discrimination index and also the effectiveness of the distractors. After the test item analysis, the moderation team either drops or adjusts items that have problems while the good items are retained.

v) Proof Reading

It is the final stage before the questions are sent to the question bank to be used for subsequent examinations. Here, the assessors and Chief examiner are in charge of cutting the 'Ts' and dotting the 'Is'.

vi) Administration

The GCE examinations are administered in the various writing centers all over the national territory. Each writing center is headed by a Chief examiner and a representative of the GCE board called the Superintendent who ensures the smooth writing of the GCE examinations with the help of invigilators. After the writing of each paper, the answer booklets are packaged in sealed envelopes for onward transmission to the marking centers.

vii) Scoring

During the marking exercise, the first day is used for the making of the marking guide, after which the trial marking exercise is done in order to acquaint examiners on the marking guide and to drill new examiners on marking techniques. During the trial marking exercise, a single script is marked by multiple examiners and the scores given by the examiners are compared with that of the chief examiner in order to know the extent to which the scores of various examiners vary. The examiners whose scores greatly vary from that of the chief examiner are then cautioned are then cautioned on how they should better allocate marks to the various questions in order to have more reliable scores. More emphasis is laid during the trial marking on new examiners. When the marking proper begins, these new examiners are placed under the guidance of more experienced examiners, who check their scripts before they hand them over for more cross checking. After a score has been given by the first examiner, it is then handed over to a second examiner who rechecks to make sure the score given is correct. After the scoring by the examiners, the chief examiners then go through all the scripts to make sure the scores given are correct.

The BAC Examinations in Cameroon

The BACalaureat examinations in Cameroon are organized, managed and run by the BAC board which is public administrative establishment. The BAC board was created by Decree No. 93/255 of 09/28/93 and amended by Decree No .97/044 of 03/05/97. The Prime Ministerial Decree No. 047/CAB/PM of May 17, 1994 came up with organizational structure of the BAC board. The BAC board called the L'OBC placed under the Ministry of Secondary education includes the following; a board of directors, a directorate with two divisions, eight services and two offices and an Examination council (OBC, 2014)

The L'OBC has the following missions

-The preparation and organization of the second cycle secondary education examinations

- The collation of diplomas with the technical supervision

- Studies aimed at the evaluation and improvement of the education system

- Collection of examination fees for the examinations it organizes

- Research work and studies on the examinations which it organizes

-Collaboration with similar organizations in Cameroon and abroad

- In voicing of CBO service

Processes carried out by the BAC Board in Test Construction, Administration and Scoring

In carrying out assessment, measurement and evaluation practices, the BAC board makes sure all the practices they carry out are in conformity with standard examination laws and the educational laws of the country.

i)Test Design Phase

The BAC board also lays emphases on the quality of its exams, as such there are quality control mechanisms that are put in place to make sure that the exams are of standard quality and in accordance with the objectives of each subject.

ii) Item Setting

The National pedagogic inspector (NPI) of each subject decides on how many kinds of setting would be neede, then the RPI's. Then the RPI's at the Regional level then choose some classroom teachers of each subject to set questions following the syllabus of the current syllabus from BAC board. These teachers at the level of the various regions design these questions and submit them to the Regional pedagogic inspectors. The RPI's of each subject then assemble all the teachers who were appointed to set the examinations for the process of vetting. At this stage, they go through each of the settings along side the respective marking guides. The regional pedagogic inspectors together with the selected panel do this by going through the various submitted questions in order to check the appropriateness of each question. After scrutinizing the various settings, the RPI's select the best settings and then submit to the NPI's, and each setting submitted should have at least a 75% coverage of the entire syllabus in each subject. The National Pedagogic Inspectors collects such examination settings from all the 10 Regions of the Republic of Cameroon. In order to further scrutinize the settings already submitted from the Regions, the NPI calls up experience teachers alongside some RPI's of their respective subjects from all the Regions of the National territory with the agenda for them to go through the various settings and select the best five settings from the lots. When these five settings have been selected, marking guides are then prepared for each of them and consequently, the questions together with the marking guides are kept in the question bank in the month of February or March of each year, the NPI of each subject call for their respective RPI's, who then come together and one of them is instructed to pick any question at random from the question bank. The setting picked out is then sent to the BAC board to be used as the setting of the year.

iii) Moderation

The moderation exercise is carried out in order to ascertain that the norms of standardization are respected and that each paper of selected questions is appropriately balanced.

iv) Pre-testing

After the moderation exercise, the questions are pre-tested. This pre-testing is done with students of the appropriate level of the examination. The pretesting is done in order to fine-tune the appropriateness of each test item. That is, from the pretesting, the item difficulty indices of each item as well as the item discrimination indices are determined, so that any item with an inappropriate, item or difficulty index could be kept aside.

V) Proof reading

When the appropriateness of the items has been ascertained via the pre-testing, the items are then well read, in order to ensure clarity and to avoid ambiguity.

vi) Administration

A 'charger de mission' is appointed by the BAC board to head each writing centre. A chief of centre who is most probably the Principal of the school serving as a writing centre is appointed as the chief of centre. Before the start of the examination, question papers along side writing materials are sealed and sent to the office of the sub director in charge of examination at the Regional delegation of Secondary education in each Region. The sub director in charge of examination in each of the Regional delegations, then checks the sealed envelopes along side Regional Pedagogic Inspectors to make sure they are sealed. The sub director in charge of examinations then calls up the various divisional delegates, and on their arrival they also check the sealed envelopes to make sure they are still in tact. After verifying the seal, each of the divisional delegates is then handed the sealed envelopes containing question papers and answer booklets for their various divisions. At the level of the Divisions, the Divisional Delegates summon the various principals who then come and also confirm that the sealed nature of the question papers and answer booklets and then carry the question papers alongside the answer booklets to their various schools, where they are kept confidentially. When the 'charger de mission' comes few days before the start of the examination, he or she goes and makes sure the envelopes are still perfectly sealed. On the day of the examination the students also verify the seals on the envelopes before the start of each paper. During the examination, candidates sit as stipulated by their examination numbers and the examinations are invigilated by invigilators appointed by the BAC board. After the examination the scripts are then taken to the secretariat for coding. The coding is done in a particular format as stipulated by the BAC board. After the coding is done, the scripts are then transported to the Regional secretariat, from where they are transported to the marking centre.

vii) Scoring

Before the start of the marking exercise, the National Pedagogic Inspectors (NPI) for each subject coordinate the preparation of the marking guides The NPI's do this together with RPI's for each subject. The RPI's each come with a proposed marking guide. With these marking guides, deliberations are done and a unique marking guide is adopted for each subject. This then sets the pace for the marking exercise. Each examiner on coming to the marking centre come along with copies of prepared marking guides. With all these marking guides in place, the heads of the marking of each subject called the 'chef de salle' then revise the marking guides already prepared by the NPI's and RPI's along side the marking guides brought by each examiner in order them all to unanimously clarify certain doubts and adopt the marking guides. The marking of each subject is also coordinated by the 'chef de salle' who goes through at least 10% of the marked scripts to ensure efficiency. After the scripts have been marked, the scores are then recorded and taken for deliberations and subsequently evaluation.

Characteristics of Effective Assessment Instruments

According to Nworgu (2015), tests are vital tools used in the gathering of valuable data in which educational decisions are based. To obtain accurate data, the test employed for that purpose should possess some essential characteristics.

Tambo (2003) purports that good assessment instruments must possess three basic characteristics which are; validity, reliability and usability.

I. Validity

There are many discripancies over the location of the appropriate definition of validity as the semantics and meaning are considered in both the field of education and psychology to be complex and fluid (Hathcoat, 2013). The two approaches which are debated on as the appropriate location for validity are the 'instrument based approach' and the 'argument based approach'. The instrument based approach sees validity as a property of measuring instruments like tests while the argument approach sees validity to be more linked to the interpretations and uses of tests. These various approaches can further be understood by having a look at their ontological and epistemological bases. Ontology stems from metaphysics which dwells on the structure of being and reality and it questions 'what exist?' while epistemology stems from Phylosophy and focusses on the nature and process of knowledge acquisition and it questions 'how we know?'. These two questions find a place in the validity theory which encompasses concepts of ontotlogy such as personality and critical thinking as well as concepts epistemology such as correlation and regression which are examples of evidentiary standards. Psychometric realism is another concept in the validity theory whichi shares aspects from both ontology and epistemology. The concept of psychometric realism explains the fact that in the actual world, there exist psychological and educational attributes whose existence could be justified (Hood, 2009).

The instrument based approach to validity sees validity in terms of the properties related to a test. This approach fell in line with the earliest definitions of validity. According to Mellenbergh (2003), a test is X considered to be valid when measuring an attribute Y, on the condition that scores on X truly measure scores on Y. In accordance with this definition, Borsboom et al (2003) came out with the proposition that validity is that concept which is built on truth and he provided the latent variable frame work model as a means for measuring validity. According to them, validity is dependent on two principal aspects which are; the existence of the attributes and the variations in the attribute can adherently cause a change in the outcome being measure ed. This definition which ties its self to attributes is directly hinged on ontology and since the variations in attributes can be used to explain differences in the expected cause of the variation such as intelligence, then the attributes are said to explain the concept of validity as rooted in epistemology (Borsboom et al, 2003).

The instrument based approach to validity simply thus focuses on the extent to which an instrument appropriately measures particular attributes. The causal relationship finds itself at the centre of this approach of looking at validity and so, delimits many other aspects and makes the scope quite specific and narrow. It keeps away aspects from the validity theory such as the consequences of testing and focuses on the lack of variance in causal relations from various settings (Hathcoat, 2013).

The next approach of looking at validity is the Argument based approach to validity. This approach does not look at validity in relation to instruments making measurements but looks at validity from four perpectives, the first perspective is that validity is a property of interpretations and not tests, secondly, that validity is based on extended investigations, thirdly that the consequences of testing is seen as aspects of the investigations and the fourth perspective which says that logical and empirical examinations could make use of test interpretations and through these examinations, proposition pertaining to test scores could be made (Hathcoat, 2013). Therefore, from this approach validity is ascertained with respect to the inferences made with respect to the test scores. That is if the references from particular test scores are given acceptable inferences the test will hitherto be considered valid and if for the same test scores, interpretations given are not favourable, then the test would not be considered valid (Kane, 2001).

This approach to validity is free from ontological strings, since it is based on the interpretation of the scores and not the outright validation of the scores as they appear, instead it has close links with the epistemological views as it justifies knowledge. Consequently, two epistemological implications are directly derived from this approach which are; interpretive arguments yield appropriate evidences and that validity is a tentative judgement derived from varying degrees of certainty (Hathcoat, 2013). This view thus makes the ascertainment of validity to be based on subjective judgement. But since this approach makes use of test scores in making the interpretations, it indirectly takes into consideration the weaknesses of the instrument based approach (Kane, 2012).

From this various approaches and schools of thought proponents and pundits coined various definitions for validity. From the instrument based approach various definitions of validity were proposed as follows; according to Othuon (1994), validity is the precision with which a test measures some particular mental ability. Moreover, Validity is the ability to produce findings that are in agreement with theoretical or conceptual values, in other words, to produce accurate results and to measure what is supposed to be measured. Thus, a research instrument is said to be valid if it actually measures what it is supposed to measure (Amin, 2005). Validity from this approach could also be defined as the extent to which a cognitive ability could accurately be measured by test scores from an administered test (Ebel and Fresbie, 1991). Therefore, instruments like rulers, thermometers, and other instruments used to measure the physical world have demonstrable validity. Thus, for a test or examination like the G.C.E or BACalaureate examinations, for a particular subject to be valid, it must measure what it intends to measure adequately. The above definitions are rooted on the instruments based approach on validity.

Other definitions of validity have been developed from the argument based approach have also been proposed. In line with this approach, Lydia (2005) porputed that validity does not pertain to the quality of a test but to the characteristics of the evidences derived from the test scores. Cronbach (1971) also posits that validity cannot be ascertained by determining the validity of the instrument but by determining if the interpretations of the test scores from the instrument is valid as well as if the implications which will stem from these interpretations are worthwhile. Also, according to Messick (1989), test validity can be ascertained by determining the extent to which the adequacy and appropriateness based on interpretation of the test scores is supported by the evaluative judgements from empirical evidences and theoretical rational.

Validity is arguably the most important criteria for the quality of a test. On a test with high validity the items will be closely linked to the test intended focus. This means that for certification and licensure tests like the G.C.E examinations the items have be highly related to the intended outcome. If a test has poor validity, then it does not measure the job-related content it ought to. When this is the case, there is no justification for using the test results for the intended purpose.

Factors Affecting the Validity of Tests

Generally, any of the following factors can prevent a test from functioning as intended and thereby lower its validity.

Unclear Instructions: Unclear or vague instructions in a test will most likely misdirect the test takers in responding to the items in a manner that may not be the actual purpose being measured.

Vocabulary and Sentence Structure: Poor sentence structure in tests and the use of inappropriate vocabularies such as unrelated technical words in test, affect the test taker's comprehension of the tasks required in the test, thus affecting the validity of the test.

Poor construction of test items: a test is poorly constructed to the extent that it does not convey its intended purpose to the test takers.

Ambiguous statements: the use of ambiguous statements in tests makes such test liable to many interpretations. This will present confusion to those being tested. This condition will compromise the validity of the test.

Inappropriateness of the test items: most tests are specific in terms of the behaviour being measured. Inclusion of items from a different behaviour other than that intended for such tests reduces its validity (Nworgu, 2015).

Types of Validity

Content Validity

The content validity of any given test refers to the extent to which the test measures, both the subject matter content and instructional objectives designed for a given course. (Nworgu, 2015) Fundamentally, content validity focuses on the extent to which the content of the instrument corresponds to the content of the theoretical concept it is designed to measure. Establishing content validity therefore, involves specifying the domain of the content for the concept, constructing and selecting indicators that represent that domain of content (Amin, 2005).

Messick (1989), points out that content validity is assessed by showing the degree to which the test content appropriately samples the subject matter, from which conclusions are made after relevant judgements of the appropriateness of the test content in relation of a particular domain in of interest and the representativeness of items or tasks on the domain. Content validity could also be seen to mean the appropriateness to which the test items represent the content which the examinees are supposed to know (Meagan, 2019). Content validity is also related to how a test covers the appropriate behaviours which it is intended to measure. Moreover, the content validity of a test could easily be judged by a table of specification. In using the table of specification, not everything in the table of specification should necessarily be part of the test, but atleast, the test should cover the major aspects of the table of specification. Such a thus therefore will certainly measure what it is supposed to measure and will definitely have content validity (Hughes, 2003).

Content validity is a logical process where connectors between the test items and the job related tasks are established; if a thorough test development process was followed, a job analysis was properly concluded, an appropriate set of test specifications were developed, and item guidelines were carefully followed, then the content variability of the test is likely to be very high .Content validity is typically estimated by gathering a group of subject matter experts together to review the test items. Specifically, these subject matter experts (S.M.E.s) are given the list of content areas specified in the test blue print, along with the test items intended to be based on the content area. The SMEs are then asked to indicate whether or not they agree that each item is appropriately matched to the content area indicated.

Construct Validity

Construct validity is the degree to which a test measures what it claims or purports to measure (Cronbach & Meehl,1955). The construct validity of a test refers to the extent to which the test measures a psychological construct or trait which it is supposed to measure. Examples of psychological construct or traits include, intelligence, speed of reading, honesty, sociability, verbal fluency, amongst others (Nworgu,2015)

Construct validity is the appropriateness of inferences made on the basis of the observations or measurements (often test scores), specifically whether a test measures the intended constructs that are deliberately created by researchers in order to conceptualise the latent variable which is correlated with scores on a given measure (although it is not directly observable). Construct validity examines the question. Does the measure behave as the theory says a measure of that constructs should behave?

Construct validity is essential to the perceived overall validity of the test. Construct validity is particularly important in the social sciences, psychology, psychometrics and language studies. Psychologists such as Samuel Messick have pushed for a unified view of construct validity as an integral evaluative judgment of the degree to which empirical evidence and theoretical rational support adequately and appropriately the fairness and actions based on the test scores (Messik, 1998). The key to construct validity are the theoretical ideas behind the trait under consideration i.e., the concepts that organise how aspects such as personality, intelligence are viewed (Pennington, 2003). Paul Meehl states that ‘’the best construct is the one around which we can build the greatest number of influences, in the most direct fashion (Cronbach *et al*,1955).

According to Alderson et al (1995) there are several ways through which the construct validity of a test could be established which are; determining whether or not the test is built on its underlying theory, assessing the internal correlations between the various components of the test, by carrying out multi trait-multi method analyses, by using convergent-divergent validation and factor analyses in order to determine the extent to which each item measures the construct under consideration. Therefore, from construct valiodity, we can talk of convergent validity and discriminant validity which are types of validity which stem from construct validity.

Convergent Validity

Convergent validity is said to exist when two measures of the same construct or variable are more correlated with each other than with measures of other variables. Convergent validity could be ascertained through the use of statistical tests such as correlation analysis, multitrait-multimethod (MTMM) matrix, Confirmatory factor analysis (CFA), structural equation modeling (SEM). (Engellant et al, 2016).

Discriminant Validity

This is said to exist when measures of different constructs correlate minimally or diverge with one another. Statistical tests which could be used to measure discriminant validity include; correlation analysis, multitrait-multimethod (MTMM) matrix, confirmatory factor analysis (CFA), and Structural Equation Modelling (SEM) (Engellant et al, 2016).

Nomological Validity

Nomological validity is said to exist when there is a relationship between measures in at theoretical network. This emanates from the fact that in building up a theory, constructs interact with one another. Nomological validity thus sets in when various measures, constructs and concepts are merging together to build a theory. Thus, this kind of validity entails building as well as testing theories in order to pin point several constructs and variable relationships (Engellant et al, 2016). Therefore, this kind of validity is only talked of when a theory is concerned. The nomological validity can be determined by statistical tests such as correlation analysis, regression analysis, path analysis or structural equation modelling.

Known-Groups Validity

This type of validity exists when a measure actually differentiates between groups which outrightly differ with respect to a particular construct. Statistics such as means, standard deviation could be used to measure this type of validity (Engellant et al, 2016). An example of this kind of validity could be seen if a measure is used to determine the attitude of men and women towards football. Normally, men have a more positive attitude towards the beautiful game as compared to women, so, if the measure actually differentiates the attitudes of the male and female gender towards football, then it actually has known groups validity.

Face Validity

Many authors do not consider face validity as a scientific concept, moreover it is still regarded as a very pertinent aspect of validity (Taher, 2012). Face validity could be seen to mean the appearance of validity or the extent to which a test appeals to both the test takers and the test users. Face validity is the extent to which a text is subjectively viewed as covering the concept it purports to measure. It refers to the transparency or reliance of a test as it appears to test participants, (Gravelter, Forzano & Lori-Ann, 2012). Moreover, face validity in order words could be seen to refer to the extent to which items on an instrument meant for measurement linguistically and analytically look like what it is supposed to measured (Engellant, et al, 2016). In other words, a test can be said to have face validity if it 'looks like'' it is going to measure what it is supposed to measure.

Some people use the term face validity to refer only to the validity of a test to observers who are not experts in testing methodologies. For instance, if a test is designed to measure whether children are good spellers, and parents are asked whether the test is a good test, this measures the face validity of the test. If an expert is asked instead, some people would argue that this does not measure face validity (Anastasi 1985). Generally, face validity means that the test looks like it will work as opposed to "has been shown to work." Face validity is affected by item quality and the clarity of instructions. That is when the items are of poor quality, instructions are not clear and precise, and as well as when the time limits or allocation for writing the test are unrealistic, the face validity might negatively be affected (Alderson et al, 1995).

Criterion Related Validity

Criterion related validity focuses on the correlation between scores on an instrument and scores on some criterion variable. Thus, criterion related validity is the degree of the correspondence between the scores, on the instruments to be validated and the criterion. There are two types of criterion – related validity, concurrent validity and predictive validity. (Amin, 2005). Criterion related validity is that kind of validity which illustrates the relationship between a particular test and a criterion to which predictions are to be made. Validity evidences thus clearly shows the extent of prediction of the criterion (Fulcher and Davidson, 2007).

a) Concurrent Validity

Concurrent validity refers to the extent to which examinees test scores in one measure are related to their scores in some other measure in which case the both measures are administered almost at the same time (Alderson et al, 1995). Concurrent validity is talked about when the criterion is obtained the same time as the test scores. This is relevant to tests employed in measuring, existing status. Usually such test provides quicker, more objective and easier means of assessing the behaviour than the previous methods, otherwise there would not be the need for such tests since the criterion measures is usually available during the time of validating the test (Nworgu, 2015).

Predictive validity

In the case where criterion is obtained at a future date, the form of validity is referred as a predictive validity. Predictive validity is concerned with how well the test can predict subsequent behaviour. Cronbach *et al* (1955) proposed that predictive validity is the extent to which a score on a scale or test predicts scores on some criterion on some criterion measure. Crocker and Algina (1986) define predictive validity as the extent to which test scores predict criterion measurements which will be made in the future, in relation to proficiency tests, predictive validity is a measure of the extent to which inferences could be derived from the test in with respect to proficiency. Rudner (1994) sees predictive validity to mean the inferences which are attributed when scores are used to predict future achievement or performances through statistical relationships. Brown (2004) further purpots that predictive validity is of great importance in placement tests, in language aptitude tests, and in admission assessment batteries amongst others. Jesen (1980) emphasizes that predictive validity is the most convincing type of validation deemed necessary by psychological tests. In a strict study of predictive validity, the test scores are collected first, then at some later time, the criterion measure is collected. The predictive validity however is established by correlating the predictive variable and the criterion variable. The coefficient obtained is called the coefficient of predictive validity (Nworgu, 2015). In simple terms predictive validity could be defined as the appropriateness to which test scores predict future performances of academic achievement.

With respect to social science, the magnitude of the correlations obtained from predictive validity studies is usually not high. A typical predictive validity for an employment test might obtain a correlation in the neighbourhood of 0.35. higher values are occasionally seen, and lower values are very common. Nonetheless, the utility (that is the benefit obtained by making decisions using the tests) provided by a test with a correlation of 0.35 can be quite substantial. Amin (2005) posits that if the validity coefficient is high, then the instrument has good predictive quality. The latest standards for educational and psychological testing reflects Samuel's model of validity (Messick, 2005) and do not use the term "predictive validity". Rather, the standards describe validity supporting evidence based relationship between the test scores and other variables. Predictive validity thus involves testing a group of subjects for a certain construct and then comparing them with results obtained at some point in the future.

Factors Affecting the Predictive Validity of Tests

According to Nworgu (2015), the predictive validity of a test can be affected by the unreliability of the criterion test and the time interval for the administration of the predictor test and the criterion test, meanwhile according to Kye-Blankson (2005), while evaluating the validity of test scores, the validity coefficient obtained as parameter which describes the relationship between the predictor and the criterion is affected by restriction of range and criterion unreliability.

The Unreliability of the Criterion Test

The essence of validity studies is to come out with relationships between the predictor and criterion variables. According to Thorndike (1949), the extent to which the predictor and criterion variables are precisely measured determines the magnitude of the validity coefficient. The aspect of precision is emphasized because the measurement of these variables is liable to measurement errors consequently the reliabilities of the predictor and criterion variables are likely to be lower than their actual reliabilities. These uncertain reliabilities in tend affects the validity measures. Thus, there is need to correct these reliability measures, but it is widely argued that the correction should only be made on the criterion variable since the unreliability of the criterion since it attenuates the correlation between the observed score on the predictor and the true score in the performance (Kuncel et al, 1998). Moreover, correcting the criterion unreliability is of prime importance in validity studies because it distorts the appropriateness of the selection instrument, the focus therefore should be on the criterion variable since the essence is just to get the operationalization of the predictor variable on the criterion and not what the value will be if it is perfectly reliable (Lee et al, 1982) This criterion unreliability may arise from poor marking, leaking or cheating in examinations. The predictive validity is bound to be low if the criterion measure is unreliable.

The time interval between the administration of the predictor and criterion tests. If this is too long or too short, the predictive validity is bound to be affected. Too short time interval will result in unduly high coefficient while too long-time interval will result in a very low coefficient.

Restriction of Range

Givner and Hynes (1979) opined that the range of scores often used in predictive validity studies often restricted, by that they mean the scores which are used for the prediction are scores of the students who were given admission and these scores are not the same as the scores of all the students who took the exams whose scores are being used as the predictor variable. Since only a proportion of the total scores are used in the prediction, thus it is termed as restricted scores. This restriction range could be as a result of incidental selection, that is, selection made through other variables which are linked to predictor test being validated or explicit selection which is done when the predictor test is used for selection before its validity is established or natural attrition which is said to occur when those at the positive or negative ends of the criterion continuum leave the setting before the criterion data is collected (Crocker and Algina, 1986). In a nut shell, range restriction underestimates the correlation between the predictor and criterion variables, which means that with limited restriction of predictor scores, the predictive validity coefficient which is a measure of the extent to which the predictor predicts the criterion will be relatively higher.

This study lays emphasize on the predictive validity of GCE A/L and BAC results (high school results) to students' academic performance in various branches of engineering. It therefore shows clearly from above that the predictive validity of these examinations could be reduced if the criterion test, which in this context are the examinations which are used to assess the students at engineering school are not reliable. In relation to the time interval between the GCE A/L and BAC examinations and the criterion which is the examinations students take at engineering school, one could clearly see that for students who got admission into the school of engineering the same year they wrote their high school final exams the time interval between the two tests, that is the High school exams and their exams at engineering school is quite short. While the interval between the predictor and criterion for students who after A/L never went directly to engineering school will be quite long. Therefore, having a mélange of the students who got admission into engineering school directly from high school with those who never got admission directly from high school will lead to more reliable predictive validity.

However, in assessing predictive validity, two major concepts come to play which are; differential validity and differential prediction.

Differential Validity and Differential Prediction

These two aspects address the fact that the extent to which test scores predict students' future performance could differ from different groups of people. As purpoted by Linn (1978) differential validity refers to the differences in correlation coefficient between various groups of examinees. In order to quantify the relationship between the predictor and the criterion variable, a prediction equation is used which shows mathematically the relationship between the both variables. The prediction equation is represented graphically by a straight line which passes through the point pertaining to a pair of predictor and criterion variables. Care is then employed in chosing the exact position of the line because the gradient of the line will definitely influence the variance between the predicted and actual value of the criterion. The correlation coefficient is what is then used to quantify the relationship between the predictor and criterion variables. Also, Young (2001) defines differential validity as a situation where a test is predictive but to different degrees to all groups. Therefore, where differential validity abides, the predictive validity coefficient would be different for the existing groups under consideration.

On the other hand, according to the National Council on Measurement and Evaluation (NCME, 1995), differential prediction is a situation which is talked of when different groups give different algorithms and in which the inferences derived from these groups are different from the inferences from the pool groups. Linn (1978), defines differential prediction as the differences in the best fitting regression lines or differences in standard error of estimates between test takers. The differences in slopes (gradients) and or intercepts is what is used to quantitatively differentiate between the various regression lines. While taking comparisons between differential validity and differential prediction, Linn (1982) asserted that in ensuring fairness in selection, differential prediction is more relevant than differential validity coefficients. Moreover, previous studies have revealed that both differential prediction and differential validity clearly show that different groups of test takers have different prediction equations. This shows that both differential validity and differential prediction are closely related, but to an extent, they are different especially when it is considered that the prediction equation provides a more level and fair ground in the selection process than the correlation coefficient. Nevertheless, in the field of psychometrics differential validity is very important when considering issues of fair use while differential prediction anchores more on issues of bias and selection (Linn, 1982a, 1982b).

From the onset, the term differential validity embodied both differential validity and differential prediction. The first studies on differential prediction was carried out in the 1930's with gender at the center. That is, the research work was focused on differential prediction in terms of gender. Research on differential prediction later became more pronounced in the 1960's when it started to include race and ethnicity as a factor of differentiation (Young, 2001). By the 1970's different schools of thought emerged, in reference to the predictive validity. The first school of thought was that which had a view on single group validity and the second school of thought opined that predictive validity should be looked upon as differential validity. The single group validity view stipulates that a test is valid only for one group example being valid to whites or blacks and invalid for all other groups, while, the view on differential prediction stipulates that a test is valid to many groups but to different degrees and that the single group validity is a special type of differential validity which occurs under special circumstances (Linn, 1978).

In order to explain why differential prediction exists amongst different groups of people, some theories were postulated by scholars. In a bid to develop theories to explain this, some theories outrightly doubted the existence of differential validity, one of such theories claimed that differential prediction is wrongly assumed because of the existence of Type 1 error which entails the rejection of a true null hypothesis (false positive errors), incorrect research design and incorrect statistical procedures (Schmidt et al, 1978). Some theorists explained that differential prediction may go un dictected. From their point of view, the undetectable nature of differential prediction might be due to fact that bias affects the predictors as well as the criterion in the same direction for a group of examinees, that is this bias could either affect both the predictor and the criterion I the positive direction or in the negative direction as a result the difference could hardly be determined with respect of the effect of different predictors on a particular criterion (Young, 2001)

Contrarily to the two previous views cited above which show the existence of differential validity to some extent, other theoris made it clear that there exists differential prediction which is brought forth as a result of differential validity in either the predictors, the criterion or both but to different extents in relation to some of the examinees. Furthermore, Cleary and Hilton (1968) brought forth the theory of misprediction. This theory stipulates that misprediction is as a result of over prediction or under prediction of the criterion by the predictors for some groups of examinees. This problem commonly arises when the differences in the predictors do not match the difference in the prediction of the criterion by these predictors (Young, 2001). In relation to this study, the extent to which high school results predict students' performance in engineering would be determined for the various sub groups in the population under consideration, and the coefficient of prediction for each of the sub groups is what is refered to as the differential predictive validity. From this premise, differential validity would be talked of when the validity coefficients of the various subgroups of the aspect under consideration are different. Thus, differentuial predictive validity is talked of when the predictive validity coefficients of the various sub groups of the variables under consideration are different.

Test Bias

In carrying out research on predictive validity, one problem which could probably be encountered is test bias. It has a great bearing on social setting and on education and this has made it to attract global attention (Cole, 1972). Some researchers made conclusions to the fact that tests used for selection and for admission did not differentiate between different groups of examinees in their functioning. This claim was counteracted by Cruise and Trusheim (1988) who claimed that most often standardized test scores favour men and whites to the detriment of women and students who are not whites. In accordance with this claim, Nettles and Nettles (1999) stated that bias experienced in standardized examinations could limit women and other minority groups from gaining admission into institutes of higher learning. Consequently, most researchers have come to the conclusion that most standardized tests used for the selection into institutes are more often biased towards women and other minority groups (Al-Hattami, 2012).

In understanding what test bias is all about, researchers have carried out studies in order to appropriately carve out the meaning of test bias and have come out with various definitions of test bias. According to Cleary (1968) a test could be observed to be biased in a population when consistent non-zero errors of predictors are observed for members of the sub group in the course of predicting the criterion by the predictors. Also, Sheperd (1987) simply defines test bias with the word ‘invalidity’. He implied that already gathered validity evidencies of tests are affected by systematic errors brought forth by bias and that the meanings or inferences of derived from measurements of people of a particular sub group using a test could be distorted by systematic errors in the test. In line with seeing test bias as a product of errors, Jesen (1980) defined test bias as systematic measurement errors brought forth as a result of using a test with two or more specified populations. Furthermore, Camilli and Sheperd (1994) defined test bias as invalidity or systematic errors in carrying out measurements of people of particular groups with the use of tests as measuring instruments. Moreover, Linn (1984) sees test bias to stem from the over estimation or under estimation of the potentials or the criteria under consideration for measurement of members of a particular group of examinees who are stratified by demographic variables such as gender and ethnicity. According to Al- Hattami (2012), test bias arises when different meanings are given to test scores in different subgroups. Wightman (2003) argued that differences in test scores between groups is not sufficient enough to use as a premise in concluding that the test is biased.

According to Camilli and Sheperd (1994), there are two methods of determining test bias which are; the internal and external methods. The internal approach is similar to the instrument based approach to validity. That is, the internal method makes use of methods such as comfirmatory factor analyses in order to investigate the relationship between latent traits and item response (Vandenberg and Lance, 2000), as well as item response theory (Camilli and Shepherd, 1994) and methods of differential item functioning (Meade and Fetzer, 2009). The external method is a reflection of the argument based approach to the validity theory and it assesses the relationship between the test and the specified criterion. Using one of these methods in identifying test bias is of great importance as it gives the necessary information on whether or not a test is consistently bias or unfair in in relation to some particular groups of test takers (Meagan, 2019). In the psychometric world, misprediction is the concept which could be seen to be tightly rooted to test bias and as articulated by Ann Cleary in 1968 who asserted that bias occurs when the criterion score predicted from a regression line is constantly too low or too high for members of a particular sub group. The concept of misprediction comes to play as it is dwells on the question if the single equation used in the prediction of a criterion does over predict or underpredict for certain groups (Zwick, 2002).

Cleary's definition set the pace for test bias and differential prediction to be used interchangeably but later, researchers started drawing differences between the two terms. Nowadays, researchers as well as renown educational associations have come to consessus with the fact that a statistic is biased when the expected value is not a match with the actual value of the population. Consequently, test bias is defined as that situation which comes on board when systematic errors are part of measurements done on members of a particular group and it is best evaluated using internal methods (Meade and Fetzer, 2009). Moreover, other researchers have said the test its self is not biased, but bias is brought forth as a result of interpretation of test scores, therefore external methods could be used to an extent could be used to determine differential prediction, example the use of Cleary regression based approach. In accordance to this approach, Meade and Fetzer, (2008), suggested that differences in the slopes or gradient are an indication of differential validity and differences in the intercepts are a consequence of differential prediction and these indicators are not necessarily indicators of test bias. They further suggested that differences in the regression line intercepts could be as a result of either differences in the mean predictor or differences in the mean criterion. Meade and Fetzer (2008) asserted that if should in case there are differences in both the predictor and the criterion and the differences between both are proportional, it will result to adverse impacts but not necessarily bias. In case where there could be differences of the criterion and no differences observed in the predictor, one could attribute the occurrence to true score difference, bias in criterion measure, omitted variables of differences due to random errors. In the case where there could be differences in the predictor and no differences in the criterion, the occurrence could then be attributed to bias. In case where there are non-proportional differences between the predictor and the criterion, there will be need for further evaluation in order to find out if there is bias or not. But, if the difference in the predictor is large and that of the criterion is small, then test bias could be assumed should in case there is no availability of further information (Meade and Fetzer, 2008). From the above illustrations, the scenarios where test bias could best present its self has been defined to a great extent and from these a more concise definition of test bias could be coined. Test bias could also simply be defined as a situation which presents its self when test results emerging from different sub groups in a population are not the same and it is the cause of these observed differences that are responsible for the bias.

In order to understand the differences in performance of different groups in tests, theories have been have brought to the lime light in order to ease the explanation of test bias. As cited in Kye- Blankson (2005), these theories include; theories of performance in Biology which has proponents like, Jesen (1980) and Halpern (1992), differences in brain laterization (Halpern et al, 1998) and difference in social, psychological and demographic factors (Austin, Clark and Fitchett, (1971), Burton, Lewis and Robertson (1988), Borland (1995), Young and Fisler (2000). These various theories in their different perspectives detailly explained the possible causes of test bias. Amongst the various aspects highlighted in the theories cited above, demographic factors such as gender and ethnicity are the factors which have been most widely used in determining test bias.

Test Bias with Respect to Gender

Recently, educational and psychological researchers have been carrying out studies to find out the differences existing between the performances of men and women in school subjects as well as in standardized tests. Previous studies have revealed that the performances for men and women in various subjects and standardized tests differ and with variations occurring at different points at various times Kye-Blankson (2005).

Wilder and Powell (1989) carried out series of studies on undergraduate, graduate and professional school entrance tests, national tests, verbal ability tests, validity studies and quantitative ability tests. Specific testing programs which they assessed include; National longitudinal study of 1972, SAT, and the National Assessment of Educational Progress. The findings of their studies revealed that males outperformed women in Mathematics while the women performed better than men in verbal ability and achievement tests. These studies also pinpointed disparities were found between males and females, but the disparities were found to diminish with time. The findings of this study were also in concurrence with the assertion of Azen et al (2002) that the male gender is more likely to perform better in Mathematics and other science related subjects than their female counterparts while the female performed better in in verbal subjects. This also fall in line with the findings of Fenemma et al (1989) which postulated that when boys and girls are between the ages of 9 to 13 at the commencement of secondary school education boys tend to perform better than girls in Mathematics and this remains consistent though with minute differences by the age of 17. This was contrary to the findings of Hyde et al (1990) which stated that while at elementary and middle school, girls perform better than boys in Mathematics and by High school, boys tend to perform better than girls.

Moreover, Maccoby and Jacklin (1974) stated that females outperformed their male counterparts in the verbal subjects and to them, these differences tend to increase with time. Hyde and Linn (1988) did extensive analyses on studies which reported on differences in verbal ability with respect to gender. From their analyses, they came out with results which revealed that the difference in performance in verbal subjects is so small that it could be considered to be negligible. They further did a research on gender by age interaction and the findins showed that there is no difference in the performances with respect to gender. Willingham and Cole (1997) also did a study on gender differences. The findings of the study revealed that there were gender differences across various testing programs and in diverse subject areas. The findings of the study revealed that female students performed better in school based examinations while men outperformed the women in standardized external examinations.

Test Bias Related to Ethnicity

With regards to ethnicity, test bias has proven itself to some extent. According to Fleming and Garcia (1998), standardized test scores have less predictive power on blacks and other minority groups within the population. In tests which measure reading skills, verbal, Mathematical and quantitative skills as well as in tests which measure intelligence and scholastic aptitude, whites considerably score higher than their black counterparts (Nettles and Nettles, 1999). This can be clearly seen from statistics provided by Nettles and Nettles which indicate that the scores of Blacks in the verbal and quantitative sections of both the SAT and the GRE are about 100 points lower than the points of whites. Despite the fact that some findings have proven that the difference in academic performance due to racial differences is narrowing down, some other findings have proven the contrary implying the differences in scores as a result of racial differences still persist, stipulating that whites performed better than Black students and could be considered to be about five times, seven times or even twelve times better in standardized examinations which are used in the selection of students into institutes of higher learning such as; medical schools through the Medical College Admission Test (MCAT), Law schools through the Law school Admission Test (LSAT) (Persisting racial scoring gap, 2003). There is still insufficient information pertaining to differences in performance in different test formats such as multiple choice or essay type questions with respect to ethnicity (Bridgeman and Mc Hale, 1996).

Test Bias and High School Location

High school location is another factor that is used to illustrate test bias. High school location in this case refers to the actual context which the school finds itself which could either be in rural or urban areas. Test bias is said to hold in this case when students from urban areas perform in tests differently from students of rural areas. School location has been proven to an extent to significantly affect students' performance. Young (1998) found out that students from urban areas outperformed those from rural areas, but he went ahead to argue that the cause of this difference is not only urban or rural setting, but it is to a greater extent as a result of the socio-economic status (SES). In line with the finding of Young, Geske et al (2006) also posited that socio-economic status is partly responsible for students' achievement and not only necessarily the urban/ rural differences. Contrarily to the other findings which indicated that urban schools relatively had better performances than rural schools, Bylund and Reeves (2005) revealed that there is no clear evidence to the claim that urban schools are superior to rural schools and also that the annual performances of rural schools either equal or surpass those or urban schools. In terms of standardized examinations findings have revealed that there is no significant difference in the performances of students from urban and rural areas as Monk and Haller (1986) opined that students from schools in rural areas performed as well as those from schools in urban areas. Kleinfeld et al (1985) also had similar findings as Monk and Haller as he asserted that high school location did not affect students' performance in standardized tests. From the above findings, one can see that to a greater extent, high school location does not affect students' performance.

Ensuring the fairness of tests or reducing the possibilities of bias will go a long way on improving upon the validity of the test. Since a test is meant to measure students' knowledge, attitude, aptitude and ability on a particular subject matter, the appropriateness to which this test measure should be equitable to a grater extent for the subgroups within the population for whom the test was meant for.

Differential Item Functioning (DIF)

This is a phenomenon which could inherently cause test bias. DIF is said to exist when test takers or examinees with same abilities do not have the same probability of having an item correct because they belong to different groups (Hambleton, Swaminathan and Rogers, 1991). These different groups could be male and female (gender), it could be different ethnic groups and it could groupings as a result of different school types. Since the difference in the performance of an item is linked to belonging to a particular group, then, it therefore implies that the groups account more to this performance more than other psychometric measures. The differential item functioning could be determined from the item response theory through the use of the item characteristic curve (ICC) of the various groups. This could be done by computing the areas between the ICC's of the groups involved

Reliability

Tambo (2012) opines that reliability is the second important quality of a good assessment instrument. Reliability of a test is the degree to which it measures what it says it is measuring consistently. According to Anastasi and Urbina (2002), reliability refers to the consistency of scores obtained by the same individuals when re-examined with the same test on different occasions or with different sets of equivalent items, or under other variable examining condition. Crocker and Algina (1986) also defined reliability as the degree to which test scores of individuals remain unchanged or consistent over multiple administrations of the test or after administration of alternate forms of the same test. According to Messick (2000), reliability is principally dependent on consistency. It is the extent to which the instrument gives consistent results whenever it is repeatedly used to measure trait or concept from the same respondents even by other researchers. In line with this, Kimberlin and Winterstein (2008), opine that reliability is used as a tool to judge the extent to which measures which are administered at different times to the same individuals and the equivalent forms of a test are stable. In educational settings, reliability may be defined as the level of internal consistency or stability of the measuring device over time. In classical test theory, the reliability of a test refers to how much measurement error is present in the score yielded by the test. The more reliable a test is, the more confidence we can have that the scores obtained from the test are essentially the same scores that would be obtained if the test was re-administered (Amin, 2005).

In quantitative research, reliability refers to the consistency and stability of research results after subsequent measures have been made in identical situations but in different circumstances. Meanwhile in qualitative research, reliability is talked about when the researcher approach in various research works and projects remain consistent (Twycross and Shield, 2004). Subjectivity is a key aspect of reliability in research, that is, when a researcher becomes subjective in research by adopting subjective approaches, he or she greatly compromises the credibility of the research findings and of the research work in general (Wilson, 2010). Furthermore, in the case of research, the higher the reliability of an instrument, the more accurate the results, and this leads to increase chances of making correct decisions from research findings. Also, reliability is important in research but not a sufficient condition for research validity (Haradhan, 2017)

Reliability is quantified with two indices, which are; the reliability coefficient and the standard error of measurement Kyei-Blankson (2005). The reliability coefficient denotes the extent to which a test can consistently measure what it is supposed to measure and thus it measures errors associated with test scores and the standard error, summarize inconsistencies is students' scores. Reliability coefficient falls between 0 and 1, with no existence of reliability having value 0 and perfect reliability having the value of 1. For high stake purposes like licensure examinations, reliability coefficient should be greater than 0.9, meanwhile, values like 0.7 and 0.8 could be acceptable at less important occasions. Generally, reliability values greater than 0.8 are considered high (Downing, 2004).

According to Gronlund (1981), there are three points worth noting with respect to reliability. Firstly, he made mention of the fact that tests are not usually reliable and consequently, the reliability coefficient is often as a result of consistency, which could be as a result of scores being consistent over a period of time (stability), or consistent of scores as a result of different samples of test items being used (equivalence). Secondly, he emphasized on the fact that reliability is a statistical measure. That is the reliability coefficient is derived as a correlation coefficient between two different sets of scores obtained in successive occasions, and thirdly, that the results of reliability are obtained from another instrument and not from the original instrument itself.

Some of the characteristics of reliability are;

-Reliability represents the consistency of test scores

-It measures variable error, chance error or measurement error

- It is a function of the length of a test

-For some population it could be referred to as the stability of a test

- The reliability coefficient is derived by self-correlation

- It represents the accuracy or precision of a measuring instrument

In summary and in simpler terms reliability refers to the extent to which a test or measuring instrument is dependable, trust worthy and consistent in measuring what it is supposed to measure. The test scores then serve as a reflection on which the reliability of the test per say could be ascertained. This is a very important psychometric property especially in high stakes exams such as the GCE and BAC examinations.

Types of Reliability

There are many types of reliability, and each type addresses a particular aspect, example, test retest reliability addresses stability, alternate forms reliability addresses equivalence, Kuder Richardson and Cronbach alpha and split half address internal consistency. In designing standardised tests and examinations such as the GCE and BAC examinations, reliability of the examinations could be ensured by one of the methods elaborated below.

a) Test-Retest Reliability

The central aspect of test-retest reliability is a measure of stability. Stability here refers to the potential of a measure to remain unchanged or the same over time or after multiple measurements or how much variance could be expected in a person's score from one test administration to the next (Allen and Yen, 1979). Therefore, a measure of perfect stability will produce will produce the same scores upon several measurements. Stability could be seen in test retest reliability

Test-retest reliability is also called stability reliability. It refers to the degree to which scores on the same test by the same individuals are consistent over time. It provides evidence that scores obtained on a test at one time are the same or close to the same when the test is re-administered at some other time (retest) (Amin,2015). This type of reliability thus answers the questions "will the scores be stable over time?" The timing of the second administration is critical. Ideally, the interval between administration should not be too short so that values obtained from the second administration will not be affected by the previous measurement.

On the other hand, if the retesting is delayed for too long, there is a good possibility that the respondents' ability to answer some items will change due to intervening learning or maturation. Or, if a questionnaire is being administered to workers of a particular enterprise and the interval of administration is too long, then may be before the second administration the status of the enterprise might have changed and this will greatly affect the reliability (Bland and Altman, 1986). It is therefore very important for each instrument to have enough test-retest information, that is, précising the time interval between the tests.

After the test has been given twice to the appropriate group, the two sets of scores are then correlated and the results evaluated. If the resulting coefficient, referred to as the coefficient of stability is significant and high, then the test has good test-retest reliability. That is, if the reliability coefficient is greater than 0.9, then it could be suggested that the measurement instrument is free of errors, with a reliability coefficient greater than 0.8, could be considered very good while a reliability coefficient of at least 0.7 could be considered acceptable (Madan and Kensinger, 2017). The reliability obtained by this method is often lower than that obtained from split half and higher than that obtained from equivalent forms.

Assumptions of test-retest reliability method

- Since the number of test items are large, memory, practice and the carry over effect will not affect the retest scores

- Since the innate ability of individual test takers remain constant, growth and maturity will not affect the retest score

- The time gap between the test and retest should not be more than six months

- It is very pertinent for speed tests

b) Alternate/Parallel Forms Reliability

Alternate or parallel form reliability illustrate the measurement of equivalence. It refers to the measure of reliability obtained when different forms of an assessment tool is administered to the same group of individuals (Haradhan,2017). This is a measure of equivalence. It answers the question “are the two forms of the measure equivalent?” In some way, it is similar to the test retest method in that it always involves two testing situations with the same people but differs in that the same test is not given on second testing, but an alternative form of the same test is administered. These two forms are intended to measure the same thing. For example, the two tests may be based on arithmetic operations, with each containing 25 problems that are approximately of the same level of difficulty. The two forms should not differ in any systematic way. One way to help ensure this is to use random procedures to select items for the different forms of the test. If different forms of the same test or measure are administered to the same group in order to ascertain the equivalence of the two forms, administer one form of the test to an appropriate group, at the same session or shortly thereafter, administer the second form of the test to the same group, then correlate the two sets of scores and evaluate the results.

The resulting coefficient is referred to as coefficient of stability and equivalence (Amin, 2015). When the alternate forms of the test are given at different times, it reduces practice effects that may be an important factor if the two forms are administered at the same time. The major problem with equivalent form of reliability is the difficulty of constructing two forms that are equivalent and yet lack of equivalence is a source of measurement error. The other problem is that it is not always feasible to administer two different forms of the same test or even the same test twice. Though the correlation done in parallel forms is the same as that done in test retest method, it still to some extent eliminates the draw backs of the test- retest reliability method. This method is widely used by researchers of achievement tests in the psychological, educational and other scholastic fields (Sarmah, 2012).

Assumptions of the parallel form method

- The carry over effect and memory affect the test scores in this case

- The items of the two forms of the same test have the similar difficulty and discrimination indexes, are of similar types, contain the same number of items

- That the two forms of the same test are similar

c) Scorer or Rater Reliability

This refers to the measure of the agreement of the various measurements arrived at by the various raters (Gwet,2012). Scorer reliability measures the degree of correspondence among various examiners who mark the same set of test items. Here, the equivalence of ratings gotten with the aid of an instrument when used by different raters (Haradhan, 2017). The source of error variance here is always in the different scores assigned by different independent examiners. This type of reliability is more important for such tests or measuring instruments whose scoring is subjective such as in essay type questions or observational schedules (Checklist or rating scales). Ideally, a candidate’s response to test items should attract the same scores by various examiners. This is possible with multiple choice questions and almost impossible with essay type questions. To compute the scorer reliability, a set of answer scripts are photocopied and given to two or more examiners to score independently. The scores more often obtained from the examiners are then correlated. The correlation coefficient thus obtained gives the coefficient of scorer reliability.

d)Internal Consistency

Internal consistency is a commonly used form of reliability that deals with one test at a time. This refers to the measure of the extent to which different item which are out to measure the same construct, produce similar results. It also measures the homogeneity of items which are intended to measure the same construct (De Vellis, 2006). It is conceptualised through different approaches: split half reliability (sub divided tests), Kuder-Richardson method of rational equivalence, Cronbach Alpha. Each Approach provides information about the consistency among the items in a single test (Amin, 2015).

i) Split Half Reliability/Subdivided Tests.

Split half measures internal consistency by comparing one half of a set of results derived from scaled item to the other half results (Ganesh, 2009). This method of verifying internal consistency is preferably most applied when the test is very long and thus a single administration will be appropriate. This requires one test administered to a set of individuals, and the total set of items divided into 2 halves and the scores on the halves are correlated to obtain an estimate of reliability (Murphy and Davidshofer, 2005). A test could be split into two halves in various ways, it could be putting all odd numbered items in one half and even numbered items in another half. It could also be split in such a way that the first part of the test or the first half of the test becomes the first part and then the second half of the test (Haradhan, 2017).

The split half method is most appropriate for instruments which contain a large number of questions and in which the questions measure the same construct, and will be quite in appropriate in the case where the questions measure different constructs (Chakrabartly, 2013). This is because one can split and compare two parts of questions if they have a common purpose. If the questions do not measure the same construct, then doing a correlation between the two parts of the instrument will not yield reliable results. An example of applying the split half method is as follows; a teacher administers a six-word spelling test to his students and wants to determine the reliability of the total test. He will divide the test into two halves, determine the number of words that each student has spelled correctly in each half of the test rather than the total test. A statistical correlation is done so that the teacher gets an estimate of the reliability of the six-word test not just the three-word test. The split half method has provided adequate solutions to the problems faced by the parallel forms. The draw back with this method is that since the test could be divided into equal halves in different ways, and each of these ways will give different reliability coefficients. But this is only possible when the test items are of have equal difficulty indices. Thus, a test having graded difficulties can be divided only by putting odd numbered items on one half and even numbered item on the other half (Shreyas, 2013).

Assumptions of the split half method

-It gives information on the internal consistency of a score

-All the items of the test measure the same construct

-All the test items have the same difficulty index

-The two halves which are correlated are equivalent

- The assumption of Pearson method which is linearity also holds here.

The value of reliability using the split half method can be obtained by using either the Spearman and Brown Prophecy formula, the Rulon method or the Flanagan method

The spearman Brown prophecy formula

The correction formula which is used is the Spearman Brown prophecy formula given by

$$r_{xx} = \frac{2r'_{xx}}{1 + r'_{xx}}$$

Where r'_{xx} = the correlation between the two halves

r_{xx} = split half reliability coefficient (Amin, 2005)

From the above formula, it shows clearly that the higher the correlation between the two halves is directly proportional to the reliability of the whole test. Therefore, the higher the value of the correlation between the halves, the higher the reliability coefficient of the whole test.

The Rulon method

This method was developed by Rulon as an alternative method of finding split half. It makes use of variance of the difference students' scores in the two halves of the test (SDd^2) and the variance of the total scores (SDx^2). The two values are then substituted in the following formula:

$R_{tt} = 1-(SDd^2/SDx^2)$

Where,

R_{tt} = Reliability of the test

SDd = SD of difference of the scores

SDx = SD of the scores of the whole test

From the above formula, the higher the variance of the difference of the scores of the half test, the smaller will be the reliability coefficient, that is from the formula above it is inversely proportional to the reliability coefficient. The variance of the whole test is directly proportional to the reliability coefficient, that is, the higher the value of the variance of the whole test, the higher will be the reliability coefficient.

Flanagan Method

Flanagan also came out with a formula to determine reliability using the split half method. The statement of the formula is as follows;

$R_{tt} = 2(1- (SD1^2 + SD2^2/ SD1^2))$

Where;

R_{tt} = Reliability of the test

SD1 = SD of the scores on 1st half

SD2 = SD of the scores on 2nd half

SD_t = SD of the scores of the whole test

ii) Kuder-Richardson (K-R) Method

This method like the split half method provides an estimate of the internal consistency of the test items. However, this approach avoids the problem of how to split the items. It provides an average of all the possible ways of splitting the test.

The K-R reliability coefficient is obtained by administering a single test to a group of examinees. It estimates the consistency of responses to all the items in a test. To compute an estimate of internal consistency using this method, the formula below could be used;

$$r_H = \left(\frac{n}{n-1}\right)\left\{\frac{\sigma_1^2 - \sum pq}{\sigma_1^2}\right\}$$

Where ; r_H = K- R *reliability coefficient*

n = number of items in the test

p = proportion of individuals who passed each item

q = proportion of individuals who failed each item

$\sum$= *summation of*

σ_1^2 = *variance of the total score on the test*

From the above equation, the higher the number of test items, the higher the reliability coefficient. That is, the number of test items is directly proportional to the reliability coefficient. From the formula above, it also shows clearly that variance is also directly proportional to the reliability coefficient, that is, the higher the variance of test scores, the higher the reliability coefficient. This also goes further to elaborate the fact that the more dispersed the test scores are, the higher the reliability and consequently the higher the test discriminates, the higher will be the reliability coefficient and the higher will be the measure of internal consistency.

iii) Cronbach's Coefficient Alpha (α)

This is a general form of that can be used when items are not scored dichotomously. For polytomously scored items such as attitude and personality scales, a modification of the which was developed by Cronbach is used. This modified formula by Cronbach is referred to as Cronbach's Alpha or coefficient alpha (α). It is given as

$$\alpha = (\frac{n}{n-1})\left\{\frac{\sigma^2 - \sum \sigma}{\sigma^2}\right\}$$

All the symbols retain the same meanings as stated above.

From this formula, it also indicates that the variance is directly proportional to the coefficient of reliability, that is, the higher the variance, the higher the reliability coefficient and consequently the higher the internal consistency.

Factors Affecting Reliability

According to Nworgu (2015), the following factors affect reliability

1)Motivation of the Marker

The scores an individual examiner assigns to scripts on different occasions would depend on his motivation during those sessions. If he is highly motivated, he would assign high marks and vice versa.

2)Variation of the Test

The equivalent form reliability method presumes that test items in the two forms are essentially the same. Should the two test forms vary, the individual performance on the two tests would vary. This would affect the reliability of the test.

3)Inter-individual Changes

Certain changes resulting from newly acquired information or skills, memory decay or actual physical and cognitive developments may occur between the intervals separating the two administrations of a test. This would affect the individual scores and consequently the reliability of the test.

4)External Variables

Variables such as general condition of the weather, activity before the test, distractions from within or outside the test room during testing may cause the scores of some individuals to vary when tested at different times.

Techniques to improve upon the reliability of a test

To improve upon the reliability of a test, the following should be ensured

1. The items or different questions should be clear
2. The test should not be too short or too long for the time allotted
3. Instructions should be clear, precise and concise
4. The marker should keep a good and moreover the same disposition (feelings) over each of the scripts
5. Extraneous variables such as the candidate's handwriting, gender, and previous performance are not considered. If such factors are to be considered, the candidate must be told in advance and the teacher should show how important they are as objectives of the course.

Suggestions for Improving Test Reliability

According to Craig and James (2003), there are two methods which a classroom teacher could use to improve on test reliability which are; test length and item quality

Test Length

In general, the longer the test, the higher the reliability. Normally, teachers will not feel comfortable to assess a learner only from a single multiple choice question, but will feel more at ease if he is assessing students on a particular topic or chapter with a set of 50 multiple choice questions. This is simply because students' scores for each item could have a large proportion of measurement errors. But as test length increases, the percentage of measurement error decreases. This is further buttressed by the fact that low achieving students could get the single item correct even through guessing in the case of a single item test, but this would not be the case if the test had about 20 items. Making a test longer or increasing the items of a test depends on the number of items the initial test first contained (Craig and James, 2003). For example, increasing a five-item test by five items will affect the reliability more than increasing a twenty-item test with five items. This can be explained using the Spearman Brown prophecy formula which is as follows;

$a^{new} = ma^{Old} / 1 + (m-1)\, a^{old}$

where;

a^{new} refers to new reliability coefficient obtained after the test has been lengthened or shortened

a^{old} refers to the reliability coefficient of the test under consideration before lengthening or shortening

m is a quotient determined by dividing the new test length with the old test length.

From the above equation, it shows that given the reliability coefficient of a test containing a particular number of items, the reliability coefficient of the test could be calculated if the number of items are either increased or reduced in the test. For example, given that the reliability coefficient of a test with six items is 0.6, then the items are increased to 12, it therefore means the new reliability coefficient would be calculated as follows;

Given that the test items have been increased from 6 to 12, it implies m= 12/6 = 2

Therefore, $a^{new} = 2(0.6)/ (1+ (2-1)0.6) = 0.75$

This indicates a remarkable increase in the reliability coefficient from 0.6 to 0.75, therefore the reliability coefficient has been increased by a factor of 1.25. Generally, when lengthening the test precautions must be taken to make sure that the items to be included in the test are of the same quality as those of the already existing test. Also, aspects such as time or duration for writing the test as well as examinee fatigue should be taken into consideration.

Item Quality

This is another aspect which could greatly affect the reliability of a test. Good items in a test tend to increase the reliability of the test while poor items tend to reduce test reliability. Item quality refers to the difficulty index and discrimination index of the items of the test. The item Difficulty Index also known as p- value is a measure of the proportion of examinees who get a particular test item correct (Tavakol and Dennick, 2011). It is computed as

Item Difficulty Index = Number of examinees who get item correct / Total number of examinees

The difficulty index indicates the easiness of an item in a test. The p- value ranges from 0.0 to 1.0. The value is often interpreted as follows

< 0.3 = too difficult

0.3- 0.7 = recommended, good or acceptable

> 0.7 = too easy

According to assessment experts, the most preferred values for item difficulty index should be in the range 0.5 – 0.6 (Ananthkrishnan, 2000) as cited in (Ahmed, Shaheen, Elmardi and Musa, 2018). From the p- values above, it shows that in order to ascertain the reliability of a test, the difficulty indices of the items should be of the desired range as being too difficult or too easy might affect the reliability negatively in different ways. Items being too difficult or too easy could also affect the validity of the test. For example, the predictive validity of a test having such items will be quite low, because if the test has items which are too easy, then most of the students might have high scores and if these scores are used to predict future performance, they will be highly unreliable. Likewise, if the items are too difficult, that is having difficulty indices which are less than 0.3, most of the students might intend have relatively low scores and if these scores are also used to predict students' future performances, they would also be quite unreliable because they were not a true reflection of whom the students were since the test item were quite difficult.

Another aspect of item quality is the Item discrimination index simply called the d-value refers to the difference between the proportion of top achievers who had the item right and low achievers who low achievers who had the item right. It illustrates the ability of an item to distinguish between the more knowledgeable test takers and the less knowledgeable. That is the higher the value of the item discrimination index, the higher the item distinguishes between students of higher and lower abilities (Ahmed et al, 2018).

Item discrimination index is simply calculated using the formula;

$D = P_T - P_B$,

where,

D = discrimination index

P_T = Proportion of top achievers who got the item right

P_B = Proportion of low or bottom achievers who got item right

Other methods have been developed to derive the discriminatory power of an item, such as the biserial correlation coefficient, the point biserial correlation coefficient and the phi- coefficient. Though the prime position held by the item discrimination index as it succinctly describes item quality, it is not reported in the remark software reported item statistics. Instead, this provides the point biserial coefficient (r_{pbis}) (McAlpine, 2002). It quantifies the relationship between an individual's score on an item which is a categorical variable and the individual's score in the whole test which is a continuous variable. Therefore, when the value of the point biserial coefficient is high, then, those who had high exam scores had the item correct and those with low scores did not get the item correct. Also, low values of r_{pbis} indicates that the examinees who had low scores in the examination had the item correct while those with high scores did not get the item correct. Using the point biserial coefficient is more advantageous than using the item discrimination index because the item discrimination index makes use only of the top achievers and bottom achievers of the particular test or examination, that is, making use of just about 54%(27% Top and 27% bottom) of the total test takers whereas the point biserial coefficient makes use of all the test takers in order to derive the discrimination index (Shannon, 2007).

The values of point biserial coefficients range from -1 to 1. The value is positive for the right answers and negative for the distracters. The higher the value of the point biserial coefficient, the more the item discriminates between the top and bottom achievers. A discrimination index of 1 signifies an item which perfectly discriminates between high and low ability students (Ahmed et al, 2018). Item discrimination index which is greater than 0.2 is acceptable because it could clearly distinguish between the top and bottom students (Shete, Kauser, Lakhkar and Khan, 2015). Also, items with very low discrimination indices which are close to zero should be excluded from the test, because it shows clearly that such items are do not discriminate between good and weak students as the weaker students score better in them than the top students (McAlpine, 2002).

Ebel and Frisbie (1986) as cited in Ahmed (2018) qualified item discrimination indices as follows; -Item discrimination index which is equal to or greater than 0.4 are considered excellent

-Item discrimination index between 0.3 and 0.39 is considered good

-Item discrimination index between 0.2 to 0.29 is considered acceptable but the item needs to be reviewed

- Item discrimination index less than 0.2, implies the item needs major revision, if not it should be discarded

-Item discrimination index of less than 0, implies the items should be discarded.

III) Usability

Usability is the third quality of an effective instrument. A simple way to determine usability is to ask the question “is it practical to use the instrument?” That is, can it be used with minimum expenditure in time, energy, resources and money? According to Michael (2016), usability refers to the extent to which tests are used without much expenditure in relation to time, money and effort. In addition, usability is affected by factors such as; administrability of the test, scorability of the test, interpretability of the test and test results, proper mechanical makeup of the test and the economy of the test.

Administrability refers to the ease, clarity and uniformity which should accompany test administration. For this to be a reality, clear, concise and simple directions should be given as well as the specification of time limits accompanied by oral instructions and the specification of sample questions. There must be definite and clear provisions for the preparation of test materials, the distribution of the test materials and the collection of these test materials. Scorability on its own part refers to adequateness and smooth nature of the test in relation to allocating scores. Thus, for a test to be considered good, it should be easy to score, and for it to be easy to score, the directions of scoring should be clear, the answer to each item should be available, the scoring key should be made simple as well as the machine scoring should also be possible. In relation to interpretability, the test results after scoring should be meticulously, systematically and correctly interpreted so that the test results could be used in the making of important educational decisions such as guidance and counselling, placement, selection and predicting future performances (Michael, 2016).

In general, an instrument with a high degree of usability is

1. Easy to administer to pupils
2. Easy to mark or score
3. Economical to use
4. Has good format or design

The Concept of Measurement

The word measurement originates from the latin word ‘mensura’ which means measuring something accurately (Kizlik, 2014) Measurement is the assignment of numbers to objects or events in a systematic fashion. Measurement entails collection of quantitative data. A measurement is made by comparing a quantity with a standard unit. Measurement directs behavior (Hopkins Stanley, 1981). In the same light measurement is defined by Tchombe (2019) as the process which involves the assignment of objects, or events with numerals so as to quantiatatively represent such qualities. Measurement could also be defined as the process of determining the attributes or dimensions pertaining to some physical objects. Measuring thus entails the use of some standard instrument in order to determine per say how long, how hot, how cold or how volumnous that particular thing under consideration is. Standard instruments refer to physical instruments used for measurement such as rulers, pressure gauges, thermometers and scales amongst others. The usability of the measurement then depends on how reliable and valid it is. (Kizlik, 2014). Also, the term measurement is conceived generally as the process of assigning numerical values to describe features or characteristics of objects, persons or events in a systematic manner. This conception connotes that measurement is only quantitative. It tends to exclude the possibility of measurement being qualitative. However, measurement in its broadest sense can be both qualitative and quantitative. At the rudimentary level, measurement is qualitative but as the precision improves, it becomes more quantitative. Consider for instance, the classifying a group of people in terms of the colour of the dresses they are putting on, states of residence or according to their various heights, whether they are tall, of moderate height or short. The above measurements can only yield quantitative results and thus they are considered to be rudimentary measurements (Nworgu, 2015).

Measurement could also be seen as the assignment to a position on a scale of greater than or less than Horrocks and Schoonover (1968) as cited in Nworgu (2015). Such assignment can be to a qualitative series. This definition as broad as it is, tends to portray measurement as only a process but measurement could also be viewed as a product. Looking at measurement from this perspective, measurement could be seen as that value or position on a scale assigned to a feature or to the characteristic of an object (Nworgu, 2015). From these one can define educational measurement as the assignment of scores appropriately in accordance to students' achievement as assessed.

Most definitions of measurement either coined under the representational theory or the information theory. In the representational theory, measurement is defined as the correlation of numbers with entities which are not numbers. The additive conjoint measurement is the strongest form of the representational theory. In this form of representational theory, the assignment of numbers is based on the similarities between the structure of the number system and the structure of the qualitative system to be quantified. Thus, a system could be quantified if this correspondence is established. The concept of measurement is often misunderstood as merely the assignment of a value, but it is possible to assign a value in a way that is not in accordance with additive conjoint measurement. One could assign a value to a person's height, but unless it can be established that there is a correlation between measurements of height and empirical relations, it is not a measurement according to additive conjoint measurement theory. Likewise, computing and assigning arbitrary values, is not satisfactory criteria and thus such is not considered as measurement (Achankeng, 2011).

The information theory takes into cognizanse the fact that all data are inexact and statistical in nature. Thus, basing on the assumptions of the information theory, measurement can be defined as a set of observations that reduce uncertainty where the result is expressed as a quantity. This definition is reflected in what scientists do when they measure something and report both the mean and statistics of the measurements. In practical terms, one begins with an initial guess in relation to the value of a quantity, and then using various methods and instruments, reduces the uncertainty in the value. In this view, as well as in the positivist representational theory, all measurements are uncertain, therefore instead of assigning one value, a range of values is assigned to a measurement. This also implies that there is a continuum beteween estimation and measurement (Achankeng, 2011).

It is of prime importance to elucidate outrightly the differences between mere physical measurement and measurement in the education milieu. This is because although measurements are done in so many fields, they differ in the instruments used as well as in the mannerisms of measurement due to the different scenarios presented in the different fields. According to Nworgu (2015) there are a plethora of differences between measurements carried out in the physical sciences and those carried out in the educational sciences. Firstly, in the physical sciences, what is to be measured and how it is going to be measured is well carved out and desined example measuring the mass of a substance or the length of a wall is clearly defined, while carrying out measurements in the educational sciences what is to be measured and how it will be measured, example, measuring giftedness is not as clear because there is no standard instrument as compared to measuring length which a standard instrument called the ruler is used.

Secondly measurements in the physical sciences is quite direct while the measurements in the educational sciences are indirect. This is simply because in measurements in the physical sciences, the instrument used for measurement have similar attributes with the object which it is measuring example a metre rule which is used to measure the dimensions of an object, possess the properties of the dimension to be measured be it the length, the width or the height. This therefore makes it easy to directly measure the length for example of an object by placing the metre rule on along the length to be measured. Meanwhile in the case of carrying out educational measurements, the instruments used for the measurement do not have the attributes of what is being measured, for example, in measuring intelligence using an intelligence test, the test its self does not possess the characteristics of intelligence thus it is not possible to determine the intelligence of individual person's directly as in the case of using a ruler to get the length in the case of physical measurements. Thirdly, measurements in the physical sciences are more exact and accurate since most of the measurements are done in the interval and ratio scales of measurement as compared to measurement in education where most of the scales do measurements at the ordinal level. Fourthly, the attributes being measured in the physical sciences are not affected by extraneous environmental factors, example, measuring the resistance of a wire, noises from the environment will not affect the resistance being measured in any way. Meanwhile, in the case of measurement carried out in education, the attribute being measured are highly sensitive to extraneous environmental factors. For example, in measuring students' academic performance in a classroom, the noise in the classroom can strongly affect the measurement (Nworgu, 2015).

Scales of Measurement

The assignment of values is usually done during measurement in accordance with specified rules, thus making the process systematic. This is also done at various levels depending on what is being measured, what instruments are involved and the desired level of accuracy and precision. These various levels at which measurement could conveniently be carried out are called the scales of measuring instruments or levels of measuring scales. The scales are; the norminal scale, the ordinal scale, the interval scale and the ratio scale. The appelations; norminal, ordinal, interval and ratio are also given to data obtained at the respective scales. The scale type of scale also determines the kind of statistical treatment which could be given to the data (Nworgu, 2015, b.)

The Norminal Scale

This scale is the most simplified scale. Measurement at this level entails the assignment to class or categories in which all the categories are considered to be at the same level, that is, none can be considered greater than the other. Measurments in this scale do not have magnitude (Nworgu, 2015, b.) Examples of measurements from this scale are; gender, which could be male or female, ethnic groups which could be Bamilekes, the Bangwas, the Fang-Beti, the Bamouns or the Ngembas amongst others. These various tribes in Cameroon for example could be labelled using numbers example 1 for the Bamilekes, 2 for the Fang Betis, 3 for the Bangwas, 4 for the Bamouns and 5 for the

Ngembas Variables in the norminal scale are called categorical variables. The theory of measurement was introduced by statisticians to justify norminal scales or measurements: the use of numerals as names for classes is an example of the assignment of numerals according to rules, the rule is: Do not assign the same numerals to different classes or different numerals to the same class. The central tendency of the nominal attribute is given by its mode, and in the nominal scale, neither the mean nor the median could be defined. Example, given a set of people, we can describe the set by its most common name (the mode), but would not be able to provide an average name or even the middle name among all the names. Thus, the permissible statistics which could be done with data on this scale in the mode and the chi-square (Achankeng, 2011).

The Ordinal Scale

Unlike the norminal scale where order and magnitude does not exist, there exist order and magnitude with the ordinal scale. On this scale, members of a group can be classified and in addition to that, they could also be compared with reference to their different magnitudes and sizes, and they are compared with the use of Mathematical tasks such as less than, equal to or greater than. Examples of such categorization are grades scored in examinations such as A, B, C, D, E, F, sizes of shoes such as 38, 39, 42, 44, 45 and the positioning of students in class in order of merit with the use of 1st, 2nd, 3rd, 4th. Considering a case where students in an end of course examination score grades A, B, C and, D and in which the 4 points are associated to grade A, three points to grade B, two points to grade C and one point to grade D with these grades, one cannot conclude that a student who scored an A grade is two times more knowledgeable than a student who scored a C grade (Nworgu, 2015.b). In order words, equal intervals do not represent equal quantities of the attribute under consideration which is being measured. When using the ordinal scale, the central tendency of a group of items can be described by using the group's mode (or most common item) or its median (the middle-ranked item), but the mean (or average) cannot be defined.

Interval Scale

An interval scale has both magnitude and equal intervals, but it does not have the absolute zero. Temperature is a classic example of an interval scale because we know that the difference between each degree is equal, and it can be easily determined if one temperature is equal to or greater than or less than another. Temperature, however, has no absolute zero because there is theoretically no point where does not exist. Also, temperature scales are interval data with 25C warmer than 20C and a 5C difference has some physical meaning. Note that 0C is arbitrary, so that it does not make sense to say that 20C is twice as hot as 10C. Quantitative attributes are all measurable on interval scales, as any difference between the levels of an attribute can be multiplied by any real number to exceed or equal another difference. The temperature with the Celcius scale is a common example of the interval scale. On this scale, the zero point is arbitrary and consequently, negative values can be used. The terms 'interval variables' or 'scaled variables' are used to describe variables measured on this scale. The mode, median and arithmetic mean could be used as measures of central tendency to represent variables measured on this scale Measures of dispersion could be measured from the range, inter quatile range and the standard deviation (Achankeng, 2011)

The Ratio Scale

This is the most refined scale. It has properties of order, magnitude as well as equal interval. In addition to the above, the property of absolute zero which is absent in the other scales is present in the ratio scale. These scale is more commonly used in physical measurements morethan educational and psychological measurements (Nworgu, 2015, b). Physical measurements of height, weight, time, plane angle, energy and electric charge and length are typical ratio variables. In this zero, there is a natural zero. Thus, it is meaningful to say that a length of 10m is twice as long as a length of 5m. Also, a person who is 25 years would not only know that he or she is older than a person of 18 years but also that he or she is 7 years older than the fellow counterpart. The name of this scale is brought forth from the fact that measurement is the estimation of the ratio between a magnitude of a continuous quantity and a unit magnitude of the same kind. All statistics used in the case of interval data is permitted in the ratio scale including geometric mean, harmonic mean, coefficient of variation and logarithms.

Measurement Errors

The most desirable characteristics of every measurement done is the reliability and validity of the measurement, but with the existence of errors which could significantly affect the measures, these pertinent psychometric properties may not be a reality. The measurement error is defined as the difference between the measured value and the actual value. The true value is gotten as the mean or average of the infinite number of measurements while the measured value is the precise value. Mathematically, this measurement error could either be a positive value or a negative value, this can be seen from the equation

$X = X_r – Xi$

Where X is the measurement error and Xr is the real but not the true measurement and Xi is the ideal and true value of the measurement (Haradhan, 2017). That is, from the mathematical representation above, when the real value is greater than the idea value, the value of the measurement error will be positive and when the ideal for the measurement is greater than the real value, the measurement error will be negative. Malhotra (2004), categorized measurement errors into three categories which are; Gross errors, systematic errors, which are those which affect the observed scores in a like manner across multiple measurements and the systematic errors

Gross errors

To Corbett et al, (2015), these are errors which come as a result of human mistakes, computational errors, failure of equipment and carelessness on the part of the experimenter. This kind of error can arise for example if an experimenter in taking a thermometer reading, takes the wrong reading, let’s say in the place of 19.1^0C he or she instead records 18.1^0C, this happens because of wrong reading and thus a wrong measurement is taken. In order to to away with such errors, two techniques could be employed, the first of these techniques is to employ a high degree of care in reading results on instruments and the second technique is that two or more readings should be taken by the experimenter at two different times (Haradhan, 2017).

Systematic Errors

They affect the scores of test takers in a systematic manner. Systematic errors as a consequence of faults on the measuring instrument. These errors can thus be limited by correcting the measuring device (Taylor, 1999). Systematic errors are classified as; instrumental errors, environmental errors, observational errors and theoretical errors.

a) Instrumental Errors

According to Swamy (2017), these are errors brought forth as a consequence of poor manufacturing in accurate calibration or poor usage of the instrument. In order to reduce or eradicate these errors, some stringent measure have to be employed and in very precarious situations, the instrument should be carefully recalibrated in order to have an instrument which will give more reliable measures.

b) **Environmental Errors**

To Gluch (2000), when an instrument used for measuring is exposed to external factors such as temperature, pressure, electric and magnetic fields amongst others, the instrument will be liable to such errors called environmental errors. In order to minimize these errors, there environment where the instrument is being used in doing measurements such as the laboratory should be made to have constant physical conditions such as constant temperature, pressure and also to make sure that there are no magnetic or electric fields around the instrument. These environmental errors are likely to occur in measurements in the physical sciences.

c) Observational Errors

Allchin (2001) sees observational errors as those errors brought forth as a consequence of false observations made or wrong readings made on the instrument. Making the instruments to be more accurate and having mirrored scales will help reduce errors due to parallax which is one of the main causes of this error. Also, in order to reduce this error, the person using the instrument should be extremely careful and should make sure he or she takes the readings or observations morethan once. This is another type of error which is predominant in the physical sciences.

d) Theoretical Errors

This error comes up when a theory used is assumed to postulate a particular phenomenon which it does not actually postulate, and consequently, working with this theory with the wrong assumptions will lead to errors since the assumptions are not apt in the particular scenario under consideration. Example, if a theory which is being used postulates that the temperature of the surrounding does not affect the readings taken by the instrument, meanwhile it actually affects it. In that case, the readings will be faulty, and it will be as a result of theoretical errors (Allchin, 2001)

Random errors

Haven taken into consideration all the systematic errors, there is still some form of errors which exist, or which could not be accounted under systematic measures and these errors are called random errors (De Vellis, 2006). These are the kinds of errors which spring up as a result of changes in experimental conditions such as unexpected temperature or voltage changes, noise as well as fatigue in the work place. The random errors could either be positive or negative (Taylor, 1999).

Nenty (2015), in his own view measurement errors affirmed that there are two kinds of errors attributed to measurement which are random errors and systematic errors. To him, random errors arise when we find that for a true score (Xt) that is invariant, we observe variability in our observed score (Xo). That is the same measure taken more than once yields different scores. It indeterminately occurs whenever physical or psychological measurement is made. From the classical test theory, the scores of testees which is called the observed score (Xo) is made up of the true score (Xt) which represents what is actually being measured and the random error (Xe).

That is, $Xo = Xt + Xe$

The classical test theory only takes into account errors which are attributed to random errors which are principally those errors which emanate from the interactions of factors under consideration except the trait factor which is being measured but which affects the observed score beside the trait which is being measured. This thus brings to the lime light the two kinds of measurement errors, which are the random and systematic errors. While the random error is that which makes a testees score unrepeatable, for example any variation in performance across examinees and across time, systematic errors is that which makes the observed score predictably different from what it would have been without it. Different aspects that makes test takers perform differently in a particular test given that they are of the same ability is tied to systematic error. Persistently faulty instrumental or human observation or measurement is a good source of systematic error (Nenty, 2015).

From these basics, the classical formular of variance can be expressed, that is;

Vo = Vcom + Vsystematic extraneous + Ve2 (Source; Nenty, 2000 as cited in Nenty, 2015)

That is, our test score variance is made up of the systematic variance due to the ability our test was designed to measure plus another systematic variance due to extraneous sources, plus the ever present random error variance This provides the basis for the development of item response theory which is based on the unidimensionality assumption. Moreover, random errors affect the variance of test scores across time, occasion and across items, systematic error instead affects the magnitude of the test score and makes it to either be bigger or smaller than what it would have been without the error. Therefore, random error affects differences in variability and necessarily the mean of scores in a distribution while systematic errors affect instead the mean and not necessarily the variability of test scores (Trochim, 2006) as cited in (Nenty, 2015). Random errors affect reliability morethan validity as large random errors impede reliability while systematic errors have more bearings on validity as large errors of systematic errors infringe greatly into the test's validity. In most testing senarios today, testing or the measurement of particular aspects with the use of a tesr is done once. This is done in accordance to the classical test theory in order to determine the true ability of a testee. With many testees, the differences between individual's testees scores and the standard deviation could be determined. The reliability of the test in measurement will intend determine the closeness of the true score to the observed score. Using the standard deviation, the standard error measurement could be determined, thus;

S (measurement) = S $(1 – Rxx)^{1/2}$

Where; S(measurement) = the standard error of measurement

S = Standard deviation

Rxx = Reliability coefficient

The value of the standard error measurement will be used to know the limits within which every score lies taking into consideration its error margin. That is, if a value of

2.032 is arrived at, it therefore means that every score in the distribution lies between + 2.032 and -2.032 of its current value (Nenty, 2015).

The Concept of Evaluation

According to Tuckam (1975) evaluation is the process wherein the parts, processes or outcomes of a program are examined to see whether they are satisfactory particularly with reference to the stated objectives of the program or own expectations or own standards of expectations. Evaluation in this sense is purely qualitative and is preceded by measurement. Measurement makes available the pertinent information and evaluation judges the worth or value of that information.

To Tchombe (2019) evaluation entails the judgement of the effectiveness as well as social utility and desirability of a product, process with regards to the defined and agreed upon objectives or values. Evaluation thus comes in to make assessment spiced up with value judgement. Tchombe in her definition did not only dwell on judging the effectiveness of the particular aspect under consideration, but goes ahead to look into the implication of the particular aspect in society by having a look on the social utility, and desirability of the aspect under consideration.

Tambo (2012) sees evaluation as the interpretation of the marks or scores produced by the assessment process. It means making a judgment about the performance of the student based on the information obtained from the assessment where a teacher for example says that the student has performed “excellently”, “very well”, “averagely” or “poorly”, such words represent an evaluation of that performance. Moreover, evaluation also means the conversion of test or examination marks into grades such as A, B, C, D, E and F with each grade given a value such as “excellent” and so on.

Nworgu (2015) opined that the term evaluation is generally used in two senses. In the first sense, evaluation is seen as the process through which value judgement made or decisions are taken about events, objects and their characteristics. These judgements and decisions arrived at are predicted on certain criterion or criteria use empirical data or information which is made available through measurements. In this circumstance, evaluation is purely qualitative, and it is preceeded by measurement. That is measurement makes available the relevant information and through the process of evaluation, judgements are arrived out pertaining to the information. Therefore, evaluation makes the information from measurement more succiptible and relevant, as it begins where measurement stops. Moreover, evaluation is also used in a wider and more encompassing sense as a process of seeking, obtaining and quantifying data with a view of making value jugdements about objects events or characteristics. Conceptuaqlized in this direction, evaluation encompass measurement and more and it is both qualitative and quantitative (Nworgu, 2015).

According to the Cameroon GCE board, at the Advanced level, the performance of a candidate in each subject attempted is indicated in descending order of merit by the grade A, B, C, D, E, O or F which is recorded on the results slips issued to candidates. At the ordinary level, the performance of a candidate in each subject attempted is indicated in descending order of merit by the grade A, B, C, D, E or U which is recorded on the results slips issued to candidates. A pass in an ordinary subject is indicated by one of the three grades A, B, C, of which grade A is the highest and grade C the lowest. Performances below the standard of grade C are not recorded on the certificate. Grade O indicates an Ordinary level result awarded in a subject taken at Advanced level. It signifies that the candidate did not pass at Advanced level but was judged to have reached the standard of grade C of the ordinary level examination. A pass in an Advanced level subject in indicated by one of five grades A, B, C, D, E, of which grade A is the highest and grade E the lowest. Grade F is a fail grade and is not recorded on the certificate.

In the BACalaureat examination, the grading system is according to what is called ‘mention’ the five categories in descending order are: Mention Tres Bien, Mention Bien, Mention Assez Bien, Mention Passable and Echec. Therefore, the highest Pass grade is Tres Bien while the least is Passable and Echec is a Fail grade.

Types of Evaluation

Evaluation which is generally involved in the passing of value jugdement can be classified into various types and categories. The most common types of evaluation are classified according to the purpose and timing of the evaluation and the object of evaluation. The different types of evaluation do not insignuate that the process of evaluation will be different in the various circumstances, thus the process of evaluation remains the same but what differs is what is evaluated, the mode of aapplication of the evaluation process and the judgements arrived at. According to Hezel (1995) evaluation could be based on the leader or instructor, program, instruction, technology, environment, support services as well as level of use, cost outcomes and management. Gagne at al (2005) in line with Hezel (1995) came out with six aspects which could be evaluated which are;

Evaluation of the instructional materials

This involves passing value judgement on the quality of materials used during the teaching- learning process. This assessment is carried out in order to ascertain the worthwhileness of the instructional materials and to also determine if the instructional materials were apt enough in making the educational objectives a reality.

Quality Review of the Instructional System Design

This has to do with determining the extent to which the instructional system at each point in time is appropriate and adequate in accomplishinh the educational objectives.

Assessment of Learner's Reaction to the Instruction

This entails ascertaining the various ways learners react in face with the instruction. That is, determining whether the learners are impressed with the instruction whether the are not impressed with the instruction

Measurement of Learner Achievement of the Learning Objectives

This has to do with passing value judgement on the extent to which the learning objectives have been achieved, so that consequently, modifications could be made on the teaching approach and could even lead to the fine tuning of the objectives to more attainable objectives.

Estimation of Instructional Consequences

Here, the essence is judging the relevance of the consequences of instruction. This has to do with determining whether the instruction metted has positive consequences or negative consequences on the learners. Thus, the judgement passed in this case will make it clear whether the consequences are desirable or not.

Transfer of Learner’s Skills to the Environment

Evaluation here has to do with passing value judgement on the extent to which learners apply what they have learned to the environment. Therefore, the expression of the degree of satisfaction of their applicability of knowledge to the environment will tell whether the skills were properly acquired or not.

According to Gafoor (2013), the various types of evaluation can be classified based on the purpose of evaluation and on what is being evaluated. That is the purpose of evaluation in this context also includes the goals and objectives of evaluation while what is to be evaluated refers to the object which is to be evaluated.

Types of Evaluation based on Purpose

The various evaluation types which are classified based on purpose are; placement evaluation, formative evaluation, diagnostic evaluation and summative evaluation.

Placement Evaluation

This is the type of evaluation which is used put students in the appropriate class based on their ability and aptitude. The putting of students into various classes can also be done basing on the subject combination which the students are offering example, sciences, the arts, technical or commercial (Gafoor, 2013). The placement evaluation involves making decisions which would be used to situate students in different classes or educational programs, and this evaluation only comes as a prelude after the placement test has been administered and measurements made. Moreover, Madaus (1970) postulates that placement evaluation is used in the placement of students taking into consideration their previous performances as well as their individual personal characteristics into the most pertinent point of the instructional sequence, to a perculiar instructional strategy or moreover to a suitable teacher. He explained placement using the analogy of a number line where, students prerequisite knowledge as well as past learning experiences are placed on the negative arm of the number line, that is to the left of the zero point on a number line while the presence of these skills and the non existence of the students mastery of knowledge in relation to the objectives of the course still to be done is represented by the zero point and the course objectives are represented by the positive arm of the number line. Therefore, locating in order to appropriately place students in their actual positions on the number line is definitely the main purpose of placement evaluations. But, the pitfall in this analogy can be seen from the fact that prerequisite skills as well as course objective caanot easily be quantified and are not necessarily sequential or hierarchical for their locations on the number line to be apt. Consequently, in most formal education settings, students are randomly placed on the imaginary zero point since cognizance is not taken with regards to their prerequisite skills as well as their prior mastery of the course objectives. Also, students could be placed based on the appropriateness of the teacher, that is to the most appropriate teacher and also according to optimal instructional strategies. From the analysis above by Madaus (1970), it is very necessary for educational institutions to consider students' prerequisite knowledge as well as the extent to which they are prepared for the new academic challenge from their prior mastery of the course objectives.

Formative Evaluation

According to Tanyi (2016), formative evaluation refers to the process of judging the value or worth of a program, while the program is ongoing. Formative evaluation enables designers, learners and instructors to know the extent to which instructional goals and objectives are being achieved, so that necessary remediations could be made with respect to identified deficiencies so that learners could easily aquire the necessary skills and knowledge.

Formative evaluation is evaluation carried out in order to give feed back both to the teacher as well as the students on the mastery of the various tasks taught within specific units. Formative evaluation also helps the teacher to know whether or not instructional objectives have been attained. This type of evaluation is thus used to ensure teaching success. Formative evaluation comes to play through the use of weekly tests, monthly tests and even terminal examinations (Gafoor, 2013). During formative evaluation, the evaluators take into consideration the goals and the objectives of the program, the extent to which the materials being taught are sufficient enough to achieve the objectives, the extent to which the educational objectives carried out could lead to the attainment of the objectives, the evaluators also make sure the materials are technically correct, as well as if the learning activities are relevant and what resources are required for these learning activities. Furthermore, evaluators should also take into consideration the modifications needed to improve learning and also to determine what problems exist in the teaching-learning milieu (Achankeng, 2011).

Diagnostic Evaluation

This is the type of a ssessment carried out most often to identify the strengths and weaknesses of learners which could not be identified by formative evaluation. It is most at times thus carried out after formative assessment has been carried out. In a very practical sense, when formative evaluation has been done and there still exist persistent weaknesses amongst the learners, the teacher can then design a diagnostic test in order to appropriately diagnose or identify the main causes of students' persistent learning difficulties (Gafoor, 2013).

To Madaus (1970), the purpose of diagnostic evaluation is to identify learners whose behavior in the classroom is not directly caused by factors linked to the teaching-learning transaction process or to the instructional system. Therefore, the rational for the evaluation is to identify the extra classroom factors which affect students' performance in school.

Summative Evaluation

To Tanyi (2016), summative evaluation is that method used to judge the value or worth of a program at the end of the program. This is the type of evaluation carried out at the end of instruction or at the end of a learning program in order to determine or assess the extent to which the learning objectives have been attained. It is some sort of evaluation which entails summarizing because it passes value judgement on the teacher, the students, the curriculum and the entire educational system as a whole after haven had a panoramic view on the whole system. This is the type of evaluation used for certification (Gafoor, 2013). Tests conducted for Summative evaluation's sake, contain weighted items, that is the number of items measuring a particular objective will be as a result of the importance placed on that particular objective. That is summative tests are a reflection of weighted judgement with relation to the worth objective under measurents from the table of specifications (Madaus, 1970).

To Mohanty (2005), summative evaluation is usually done at the end of a semester or a period of instruction, and it often takes place a few weeks before the seizure of classes for the term or semester. The evaluation is carried out with the students in their various classes. The evaluation could be done either with the paper and pen format or through the use of online technology. Using the paper based format, the teacher after submitting the test questions to the school administration, after the students take the examinations, the scripts are the sealed in envelopes and the teacher might only come in contact with them after the final grades are submitted. The online version could make use of branching question technology in order to properly assess the students. Nevertheless, the both methods provide feed back to the teachers, and the feed back will help the teacher assess the quality of instruction, and which could also be used to further assess the teacher for promotion purposes amongst others. Summative evaluation focuses on determining the effectiveness of a completed program, and it is done at the conclusion of a program. This is because it determines the effects of the program and reports the effectiveness with the major focus on whether a program should be continued or not. Summative evaluation which is also refered to as product evaluation looks at the results of a program after its implementation and focuses on summative question techniques, and also deals with the examination for accuracy (Achankeng, 2011).

Types of Evaluation based on what is being Evaluated

Evaluation types also vary, depending on what is to be evaluated. All these entail the giving of value judgement to the particular aspect under consideration. Example it could be the evaluation of students, the evaluation of a school, the evaluation of a personel amongst others.

Student Evaluation

Students could be evaluated through assessing their academic avhievement, their attitude, personality and their interest. The most common way in which students are evaluated is through the out put from tests or assessments in other forms administered to them. Therefore, in order to assess achievement, tests which could be standardized, or teacher made tests, or through other forms of assessment such as oral examination, portfolio's and projects. The data teachers get from such assessments are not only used to evaluate the learners but also to evaluate them selves with regards to their teaching methods, their manner of assessment and their instructional patterns in general as information or feedback gotten from students at present could be used to adjust future instruction in order to ease the teaching-learning transaction. Evaluating students entail the making of various kinds of decisions in line with whether or not the objectives have been attained, whether the student is up to the expected potential, if there are any students who require special needs like special special learning environments, as well as placement of the students if need be into special programs, the employment of students basing on their academic performance and the admission of students into institutes of higher learning (Gafoor, 2013).

In line with the scholar academic ideology, students' evaluation attempt to measure student's ability to represent to the members of the discipline that which has been transmitted to them through the curriculum. This evaluation thus rests on the correspondence theory of knowledge which postulates the fact that the extent to which what is in one's mind in a particular discipline reflects what one actually possesses. The certification of students rising within the occupational hierarchy is one of the main reasons for student evaluation as purported by this ideology. Evaluation thus ranks the test takers by assigning them a sequential ordering from best to worst within the group to whom the test was administered. The ranking is determined by some posterior through norm-referenced tests, the results of which are determined after students have been evaluated. It is not used to separate students according to what they know, but according to who knows it best. While in line with the learner centred ideology, the most preferred way of student evaluation in the yesteryear has been through teacher observation of students during instruction and collection of artifacts created by students. Nowadays, student evaluation should be done through authentic assessment that describes students' performance during typical instructional activities. Authentic assessment refers to; portfolio assessment, assessment of teacher's notes and diaries, assessment of developmental checklists, learning logs and journals, student peer assessment and informal anecdotal activities. (Schiro, 2008).

Curriculum Evaluation

It involves the evaluation of instructional materials and instructional programs such as the evaluation of instructional strategies, audio visual materials, text books as well as physical and organizational arrangements. Curriculum evaluation could either be the evaluation of an entire program or curriculum or the evaluation of part of a program or curriculum (Gafoor, 2013). When a curriculum has been planned, designed and developed, there is need to ascertain if it has all the criteria which it was designed for and if it is worth implementation. Curriculum evaluation could be seen to be internal and external. Internal evaluation has to do with the extent to which the newly designed program for example attains its objectives or to determine the extent to which it matches the objectives. External evaluation has to do with the extent to which the process or product is apt enough in doing what it is designed for more than other processes or products (Gafoor, 2013).

Moreover, the scholar academic ideology sees curriculum evaluation to comprise of aspects of formative evaluation and summative evaluation. Formative evaluation takes place while a curriculum is being developed or implemented and serves the purpose of providing information that allows that allows the curriculum to be revised and improved. Summative evaluation considers how well the curriculum reflects the discipline and prepares students for further work in the discipline. There are two aspects of formative evaluation which are; the curriculum content and the learning experiences used during instruction. Curriculum content could be assessed through the use of logical analysis in order to determine how well it reflects the discipline. Evaluation of a curriculum's learning experiences is carried out both through logical analysis in order to determine how well they embody the essence of the curriculum and through field testing so as to determine the effectiveness in helping teachers in teaching and students in learning the discipline. Unlike the scholar academics, learner centred educators tend to have little interest in summative curriculum evaluation. When such is compiled, it tends to be in the form of testimonials, and it tends to measure the degree of student involvement in the curriculum and the degree of learner enthusiasm about the curriculum. Thus, formative evaluation of the curriculum is contrarily brought more to the lime light as it leads to the improvement in the curriculum as it is being developed. Such evaluation is most often based on measures such as the extent of learner's involvement with the curriculum, is usually conducted through developer observation and teacher reports, and is usually based on criteria such as the extent to which the curriculum is believed to be in the best interest of learners as dictated by their nature, needs and interest. Contrarily to the learner centred ideologists, social construction ideologists see curriculum evaluation and summative evaluation as two aspects which are inextricably tied together in the particular social environment in which students live, while according to the social efficiency ideologists curriculum evaluation involves comparing a curriculum to a predetermined standard through the use of criterion-referenced tests. (Schiro, 2008). Generally, curriculum evaluation could be seen as an assemblage of all the processes through which the worthwhileness of a curriculum could be ascertained. In using high school results as predictors of performance in university one indirectly carries out an evaluation of the curriculum used in high school. With the findings, adjustments could be made to fine tune the curriculum used in high school.

Curriculum Evaluation Steps

In carrying out curriculum evaluation, the evaluator is supposed to have a fundamental or basic plan to follow. According to Ornstein and Hunkins (2009), the following steps should be followed in carrying out curriculum evaluation.

1)**Focus on the curricular phenomena to be evaluated:** Evaluators should determine just what they are going to evaluate and what design they will use. They should also determine the evaluation's focus for example, the total school system, a particular school, one particular subject area within a school. Moreover, the objectives of the evaluation should be spelled out as well as the identification of the constraints and policies under which the evaluation will be conducted.

2) **Collecting the information:** Evaluators are supposed to systematically identify the necessary information sources and the various means by which they can collect the information. They should also map out the stages for collecting the information in terms of their time schedule.

3) **Organizing the information:** Evaluators should organize the information so that the intended audience will be able to interpret and use it. They should come out with means of coding, organizing, storing and retrieving the information

4) **Analyzing the information:** Evaluators should select and employ analysis techniques appropriate to the evaluation's focus.

5) **Reporting the information:** Evaluators should also decide the nature of the reporting, keeping in mind the reports audience. They might engage in informal reporting such as giving opinions and making judgements based on general perceptions.

However, they might decide that they should collect, treat and report the data more rigorously, in which case the final report would have detailed statistical data.

6) **Recycling the information:** The need for current information calls for continuous reevaluation. Even if the curriculum appears to be viable, continuous feedback and modifications are necessary because the forces affecting schools are always changing.

School Evaluation

School evaluation could be defined as the process os systematically investigating the extent to which the school satisfies the needs of the community and the quality of the school in general (Sanders and Davidson, 2003). as School evaluation entails the passing of value judgement on all aspects of the school and on the entire educational program. School evaluation lays emphases on major processes such as teaching and learning, school environment and the management of human resources as well as school administration which will ensure the accomplishment of the institution's goals and objectives. All these is done along side taking into consideration students' academic output and their academic progress. School evaluation also takes into consideration judging the quality of inputs such as funding, characteristic of the staff and funding. Moreover, as part of appropriate management practices, school evaluation helps in the identification of the needs of a particular school, clarifies the goals of the institution, helps in adequately selecting strategies which would be employed to achieve the goals, monitoring and follow up of the progress as well as assessing outcomes and impact (Sanders and Davidson, 2003). Another major component of theschool which is worth evaluation is the school testing program which measures achievement, aptitude, personality and interest. Normally, the test desigened for a school should be in accordance with the objectives of the school. In evaluating a school, instruments such as interview schedule, questionnaire, which could be used to collect data from students, teachers, counsellors and the school administration (Gafoor, 2013). From the above view points, one could also see that school evaluation entails the process of assessing the various components within the school setting in order to improve on the performance of the various actors within the school setting.

Evaluation of Personnel

Persnnel here refers to all the stake holders who are in one way or the other responsible for the out put of the students or the learners. Thus, the it entails judging the effectiveness of the teachers, counsellors, and the school administrators amogst others in their respective duties of ensuring the attainment of the school's objectives. From personnel evaluation, managers could be able to ascertain what kinds of decisions they can take at any period in time with regards to inservice and further training of personnel, increase of salaries, promotion of personnel, corrective and disciplinary measures (Lemay, 2017)

From the above analyses, one can clearly see that the evaluations carried out by the GCE board and BAC board are student's evaluation which are summative in nature. These examinations organized by the GCE and BAC boards also indirectly evaluate the curriculum of the subjects assessed by the two examination boards as well as the it also indirectly evaluates the teachers and other stake holders within the school setting who in one way or the other helped in preparing the students for the standardized high stakes examinations.

The Concept of Motivation

Motivation originates from the latin word 'Moveer', which means to move. Therefore, motivation literally is the process of arousing movement in an organism. The release of energy in the tissues is what produces and regulates this movement (Tanyi, 2016).

Patel and Chauhan (2017) see motivation as the driving force behind every human activity, which when present, individuals see them selves on top of the world and capable of doing great things, while in its absence, people will feel not being capable of carrying out particular tasks or even to some extents paralysed even when they could even be capable of carrying out the tasks. In line with this definition, Palmero (2005) as cited in Pablo-Lerchundi et al, (2015) sees motivation as that driving force which enables a person to use his will power in order to accomplish a specific task. To Tanyi (2016), ''motivation has to do with the art of stimulating interest or using already existing interest to cause an individual to perform in a desired way''. The concept of motivation therefore, is concerned with a person or an individual's will or desire to put in his or her time or effort in a particular task even if the task has difficulties or challenges (Gero and Abraham, 2016). Berelson *et al*. (1984) as cited in Mbua (2003), defines motivation as all those inner striving conditions described as wishes, desires, drives. It is an “inner state that activates or moves”. It involves efforts, persistence and goals. All the above definitions see motivation to come mainly from within a person (intrinsic motivation), failing to take cognisanze of the fact that a person could also be motivated from external factors. This can be concretised from the views of Bunch (1958) who see motives to come from interveining variables having associated stimuli such as central nervous states, sensitizing factors, symbolic processes and as well as internal states which are not stimuli or responses. He sees motivation to come from both within (intrinsic) and external (extrinsic). In accorfance to this view, Tambo (2003) defines motivation as “the art of applying incentives and arousing interest for the purpose of causing a pupil to perform in a desired way”. Motivation is thus both intrinsic and extrinsic. Moreover, Motivation also encompasses the ability of individuals to reason and to form concepts. This thus aids humans to go above the minimum state with a wide range of their desires as well as aversions. The capability of various individuals to make a choice within the range of options is guided by the goals of each person and their values as well and this could be for varied lengths of time which could be for months, years or even decades depending on the time horizons. The drive to attain goals could also be sustained by and individual’s desire to experience again a particular past event (Lock and Latham, 1990)

When motivation is looked upon as the desire to perform a particular task, is usually seen as being made up of two parts. These two parts are the directional and the activated. In directional motivation, the drive is directed to a positive stimulus or away from a negative stimulus while in that which is described as activated entails seekimg to get what is desired. This type of motivation is anchored on neurobiology (Robins et al, 1996).

Generally, motivation is seen to either be intrinsic or extrinsic. Intrinsic motivation is said to take place when people have a strong internal drive to carry out a particular activity because they surely find pleasure in doing it, they see the activity or the aspect under consideration as important or they have the conception that what they are learning is of great importance. To Nick et al, (2011) students who are intrinsically motivated try to understand the rational or reason underlying their academic work and they find self actualization in their development, that is, they are seen to apply deep learning styles. Though this kind of motivation is very pertinent for academic purposes, it has been proven that it diminishes as one moves up the academic lader. It has been further observed that making complex material, simple and easily consumable for young learners increase their intrinsic motivation to learn. Extrinsic motivation is talked of when a person does something or is attracted to do something because of prevailing external factors such as good grades or money. Nick et al (2011), see students who are extrinsincally motivated as students who focus on what they will be tested on in order to satisfy their esteem needs, thus, they are seen as surface learners.

Thorndike and Hagen (1961) noted that tests well-constructed and effectively used can motivate students to develop good study habits, correct the errors and direct their activities towards the achievement of desired goals.Moreover, the grades students score in one way or the other affects their future academic performances as Arends (1998) opined that students who have a past history of receiving high grades develop a likely positive view of themselves and will continue to aspire to work for higher grades and students with past history of low grades come to see themselves as failure. Also, Cullen, Francis, John, Hayhow, Van, and Plouffe (1975) affirmed that grades can be strong incentives for performing work. Also, motivation in the educational setting can affect the learner in various ways, such as directing the learner's behavior in order to achieve pre-determined goals, leading the learners positively so as to elevate their efforts and energy put in their various tasks, improving on learner's persistence in carrying out certain activities, enabling the growth of cognitive processes amongst learners, and helping learners to improve upon their academic performance (Omrod, 2003).

Furthermore, Anderson (1989) asserts that feedback is knowledge of results. It is a component of reinforcement which gets students to work harder or keep up with good work for a better academic achievement. Further asserts that feedback could be given answers to questions, completed and corrected assignments or tests. Anderson goes ahead to say that if particular mistakes and reasons for the mistakes are known, students can work to overcome them, and teachers can provide additional instructions directed towards correcting those mistakes. This will in turn lead to improved instructions and better achievements. Gronlund et al. (1990) pointed out that assessment and analysis of learners' performances lead to decision to provide remedial lessons which will improve leaners' achievements and correct their minor errors.

The Concept of Engineering Education

Engineering education entails the nurturing of fine, creative, inventive and critical thinking skills amongst learners. But for such a training to be succinct entails that students veiling for engineering studies should be academically apt in science subjects like Mathematics, Physics, Chemistry and where necessary, computer science, Biology and Geology.

Physics is a discipline which is quite pertinent for Engineering studies, this is because it employs a variety of methods and techniques which are used to explain natural phenomena, as it makes use words, tables of numbers, graphs, equations, diagrams and maps. Physics also requires the ability to use algebra and geometry and to go from the specific to general and back (Ornek, Robinson and Haugan, 2007). Moreover, Physics is everywhere. It is known as the fundamental science and creates a foundation for Engineering courses. But most often, it is considered as the most problematic area within the realm of science. Physics is perceived as a difficult course for students from secondary school to University and also in graduate education (Erdimir, 2009)

According to Liberty et al (2015), Physics gives breath to any technology involving electricity, magnetism, force, pressure, heat, light, energy, sound and optics. Physics has thus been called the most basic science and in many cases, is required in order to understand concepts in other sciences and in many cases, is required in order to understand concepts in other sciences. To solve problems in Physics, students must be able to read and comprehend short paragraphs, then develop problem solving strategies from them, therefore Physics helps develop both Math and verbal skills. It is a whole brain subject requiring students to use both right and left-brain regions for translating complex verbal information into pictures and finally into mathematical models in order to solve problems. In addition to the subject's content knowledge, Physics requires students to develop higher level thinking, a useful skill in any endeavor. This clearly indicates that Physics is important for Engineering education which requires higher level thinking and creativity.

Moreover, AIP (1955) emphasized that the role of Physics in engineering education is not a static one. It must respond and evolve with the momentous changes in both engineering and Physics which are occurring continually. This is because the predominant reliance of early engineering upon art is giving way to a modern technology based squarely upon the physical sciences. Since the beginning of this Century there have been much progress experienced in Physics as has been obtained in the whole previous history of mankind. Yet the obvious and enormous increase in the subject matter of modern Physics is not the most significant factor relating to the aim of instruction in Physics in the education of engineers. On the contrary, the cardinal aim should be that of imparting to the student a point of view, an attitude of mind and a capacity to deal with the principles and methods of analysis of contemporary Physics, for without training and experience in these schools of thought, neither physicist nor engineers will prove competent to give solutions to the emerging problems of science and technology.

Another very important spice for engineering studies is Mathematics according to some pundits. Mathematics is seen as a lead way to engineering, which paves the way for sound design, some other people see Mathematics as sieve which denies the passage of some would be engineers (Winkelman, 2009). This aspect is quite debatable as some schools of thought hold it that Mathematics is not quite pertinent for engineering studies. This uncertainty does not only pertain to students some practicing engineers believe the Mathematics they learned as students is not applicable to their work (Cardella, 2007). Moreover, other science subjects such as Chemistry, computer sciences, Geology amongst others could also serve as preparatory bases for engineering studies as Physics and Mathematics cannot wholly give scientific explanations to every engineering phenomenon without getting into other science related fields. Thus engineering education is definitely built on the fundamental or basic science subjects

Engineering education nowadays is geared mostly towards sustainable development, as engineering education is seen as the main vessel through which quality of lives for future generations could be assured (Segalas, 2009). In order to maintain promote quality engineering education for sustainable evelopment, accreditation boards and agencies have come out with defined standards on what engineering education should entail. According to the Accreditation board for Engineering and Techmology in the

USA, for engineering programs to be accredited, they must show that their students will be able to; have the ability to design a system, component, as well as a process which will satisfy economic, environmental, social, political, ethical and health needs, they should be able to have professional and ethical responsibility and be able to listen to the needs of the society and have a say in technological developments (ABET, 2007) as cited in (Segala, 2009)

Also, the Barcelona Declaration (2004) made it clear that engineers of nowadays should be able to; understand how their works are related to the society so as to easily identify potential risks, impact and challenges, identify the importance of their works in various contexts, be able to work in multidisciplinary teams to as to meet the complex needs demanded by sustainable life styles and be able to apply a wholistic as well as systematic approach to problem solving amogst others. Moreover, the United Kingdom Engineering Council also emphasized that engineers should have characteristics such as; they should be responsible in the carrying out of their activities, they be imaginative, creative and innovative, so as to easily provide products and services, and be able to understand and encourage the involvement of stakeholders (ECUK, 2005) as cited in (Segalas, 2009)

From the above streamline measures issued out by accreditation boards for engineering education and other major organs involved in the reshaping of engineering education and norms related to the engineering profession, it therefore implies that to a great extent, engineering education should be well handled in order to produce engineers who will have the 21st Century sustainable development qualities.

The Concept of Academic Performance

Lavin (1965) defines academic performance as an expression of student's academic standing. This can be gotten through test or examination based on specific objectives in a particular subject area**.** Academic performance or academic achievement could also be referred to as the extent to which a student, teacher or institution has achieved their short or long term educational goals. Cumulative GPA and completion of secondary, high school, and Bachelor's degree represent academic achievement. Academic achievement is commonly measured through examination and contains assessment but there is no general agreement on how it is best evaluated, or which aspect is most important procedural knowledge such as skills or declarative knowledge such as facts (Annie, Howard, Stoker& Mildred, 1996). Moreover, there are inclusive results over which individual factors successfully predicts academic performance elements such as test anxiety, environment, motivation, and emotions require consideration when developing model of school achievement (Ziedner,1998). But academic performance could be affected by individual differences. These individual differences in academic performance have been linked to differences in intelligence and personality. Students with higher mental ability as demonstrated by IQ tests and those who are higher in conscientiousness tend to achieve highly in academic settings. The semi-structured learning environment of children at home transitions into a more structured learning environment when they start first grade. Early academic achievement enhances later academic achievement (Bossaert, Doumen, Buyse, & Verschueren, 2010). Parents can influence students' academic skills, behaviours and attitude towards school. This would be also by motivation, instilling a positive attitude towards school to the child.

In Cameroon, academic performance in secondary schools and university is measured through tools of formative assessment such as continuous assessment commonly called "CAs" in universities and "Sequence tests" in secondary schools and through tools of summative assessment such as end of semester examinations in the case of universities and end of year or course examinations in the secondary school such as promotion examinations and the G.C.E or BAC examinations.In this study, academic performance is measured through the grades students score in the G.C.E A/L examinations and BAC examinations in some general science subjects and the GPA they scored in the 1st and 2nd years of Engineering studies at university.

Gender and Academic Performance

Tchombe (2019) anchores gender issues in relation to performanance of cognitive skills on the assumption that biological differences in the central nervous system produce sex differences with respect to the ability carryout specific intellectual tasks. These gender differences are brought about by hormonal, genetic and evolutionary factors. First and foremost, hormonal activities produce psychological differences and biological events determine genetic endowments. Sex hormones for example for males which are called androgens and the female hormones which are called oestrogen and progesterone directly affect an individual's behavioural and thinking pattern. These hormones affect the development of the brain differently in males and females. In males, the right hemisphere of the brain controls more visual-spatial activities compared to those of females, this thus makes the male gender stronger in Mathematical and scientific activities. In the case of the females, the left hemisphere of the brain controls more verbal activities compared to those of the males, this thus gives the female an urge over the male in verbal activities.

With these psychological differences in place, subject choices in higher education will vary with gender, as it is evident that gender differences exist in the use of cognitive skills, meta-cognitive strategies and other knowledge (Tchombe, 2019). These thus further implies that male students will be more performant in the sciences and in fields of applied sciences such as engineering. In line with this study, one sees to a great extent that male students' high school results in sciences would likely predict their academic performance in engineering differently from the high school results in sciences of their female counterparts, while the female will be more apt in the Arts and literary studies. This at times is contrary as the male is dominant in both the Arts and the sciences. This can be seen from GCE A/L results statistics from 2007 to 2012 in which the male scored an overall average of 55.47% and the female an overall average of 54.48% in Chemistry, and in History which is an Arts subject the male scored an overall average of 82.46% while the femnale scored 80.15% (Tchombe, 2014). Taking these into consideration, teaching in secondary and high school as well as in higher education should be gender sensitive so that the female students would better develop their abilities of comprehension, analyses and interpretation, and these will go a long way on improving their self-esteem and self-image which will lead to their self actualization (Tchombe, 2019).

Theoretical Framework

This research work is anchored on the following theories

-The Classical test theory

- The Geberalizability theory

- The Item response theory

- Constructivism by Lev Vygotsky

- The theory of attribution by Weiner

- The value expectancy theory

- The social cognitive career theory

The Classical Test Theory

The Classical test theory was founded by Charles Spearman in 1904, when he was figuring out how to correct the correlation coefficient of attenuation caused by measurement error and how the measurement error could be corrected by obtaining the index of reliability (Traub, 1997). The Classical test theory is one of the approaches to the random sampling theory. This theory explains how observed scores could be affected by measurement errors (Marcoulides 1999) as cited in Bichi (2016). The classical test theory was born from the attempts made in the 20th Century on measuiring the differences of individuals. This theory came to the lime light after the conceptualization of the following ideas; Firstly, after taking into cognisanze the fact that measurement errors exist, secondly, that the error is a random variable and thirdly the concept of correlation and how to get its indices (Schumacker, 2010). In order to adjust the correlation coefficient which was plaqued with errors as a result of measurement Spearman in 1904 came up with the correlation indices which was used to ajust these correlation coefficients. It was on these bases that the classical test theory was built (Allen and Yen, 1979). The classical test theory the score which an individual obtains in a test which is the observed score (O) is a combination of the individual’s true score (T) and an error (E). The error in this case are measurement errors and the measurement errors most often considered in this theory are the random errors of measurement. That is, the true score is equal to the observed score when there are no measurement errors, consequently, the greater the error margin, the greater the deviation of the observed score from the true score. The true score refers to that score which a person would obtain in the broad universe where there are admissible observations (universe score), that is, the true score is that score which will not change even upon the repeatition of a test, while the observed score is the true score which has been affected to some extent by errors, and the effect of these errors on the true score could either be positive or negative (Bichi, 2016).

The Classical test theory can be explained by the equation;

O (Observed score) = T (True score) + E (Error)

The reliability cannot be determined directly, since according to the classical test theory, the true score cannot be derived directly. Since the true score is not observable, but can only be derived from the performance of an individual on a set of items, the above linear equation cannot be directly used without taking some assumptions into consideration. Firstly, the true scores are uncorrelated with the error scores, secondly, the examinees average eror score is zero and thirdly, if parallel tests are given, the error scores will be uncorrelated (Bichi, 2016)

To Kaplan and Saccuzzo (1997), the size of the measurement error could be determined theoretically by each test takers standard deviation of the distribution of random errors. It is so, since it is assumed that the distribution of random errors would be the same for all the test takers. The Standard deviation of errors is much talked of here, because in the classical test theory, it is what is used to represent the measurement error. In real terms, the standard error of measurement could be determined from the reliability of the test and from the. The smaller the standard error of measurement, the closer is the score to the true score, while the larger the standard error of measurement the further away is the observed score from the true score.

The standard error of measurement can be calculated using the formula:

$SE_M = S_X (1-R_{XX})^{1/2}$

Where:

SE_M represents standard error of measurement

S_X represents standard deviation of test scores

R_{XX} represents the reliability coefficient

With the standard error of measurement, confidence intervals could then be made. With the confidence intervals in place, the value of the true score could then be estimated from the upper and lower bounds of the confidence interval.

Psychometricians later discovered that rather than carrying out multiple samplings on a particular individual through parallel testing formats which is time consuming, single administration of a test to multiple persons could be done in order to determine the standard error measurements. That is, instead a giving a test 100 times to an individual and then getting, the test could instead simply be administered one time to 100 persons. In the above equation, the standard error of measurement is calculated from the standard deviation of the test scores and from the reliability coefficient of the test upon multiple aministrations. Using a single administration of tests with multiple persons, the formula used is derived as follows

VAR(X) = VAR(T) + VAR(E)---------------------------------(i)

Also, reliability could be seen as the ratio of the variance of the true score to the variance of the observed score. That is.

R = VAR(T)/ VAR(X)---(ii)

From equation (ii) above, the higher the variance of the true score, the higher the reliability coefficient, while the lower the variance of the true score.

Substituting VAR(T) in equation (i) with VAR(T) = R / VAR(X) derived from equation (ii) above, we have, R = 1 – (VAR(E) / VAR(X)) ------------------------------(iii)

Also from equation (ii) above, VAR(T) = (R) (VAR (X)) -------------------------- (iv)

From the above equation, the variance of the true score VAR(T), thus gives the error margins of the measurement. Since R which is the reliability of the test administered to multiple persons and X represents the score of the tests, their variances could easily be calculated and thus their and thus the variance of the true score would be determined by the formula above. Therefore, in the case where a test could be given to multiple test takers or where there is no possibility of administering a test multiple times to a particular test taker, the above formula could be used to determine the true score and its bounds. With the true score at hand and with the observed scores also at hand the measurement error could then be determined. Getting the error of measurements will help improve upon the reliability of subsequent tests by taking into consideration measures which would help improve upon the measurements, that is why the classical test theory is generally considered as a very important theory of test scores in social science (Allen & Yen, 2002)

Moreover, Embretson and Reise (2000) came out with some ramifications of the Classical test theory. The first ramification was that the standard error of measurement is the same throughout the entire population. That is, the standard error of measurement does not differ from one test taker to another but it is a value gotten from the entire population of all the test takers and thus generalized to the population of test takers. Consequently, no matter the individual test scores, being it high scores, moderate or low, the error measurement is the same for all the test takers. The second ramification is based on the premises that since the longer the test the greater the reliability, and since test items are being sampled from a large pool of items and also that the larger the number of subjects used to collect data or as test takers, the more reliable is the statistics derived which would be generalized in the population, likewise with the Classical test theory, the larger the number of test items in a test, the better the sample of the items which will be represented in the test and thus the statistics which would be generated by such large number of items would be more reliable and relevant. Also, multiple forms can only consider as parallel when adequate clarifications have been made in order to ascertain their equality with regards to the reliabilities which are supposed to be equal, their means which are supposed to be equal, their variances which are also supposed to be equal moreover, there should be similar relationships between the test scores of the tests and other related variables. The third ramification is that, generalizations with statistics should only be done with the population from which the sample which was used to derive the statistics was drawn.

Furthermore, to Embretson and Reise (2000) true scores collected from every population are measured at the interval level of measurement and are also normally distributed. But when these conditions are not met in a particular test, those involved in developing the test could carryout various manipulations such as combining scales and converting scores of the test so that the aforementioned conditions could be met. According to the classical test theory contrarily, when these are done, in order to make the data collected to be in the interval level of measurement and to make the scores to be normally distributed, the properties of the test will change and since the properties of the new instrument are not known, it will not be wise to carryout such changes.

From the above ramifications, one could clearly identify some of the shortcomings of the classical test theory. To Hambleton et al, (1991), the first shortcoming is that one cannot clearly separate the characteristics of examinees from the test characteristics as such the characteristics of the individual test takers cannot be talked of independently without taking into consideration the characteristics of the test. Secondly, the over simplicity of the definition of test reliability which is defined per the classical test theory as the correlation of test scores from tests o parallel forms. The third shortcoming is the standard error of measurement which is considered to be the same for all the test takers without taking into consideration the fact that there are test takers who would score highly, some moderately and some who would have low scores. The fourth shortcoming is that the classical test theory is test oriented and not item oriented. That is, with this theory one can only make predictions on how a person would perform in a subsequent test and not how he or she would perform in particular items.

The classical test theory underpins this research work in the sense that if the grades students score in the GCE A/L and BAC examinations which are their observed scores are far away from their individual hypothetical true scores means that the measurement errors were large, there will thus be a low probability for these grades or scores to predict their academic performance in engineering school, especially if the scores (observed score) representing their academic performance in engineering are close to their true score for their academic performance in engineering. Likewise, if the observed scores representing the high school results are close to the true scores, but the scores representing the students' academic performance in engineering are far away from the students' true scores, the probability of the high school results to predict the students' performance in engineering will be low. But if measurement errors are highly minimized in relation to getting students' high school grades, meaning that the observed scores are very close to the true scores and likewise with students' performance in engineering, there is a high probability that the students' high school results will significantly predict their performance in engineering.

The Generalizability Theory

To Brennan (2001) the generalizability theory is a statistical theory that evaluates the reliability or thrustworthyness of psychological measurements. That is, the theory focuses on the reliability of the generalizations made from a person's test score, that is, the observed score, taking into cognisanze the fact that there exists a true score that is, a score whom an individual would obtain in a broad universe. In real terms, the expected scores or true scores are often different from the real scores or observed scores because the expected scores are obtained taking into consideration all the possible facet conditions while the observed scores are obtained amidst just a sample of the facet of conditions. From the G theory, the researcher could easily ascertain if measurement errors emanate from the sampling of judges and tasks or whether if the number of judges or tasks are increased or whether an increase in the combination of both, will lead to an increase in the reliability of measurements. Also, this theory also questions the extent to which test scores are reliable in their use in carrying out evaluations pertaining to certification (Shavelson and Webb, 2005).

The Generalizability theory emerged from the fact that the measurement error talked of in the classical test theory was not differentiated upon. That is, no clear distinction was made on the error term stipulating the sources where the various errors may come from in the classical test theory whereas the generalizability theory clearly identifies the sources of the systematic and non-systematic errors, separates them and estimates each of them. Also, while the classical test theory focusses more on relative decisions, the generalizability theory focusses on both the relative that is the norm reference and the absolute, that is, the criterion reference decisions and even differentiates between them. The generalizability theory thus acknowledges the fact that a person in a position of decision making, might decide to make two types of decisions which are the norm reference and criterion reference decisions. The norm reference decision focusses on the performance of an individual with respect to the performance of the other test takers, while the criterion reference decision dwells on the performance of a person with reference to a particular criterion, regardless of the performance of the other test takers (Shavelson and Webb, 2005).

In order to identify the various sources of measurement errors, the generalizability theory identifies the various characteristic features called facets of the measurement situation such as test forms, items, rater and or other occasions. In determining the various sources of the measurement error, the generalizability theory illustrates the variations of scores pertaining to individual test taker or persons, facets or a combination of persons and facets. With this in place, various sources of score variations could be identified. Looking into the scores of individual students, each score is composed of a student component, item component and the occasion component. The student component reflects systematic variations of individual students' appraisals of a particular test item. That is measurement errors come arise from this component since when developing the test items considerations might not be taken considering the various ways the students would see and appraise the test items. The item component reflects the fact that the wordings of some items might be more appealing to some students than other items, thus the extent to which various students would appreciate the wordings of a particular item is different, therefore, measurement errors could be bound to occur since an item constructed to measure a particular phenomenon might be misunderstood by some of the test takers and so would not adequately measure what it was intended to measure. This gives rise to the non-zero person × item interaction (p × i variance component). The occasion component refers to the various times in which a test is administered to the test takers. That is, the test could be administered at a moment when the test takers are more motivated towards taking the test or towards academics in general, for example a test being administered after a word of encouragement from a school head to the students. In this scenario, the students would probably be more motivated in taking the test and thus this will lead to differences in mean of their performances from this occasion to another occasion as a result of variations in measurement (Shavelson and Webb, 2005).

Knowing fully well that an assessment or test could be nutured for particular decisions, the generalizability theory distinguishes between Generalizability (G) studies and Decision (D) studies. The principal aim of the G study is to separate the components of the variance into various error sources, while the D study is aimed at quantifying certain quantities such as the universe score variance, error variances, as well as coefficients of measurement precisions anchored on the G study (Brennan, 2001).

G studies are designed to identify as many fascets of measurement error as it could be economically or in nut shell reasonably possible. G studies involve the making of generalizations over a variety of facets such as items, forms raters and occasions. Most often, designs are adopted whereby, all individuals are used at all levels of the various facets, that is, crossed designs. This design furnishes the user with information pertaining to the variation of the true score, the various facets and the effect of their various combinations to the observed score. The true score as it is called in the classical test theory is refered to as the universal score in G studies. The universal score (U_P) in this case connotes the expected value of an observed score derived from all the possible observations in the universe of generalizations. The universe of generalizations refers to an assemblage of all the facets and their various levels which are deemed to be generalized by the decision maker. The observed score collected is comprised of a universe score, and a collection of error measurements depending on the facets concerned. Taking for example, items (i) and occasions (o) of test administration are randomly selected for persons (p), this is going to result to a two-facet cross design, that is, person by item by occasion (p x i x o). In this case, only two facets are talked of, since person is not a facet. The combined error term will thus be denoted as X_{pio} which will represent the error term from an item and from the occasion, pertaining to a particular person (Shavelson and Webb, 2005). That is,

X_{pio} = grand mean + person effect + item effect + occasion effect + person x item effect + person x occasion effect + item x occasion effect + residual.

Where,

-Grand mean is represented by u, and u = $E_pE_iE_oX_{pio}$ (where E stands for expectations)

-Person effect is represented by $\mu p - \mu$

- Item effect represented by $\mu i - \mu$

- Occasion effect represented by $\mu o - \mu$

- Person x item effect represented by $\mu pi - \mu p - \mu i + \mu$

- Person x occasion effect represented by $\mu po - \mu p - \mu o + \mu$

- Item x occasion effect represented by $\mu io - \mu i - \mu o + \mu$

- The residual effect represented by $Xpio - \mu pi - \mu po - \mu io + \mu p + \mu i + \mu o - \mu$

Moreover, the sum of the measurement error (X_{pio}) has a variance component which is as a result of variance from all the above terms except the grand mean. Moreover, in G theory, instead of using statistical tests which would provide information about sampling variability of estimated variance components, rather, standard errors of variance component estimates are used (Brennan, 2001).

When using the generalizability theory which is geared towards decision making, the D study is employed. In a D study, information from a G study are in order to reduce potential measurement errors which may occur in the course of measurement aimed at accomplishing a particular decision. In carrying out a D study, the decision maker clearly defines all the elements contained in the universe of generalizations and this may contain all the various facets and their levels. In D studies, decisions are arrived at from the means from several observations and not just a singleobservations. The mean score derived from several or multiple occasions of different items is denoted by XpIO and the two-facet crossed D design will be represented by *P x I x O*. There are two kinds of decisions which could be made and these decisions depend on the type of measurements made. That is, either norm referenced (relative) or criterion reference (absolute). The error term in random effects with designs *P x I x O* for relative decisions is represented by

$\Delta pIO = (XpIO - \mu IO) - (\mu p - \mu)$

Also, for decisions which are absolute, that is which are built on measurements which are criterion reference based, the errors pertaining to random effects such as *P x I x O* design is given by;

$\Delta pIO = XpIO - \mu p$

Furthermore, in cases where behavioural measurements have multiple scores, the generalizability theory can be used to carryout many statistical functions. To Brennan (2001) it could be used to determine observable correlations between the scores, determining the reliability of the various scores, and also determining the universe score as well as error correlations with respect to different D designs and sample sizes. Secondly, the generalizability theory could make use of multiple regression analyses where universe scores could be used to predict observed scores in order to determine the reliability of the profile of scores. Thirdly, to Shavelso and Webb (1981) as cited in Shavelson and Webb (2005), it could be used to make a composite of scores which have maximum reliability.

In line with this study, the generalizability theory helps pin points the various sources of measurement errors be it systematic or random. Therefore, knowing the sources of measurement errors and identifying some of these errors specifically will go a long way to to bridge the gap between the universe score and the observed score. This will thus give explanations of the predictability or non-predictability of students' performance in engineering by their high school results. That is, if there are limited measurement errors encountered in the measurement resulting to students' high school results, and there are also limited measurement errors encountered in the measurement of students' performance at engineering school, then the high school results which are the BAC or GCE A/L results in sciences might likely predict students' academic performance in engineering. If there are dwindlings in the measurements which will lead to the high school results or in the measurements leading to students' performance in engineering, then the high school results might not predict students' performance in engineering. Through the generalizability theory though one could clearly identify the various errors, and with this at hand, mitigations could be made to ameliorate the measurement and the reliability of the, measurements made in general. When these potential errors have been identified, ascertained and dealt with, then the predictive validity of the results would certainly be improved upon.

The Item Response Theory (IRT)

The item response theory also known in psychometrics as the latent trait theory, modern mental test theory or the strong true score theory, is a paradigm or guide which could be used for analysis, design, scoring of tests, questionnaires and other related instruments measuring attitudes, abilities or other variables. To the IRT, traits, latent traits and abilities could be used to predict the performance of examinees and a monotonically increasing function which is called the item characteristic function could be used to describe the relationship existing between these traits and the performance of examinees on an item. Where only one trait is involved or just one- dimensional model, the item characteristic function is called item characteristic curve (ICC). This curve gives the probability with which examinees of different abilities on the trait being measured in the test could have an item correcty answered (Hambleton,1991).

That is, the ICC curve which is ''S'' shaped represents the relationship which exist between the probability of answering an item correctly and the examinees ability. A test normally is constructed using items from a test bank and thus the ICC is estimated for each item. From the ICC, inferences could be drawn on how well each item discriminates and it appropriately indicates the position precisely on the ability scale where each item best discriminates. Since the curve also provides an opportunity for individual examinees to be matched with test items, it could be a premise from which much more measurements could be done (Hambleton and Slater, 1997). That is, from the curve, iterations could be made from students' ability to their probability of having an item correct and likewise iterations could be made from their probability of having an item correct to their individual abilities.

The set of statistics pertaining to each item, that is, the item difficulty index or discrimination index amongst others could be used to describe the ICC. That is a steep ICC is observed for items with high item discrimination indices, while the ICC is shifted to the left for items which are easy since low achievers would have a higher probability of getting the item correct at the left end of the ability scale and the curve shifts to the right for items which are difficult because at this end there will be a lower probability for low academic achievers to get the item correct while there would be a higher probability for highly performing test takers or examinees to get the item correct. The number of parameters used to describe the ICC defines the model which could be adopted. Normally, a maximum of three parameters are used to describe dichotomously scored items. The Rash model is an example of a model that has just one parameter, and that lone parameter in the case of the Rasch mnodel is the item difficulty index, while the two-parameter logistic model has two parameters which are; the item difficulty index and the item discrimination index (Hambleton, Swaminathan & Rogers, 1991) as cited in Hambleton and Slater (1997). The IRT has greatly found a place in measurement works and this is because of the following reasons; Firstly, the item and person parameters are both invariant, secondly, each ability score could be given a precise measure, thirdly, both items and examinees could be reported on a common scale and fourthly, the availability of information pertaining to the functioning of items. Globally, IRT models could be used for; test development, Computer Adaptive Testing (CAT), Test score equating, Differential Item Functioning (DIF), Score reporting and in Test Adaptations (Hambleton and Slater, 1997).

The item response theory is based on the fact that the probability of a correct or keyed response to an item is a mathematical function of person and item parameters (Atieno,2012). The person parameter is thus referred to as latent trait which could represent an individual's inborn characteristics such as; attitude, or intelligence, while the item parameter refers to difficulty and discrimination indices, and the probability for guessing (Thissen & Orlando, 2001). Due to these unique characteristics of the item response theory, it is widely desirable because the item characteristics such as the difficulty and discrimination indices are not dependent on the sample of the examinees chosen from the population on whom the test is intended to be administered and also because the scores of the examinees in the test or examination does not depend on the items chosen from the pool of items for the test. Thus, the item and examinee abilities are considered invariant (Hambleton, 1991).

This theory is quite pertinent in this study because for a test or examination to adequately measure what it intends to measure, so that the results of evaluation could be a true reflection of the test takers, the item difficulty indices as well as the item discrimination indices and the probability of guessing should be appropriate. These properties of the test are what will then account for the reliability and consequently the validity of the test. That is, a test could hardly be talked of as being reliable, or having predictive validity if the item difficulty and discrimination indices are not appropriate. Thus, if the item difficulty and discrimination indices of items in the GCE or BAC exams are not appropriate, then the results of these two exams could hardly have predictive validity. This is because if the subsequent results they are to predict which in this case are students' performance in engineering is a product of tests whose items are of appropriate difficulty and discrimination indices, then there will thus be an imbalance since the predictors are products of tests or examinations whose items are of questionable difficulty and discrimination indices. Conversly, if the GCE and BAC exams are of appropriate quality pertaining to the extent of difficulty and the way it discriminates between top achievers and bottom achievers, while the examinations in the engineering school does not have appropriate psychometric properties, then the GCE or BAC results might likely not predict students' performance in engineering. Moreover, if the GCE or BAC examinations have appropriate psychometric properties and the examinations in the engineering schools are also having adequate psychometric properties, then the results of the GCE and BAC examinations would likely predict students' academic performance in engineering schools.

The Theory of Constructivism by Lev Vygotsky

Constructivism is a knowledge based theory and it explain that humans generate knowledge through the interaction of their experiences and their ideas. The process of knowledge generation is seen as self - regulated used for resolving inner cognitive conflicts that could only become eminent through concrete experiences, reflections and collaborative discourse. This theory emphasizes the fact that knowledge could be co-constructed as individuals learn from one another, that is learning is assumed to take place with the assistance of others. Lev Vygotsky believed that culture is the principal determinant of cognitive development. This theory is anchored on two major aspects which are; the zone of proximal development and scaffolding. The zone of proximal development refers to a range of tasks that cannot be mastered by a learner alone because of its difficult nature, but could be mastered with the help of adults or more skilled peers. While scaffolding refers to the process of providing the appropriate assistance to a learner at the appropriate time. Vygotsky's theory on constructivism agrees with the view that mediators help the human to alter his or her environment That is according to this theory, the social interactions in institutions have a major role to play on students' learning. That is, in a learning environment where group work is encouraged or where students are paired or put into small groups to carry out particular tasks, the learners would definitely learn better since they will help them selves as some of the learners will be more skilled in certain aspects. Social interactions could also be fostered if teachers give room for learners who have understood a particular concept to explain it to their peers who might understand the explanations and wordings from their peers morethan that of their teachers., thus acting as mediators too in the learning process along side the teachers Such mediators help the students to go across the Zone of Proximal Development, that is moving them from their actual competence that is a level where students are able to independently solve their problems to a level where students can solve problems assuming they were given guidance from a teacher. If there is an enabling environment which aids the learners to easily resolve their inner conflicts and develop new knowledge, then the learner will learn faster and perform better than a learner in an inert learning environment. If a student studied in a high school where there was very conducive social interactive environment, where he or she was always assisted by peers and teachers or where there was always group work or study grouips the student would have definitely crossed the zone of proximal development and well scaffolded and these will be reflected from their high school results. If should in case the engineering school des not have a recommendable social learning environment. then the student's high school results might not predict their academic performance in engineering.

The Attribution Theory

Humans are motivated to assign causes to their actions and behaviours (Moskowitz 2005). In social psychology, attribution is the process by which individuals explain the causes of behaviour and events. The development of models to explain this process is called attribution theory (Kassin, 2010). Psychological research into attribution began with the work of Fritz Heider in the early part of the 20th century, subsequently developed by others such as Harold Kelley and Bernard Weiner

Weiner (1979-1984) is one of the main educational psychologists responsible for relating attribution theory to school learning. The theory attempts to explain the world and to determine the cause of an event or behaviour. This theory looks at motivation in terms of how people ascribe the cause of success and failure. It also assumes that people try to determine why people do what they do, that is, interpret causes to an event or behaviour (Wiener 1972). A three-stage process underlies an attribution.1) Behaviour must be observed/ perceived. 2) Behaviour must be determined to be intentional. 3) Behaviour attributed to internal and external causes. Weiner's attribution theory is mainly about achievement. According to him, the most important factors affecting attributions are classified along three causal dimensions:

1) Stability theory (stable and unstable)

2) Locus of control (internal and external)

3)Controllability (controllable or uncontrollable)

Stability describes whether the cause is perceived as static or dynamic over time. It closely related to expectations and goals, in that when people attribute their failures to stable factors such as the difficulty of a task, they will expect to fail in that task in the future,

Locus is the location of the precise cause. If the locus is internal (dispositional), feelings of self- esteem and self - efficacy will be enhanced by success and diminished by failure.

Controllability describes whether a person feels actively in control of the cause. Failing at a task one thinks one cannot control can lead to feelings of humiliation, shame and or anger.

Thus, stability influences individuals' expectancy about their future; control is related with individuals' persistence on mission; causality influences emotional responses to the outcome of task.

When one succeeds, one attributes success internally ("my own skill"), when a rival succeeds, one tends to credit external (e.g. luck). When one fails or makes mistakes, we will more likely use external attribution, attributing causes to situational factors rather than blaming ourselves. When others fail or make mistakes, internal attribution is often used, saying it is due to their internal personality factors.

The theory dwells on the relevance of student's perception of the causes of success and failure. In relation to this research work, when students attribute their success in the GCE A/L and BAC examinations to hard work, they will know that working hard at an engineering school will also ensure them having academic success there, but if they attribute their success in the GCE exams to some external causes like gifts from parents and loved one's amongst others, when similar things are not available they might tend to underperform while at engineering school and consequently their GCE and BAC results will not reflect their academic performance in engineering.

The Expectancy Value Theory

The expectancy-value theory is also used in this research work. This theory is one of the achievement motivation theories which explain the choices of the tasks people make in order to achieve certain goals, how persistent they will be in those tasks, their drive in carrying out the tasks and finally the performances registered in carrying out the tasks

(Eccles et al, 1998). Furthermore, to some theorists, the aforementioned activities are dependent on individual’s belief on whether or not they could accomplish the tasks and the values they place on the activities. In this study, the theory is focused on the expectancy value model of Eccles, Wigfield and their other collaborators. They proposed an expectancy value model of achievement performance and choice 1983 which focused on achievement in Mathematics. This theory further explains that students are motivated to succeed or are motivated towards achievement by their beliefs on how successful they can be able to complete a particular activity as well as how much they value such an activity (Wigfield & Eccles, 2000).

To Eccles et al, (1983) expectancy for success refers to the beliefs people hold pertaining to how well they will perform in upcoming tasks either in their present context or the future. They also see ability and beliefs to mean the way a person perceives his competence at moment with regards to carrying out a given activity. This therefore indicates that while ability belief focuses more on the present, expectancy for success focuses more on the future. They also defined value with respect to the quality of different tasks and how these ascertained qualities affect an individul’s wish to carry on the task. To Wigfield and Gladstone (2019) the expectancies and values which children have predict their school performance and the choices they could make on which activity to pursue while in school and out of school with the relation getting stronger as the children become older, and moreover, they can easily resist changes or challenges when their expectancy and value remains positive. Expectancy value theory focuses on two principal aspects which are, firstly the nature of the motivational beliefs held by people, their values and goals in face of various activities, how they change with time and how all these affect performances on the activity and the choices they would make whether to continue with such activities or not. Secondly, how people’s developing expectancies, values and goals are nutured by the socialsation at home and in school (Wigfield et al, 2016) as cited in (Wigfield and Gladstone,2019)

Moreover, children’s expectancy beliefs and values vary with their development from middle childhood with different developmental trajectories too, as some children’s expectancy values will vary differently with respect to other children. That is some of the children’s expectancy values might increase in high school and some, at some other time, indicating that the stipulated patterns do not match with the trajectories of all children (Archambault et al, 2010). They also found out that the decline in competency beliefs with respect to literacy and value is more prominent amongst the male students and students of lower socioeconomic status (SES). Moreover, students' attitudes as well as their beliefs gain stability with time. Furthermore, findings have revealed that the expectancy values of people of various age groups predict their choices of activities which they could engage in and their achievement outcomes (Bong et al, 2012). That is, the expectancy value of an individual could greatly carve their respective career choices and could also predict their academic achievements or performances as it is seen as one of the strongest psychological predictors of academic performance.

To Wigfield and Gladstone (2019), the expectancies of children as well as adolescents can influence the manner in which they handle change and uncertainties. That is, in their line of thought, they perceived that if a student persay, has high expectancy values for the subjects he or she is offering, the student would likely perform well in the subjects and should in case the subjects subsequently become more challenging, the student because of the high expectancy value and previous successes that he or she has been accustomed to would likely continue performing well and this will further improve upon their expectancies for future success. The opposite thus occurs for students having low expectancies for success as well as the way they value different subjects. To some students, as subjects become more challenging, their uncertainties of offering them increase and this would make some of them to lose interest in that particular subject or in schooling in general and it could even lead to attrition.

In line with this research work, students who had a high expectancies and values with regards to the science subjects they were offering at high school, such high expectancies and values would have highly led to impressive performances in the end of course examinations in high school, and if such expectances continue at engineering school, then their results at engineering school would also be impressive and there would be a high probability for their high school results to predict their performance at engineering school. If should in case there are variations in expectancies and values from high school to engineering school for a particular student, then the high school results of the student might not significantly predict his or her academic performance in engineering. That is, results students score in the GCE and BAC examinations could make them start believing more in themselves with respect to completing more challenging tasks, and consequently would be motivated to engage into studies like engineering studies and this could go right away to make them academically apt in the engineering schools. Moreover, if students have a goal of achieving a particilar future aspect, he or she will be motivated to work hard at the school of engineering so as to get that expected goal.

The Social Cognitive Career Theory (SCCT)

To Lent et al, (1994), the social cognitive career theory is a new approach of understanding how people develop interests, make choices and how they realise successes at various levels in education as well as in professional pursuits. The social cognitive theory which is strongly hinged on Bandura’s social cognitive theory, greatly focuses on variables such as self efficacy and outcome expectations and how these variables mitigate with other personal variables such as gender, ethnicity, social supports and barriers as well as with aspects of the environment in order to nuture people’s choice for particular careers. Recent works done with the social cognitive career theory focused more on the cognitive personal variables while, most aspects linked to the environment though they affect the drives of persons, are not considered with respect to people’s drives towards different career path. The SCCT was divided into two complementary levels of theoretical analysis by Lent et al (1994). The first level comprised of cognitive personal variables, that is, variables which could be personally controlled in relation to career choice or development, examples of such variables are; self efficacy, outcome expectations and personal goals. The second level embodies variables such as gender and race (physical attributes), environmental characteristics and learning experiences. At this level, the effect of these variables to a people’s career related interests are analysed (Lent et al, 2000).

The SCCT sees that career interest and development could be affected by objective and percieved environmental factors. The objective environmental factors comprise of the learning experiences which a person has been exposed to and the social supports such as financial support which a person has at his or her disposal in view or pursuing a particular career path. These factors will affect people differently, depending on the extent to which they appraise the pertinence of the factors to them, thus in the SCCT, people are not passive but are active in allowing environmental factors to have bearings in their career choice. The perceived environment has much to do with the extent to which an individual sees and considers his or her environment, this has thus led to both practical and theoretical challenges, as a person from a condusive environment in relation to a particular career might be seen not to be interested in the career or not successful in the career, while on the other hand, an individual from an unfavourable environment in relation to a particular career, instead develops interest towards that career or excel in it. Consequently, a variety of objective variables from the environment such as peer influence, economic behavior and parental influence as well as how well individuals interprete their environment is taken into consideration when considering people's perceptions of the environment (Lent et al, 2000).

Lent et al, (1994) aimed at coming out with a frame work which will serve as bases for explaining the processes and mechanisms through which people develop career and academic interest, how career choices are made and how people achieve performance outcomes. The frame work was aimed to serve late adolescents and emerging adults in career interest orientation. Moreover, the framework was created also to predict career and academic behavior. Also, the framework was anchored on social cognitive theory of Albert Bandura which lays emphases on motivation guided by self-referent thinking. Consequently, there are certain aspects of the social cognitive theory by Bandura which serve as bases for the social cognitive career theory.

The first aspect is the person conception interaction. This has to do with the interaction between persons, their behavior and the environment. According to Bandura (1986) as cited in Lent et al, (1994), this model of interaction is called the triadic reciprocality. To him, three aspects which are; personal attributes which could be cognitive and affective characteristics as well as physical attributes, external environmental factors and the third aspect being overt behavior, all interact with one another and affect each other bidirectionally. Therefore, a particular behavior is a product of these bidirectional interactions. From the triadic causal system of Bandura, Lent et al (1994) identified three social cognitive mechanisms which are pertinent in explaining the social cognitive career theory. These mechanisms are; self-efficacy beliefs, outcome expectations and goal representations.

Self efficacy: Self efficacy appraisal is the aspect within the social cognitive theory which has received the greatest recognition in pertaining to career literature. Self efficacy refers to people's evaluation of their ability to carry out particular tasks. This belief thus determines an individual's choice of activities, choice of environment, way of thinking, persistence, the way to react emotionally in the face of challenges. Self efficacy has been revealed to predict career choices as well as academic performance (Hackett and Lent, 1992). Moreover, in the social cognitive theory, self-efficacy is not seen as static, but it is considered as a dynamic set of beliefs that interact with persons and the environment in various contexts and which are perculiar to specific performance domains. Though self efficacy deals with assessing and judging one's self on the capabilities of carrying out a particular task, it is still different from the objective assessment of skills. This is because, one could be assessed on the poseession of particular skills needed for a task, and if the individual is seen to possess the skills, it is not a guarantee that he will engage comfortable into the task, if he or she does not have the necessary self belief and confidence (self-efficacy) in carrying out the task.

Outcome expectations: Also as an important aspect in the social cognitive theory, it is concerned with peoples believes about the outcome of a particular behavior. To Bandura (1986), there are various classes of outcome expectations such as physical expectations like money, social expectations such as approvals, self-evaluative expectations such as self satisfaction. To him, these factors can adequately affect career decisions. Although both self efficacy and outcome expectations are strong determinants of behaviour, self efficacy to Bandura was seen as a more potent factor in which determines a person's behaviour. This to him was because an individual could value the outcome of a particular action, but does not engage into the action because they do not trust their capabilities. Thus, without self efficacy, even if the outcome expectation is high, there would be no significant effect.

To Bandura (1989) as cited in Lent et al, (1994), the nature of any particular activity in place determines the extent to which either a person's self efficacy or outcome expectation would affect the activity. That is in the case where the outcome is highly dependent on the quality of performance, then self efficacy would have more effect than outcome expectations, but in the case where the outcome is not highly dependent on the quality of the performance, the outcome expectations could have more bearings on the behaviour than self efficacy. This therefore means that the higher the quality of performance needed for any particular task or behaviour, the higher the self efficacy which would be needed.

Goals: According to the social cognitive theory, people can self regulate their behaviour through their goals. Though environmental factors, personal history and other deterministic factors could help shape people's behaviour, when goals do shape the behaviour, they are more could be sustained over longer periods of time even if reinforcement from external sources are absent. A Goal could be defined as the determination to embark on a particular process or to achieve a particular outcome. Goals are clearly seen when people apply a forethought of a desired future and it materializes as people constantly evaluate themselves basing on their individual internal standards of performance. Goals are very important ingredients in career choice and in decision making as goal mechanisms find a place in career plans, aspirations and in making choices. The goals, no matter their orientations are all geared towards motivating behaviour. The various gioal terms are only different in the way in which they can be applied in making various choices (Lent et al, 1994).

The above aspects served as premises on which the social cognitive career theory (SCCT) was built. The social cognitive career theory elaborates on the effect of a students' self efficacy, interest, outcome expectations, social support and barriers on their decision to follow a particular career goal (Lent et al, 2011). The first aspect in the SCCT is self efficacy. This as already defined by Bandura's social cognitive theory above is a person's belief in carrying out a particular task. That, the higher the self efficacy of a person, the better he or she is confident of carrying out a particular task while the lower a person's self efficacy, the lower his or her confidence or belief in carrying out a particular task. Since self efficacy is seen as a person's belief in their ability in performing certain tasks, it has thus been shown to predict people's drive towards different careers or their career aspirations. That is students who perform well in a subject like Mathematics, would likely be interested in embracing a Mathematics related career (Correll, 2001) as cited in Shehab et al (2015). In line with this research work, a student who often does well in a particular science subject in high school, would like to do an engineering course which is most related to that particular subject because the student would have developed high self efficacy in relation to that subject and thus, anything related to this subject would be seen as an aspect which could easily be done. Moreover, if a student has high self efficacy with regards to engineering or a particular engineering program he would to a great extent perform well in the engineering and if this self efficacy stems from self efficacy they had in relation to a particular high school subject, then the grade scored in that high school subject would to a great extent predict the student's performance in engineering.

The second aspect of the SCCT is interest which is also intrinsic in value. This has to do with the enjoyment linked to a particular activity. That is to say an individual develops interest in a career because he or she enjoys carrying out a particular activity. Thus, if a student loves studying Mathematics and the sciences, the interest to pursue careers such as engineering will be obvious (Shehab et al, 2015). This assertion goes in line with this study, because a student who enjoys studying sciences in high school would to a great extent develop interest in fields of applied sciences such as engineering. To be more specific, the student's interest will likely be more on a particular specialty, that is a branch of engineering which is likely more related to the subject they enjoy most in high school. Consequently, the grade they scored in this subject in high school will to a great extent predict their academic performance in the branch of engineering most linked to that subject.

Outcome expectation is the third aspect o the SCCT. This has to do with the belief people have about the gains and benefits which they will get or which awaits them as they pursue a particular career. For example, a student might decide to study a particular branch of engineering with the notion that they will accomplish great works as engineers. Moreover, in this study, outcome expectations as a factor which affects student's choice for the engineering career is measured through students' hope of getting employment upon finishing their engineering program, and the hope of solving pertinent societal problems amongst others. Therefore, students who are highly motivated to embark on engineering studies would likely perform well in engineering school and if this kind of motivation was not there before they wrote their end of course high school examination, then their high school results might not greatly predict their performance in engineering, but if they had always been motivated because of their expected outcomes, then their high school results might to a great extent predict their academic performance in engineering.

The fourth aspect of the SCCT is social support and barriers. This involves choosing a particular career due to influence from parents, guardian, an experience person in that career, or counsellor. Amongst these, parental influence is a strong force and a positive predictor for making a career choice or getting into a particular field of study. Social barriers refer to the absence or limited support from parents and from other stake holders and it could be in the form of limited finances, and other important factors like counselling and encouragements which could make a person to embark pursuing a particular career. These social barriers have been seen to directly downplay on a student's self efficacy as compared to the effect on their goals (Lent and Brown, 2001). Most students who are faced with these social barrier complications are first generation students in college and immagrants (Martin, et al, 2013). This is because most migrants are distant away from their parents and family, thus there would certainly be that absence of the necessary support and assistance from family as the students pave through or try to get into different career pathways. First generation students in some colleges, are also faced with this lacuna because before their coming, supporting structures such as counselling services might not have been put in place, as well as senior students to orientate them and give them their experiences are not there, since they are the first generation.

In line with this research work, students could be motivated to embark on engineering studies in university or to choose a particular branch of engineering in university intrinsically through their self belief or interest towards engineering in general or a specific engineering program in particular. Likewise, some students are motivated extrinctly through social supports as well as from the expectations they have upon graduation as engineers.

Empirical Review

Review of Studies on High School results in Sciences and Students' Academic Performance in Engineering

Darlington & Bowler (2016), did a research work which was aimed at determining engineering undergraduate's views of A-level Mathematics and Further mathematics as preparatory bases for their degree in engineering. These researchers embarked on this study because they observed that the demand for engineers in the workplace in the United Kingdom outstripped the supply of these engineers. Thus, they sought to identify the effect of the Mathematics problem to this low output of the number of engineers. In order to find plausible solutions to this problem, the researchers postulated three research questions. The first research question focused on identifying the optional units of Mathematics and Further mathematics which engineering students find to be a for their studies. The second research question was out to determine the extent to which the students find A/L Mathematics and Further mathematics as necessary qualifications for the engineering degree program. The third research question was to find out if there were any areas in Mathematics and Further mathematics from the students' perspectives which could be improved upon in order to suit the needs of future engineering students. In order to adequately grasp students' perceptions of their Mathematics preparedness for their degree, an online questionnaire was designed.

The questionnaire for this research carried out by Darlington & Bowler (2016), was designed by the researchers themselves with the help of A- level mathematics and Further mathematics specialist at Cambridge assessment. This mode of administration was put in place so that the questionnaire could easily get to a large number of students from a wide range of universities, since students of different universities are likely to have different experiences of engineering courses offered, varied mathematical entry requirements, and different mathematical background. In order to get the questionnaire to the respondents, engineering institutions in the UK offering undergraduate engineering degrees were listed and searches were made to get in contact with the administrators, departmental heads or admission tutors. The participants of the research by were supposed to have completed at-least 1 year of degree study in engineering and have taken at least As level mathematics. A total of 462 engineering students met the requirements and completed the questionnaire fully. From the data collected, the participants came from 20 different universities with an average of 0.8 coming from each of the participating universities. Also, nearly three quarters (74.2%) of the participants were men and most of them were studying for a 4year undergraduate master's degree and only 35.1% of them were studying for a three-year Bachelor's degree program.

The findings of Darlington & Bowler (2016) revealed that engineering students find both A-level Mathematics and Further mathematics are good preparation for undergraduate engineering studies. In particular, the students found mechanics and further pure mathematics units to be especially beneficial as preparatory bases for engineering studies with statistics of more limited use in engineering studies. Also, the engineering students in this study were very enthusiastic about Further mathematics with 90.8% of them describing the As or A-level as good preparation for the mathematical component of their engineering degree. The findings also reveal that studying complex calculus and matrices as well as mechanics were quite pertinent for engineering studies.

De Winter & Dodou (2011), also carried out a study to find out the extent to which academic performance in engineering could be predicted by high school scores. The study specifically investigated the extent to which students' first year GPA and their final GPA upon completion of a Bachelor's program in engineering could be predicted by high school end of course examination scores in a Dutch technical university. In the study, it was hypothesized that the high school examination scores of Physics and Mathematics would be the strongest predictors of students' academic performance in various engineering programs at the Dutch technical university. Admission data and academic scores were collected for all students who enrolled into B. Sc in engineering program in the Dutch technical university in 2003. The B. Sc in engineering programs were; chemical and biochemical engineering, Aerospace engineering, Applied Physics, Industrial design engineering, Applied Mathematics, Electrical engineering, Civil engineering, Computer science, Marine technology, Industrial design engineering, systems engineering, applied earth sciences, policy analysis and management and Mechanical engineering.

The cohort used for the study was made up 1958 students of which 80.6% were male. The mean age of the students was 19.63 years. The students either came from a pre-university education program (VWO) which is a 6-year program or from a Higher Professional Education (HBO) program, which is a one-year program. Finally, the total number of students used for the study was 1050. The variables used to measure the academic performance was the GPA scored in year 1 and at the B. Sc degree level. The B. Sc degree was categorized and coded as follows; 0 = No B. Sc, 1 = B. Sc and 2 = B. Sc with honours.

De Winter & Dodou (2011), used a variety of statistical tests, firstly, factor analyses were used on the high school examination scores of the 1050 students. In order to predict 1st year GPA and B. Sc completion, regression analyses of the extracted factors were conducted. The results revealed that natural science and Mathematics factor which comprised of Physics, Chemistry, Mathematics as loading variables was the strongest predictor of first year GPA and B.Sc. completion. The liberal arts factor weakly predicted academic performance in engineering while the language factor has no predictive value. The findings furthermore revealed that engineering programs with great reliance on Mathematics and Natural sciences enrolled better performing students. Women enrolled into the university with higher high school examination scores, but gender was not a significant predictor of year 1 GPA and was a weak predictor and significant more for women of B. Sc completion.

Rahman et al (2012), did a study in Bangladesh which emphasized on comparing students' performance in secondary school which is measured through their secondary school certificate examination results with their performance in an engineering diploma program in Polytechniques measured through the cumulative GPA scored at the end of the four-year course in engineering. The results of the diploma in engineering in civil and computer technology were used for the study. In this study, it was hypothesized that students' performance significantly varies between their secondary school results and their diploma results in engineering. The study employed the quantitative researcg paradigm which compared results between secondary school and those of the polytechnique institutes. The population for the study comprised of students of all the 29 departments of engineering in all the 45 polytechnique institutes run by the government. From this population, four government polytechnique institutes were sampled and from these polytechnique institutes two departments were also sampled which were the civil technology and computer technology departments. The simple random sampling technique was then used to select 50 students from each of the already sampled departments. The sample of the study was then comprised of 200 students. In order to collect the results of the students sampled for the study, the researcher designed a data collection form which he used to collect data from the registras of the polytechnique institutes used for the study. The data collected was then analysed using the Pearson product moment correlation coefficient. The results of the study revealed that there was no significant difference between students' performance at secondary school and at the polytechnique institutes. Therefore, students' results in the engineering diploma in the polytechniques were found to be consistent with their performance at secondary school.

Furthermore, Vidal & Zanini (2015), did a research work on the role of the A-grade at the Advanced level as a predictor of students' university performance in the United Kingdom. The study was thus carried out to determine the predictive validity of the A grade at A/L which had been awarded for the first time in 2010. This grade was introduced to help higher institutions easily differentiate candidates with higher academic achievement. The study investigated for the first time the extent to which the A grade predicts students' performance in three-year courses at institutes of higher learning. Using a multi-level regression model, the results of the research work showed that the A grade was a significant predictor of achieving either a first class or second class upper degree. Moreover, analyses of specific level subjects revealed that a number of top grades scored at the A/L in some subjects was associated with good degree outcomes in specific degree subject areas.

Lee et al, (2008), researched on the prediction of students' performance in the first year of study in engineering and the importance of assessment tools there-in. The study was carried out in order to produce a suitable first year curriculum for engineering studies that will suit adequately with their prior knowledge from high school. Two research questions guided the study. The first research question was out to identify the factors which significantly predict students' overall first year university performance and the research question focused on identifying the factors which significantly predict the grades students score in the mechanic's module in the first year of university study. A total of 133 students of mechanical engineering at Loughborough university were selected for the study. This was done because mechanics has a more direct bearing on the studies. Data was collected with the aid of two research instruments which were a questionnaire and a diagnostic test. From the research instruments, data pertaining to 14 predictors to be used for the study were collected. These predictors were Mathematics diagnostic test mark, mechanics diagnostic test mark, Mathematics A/L grade, gender, whether or not the student did A/L Further mathematics, the number of modules studied in mechanics in A/L Mathematics, the number of modules of statistics studied in A/L Mathematics, the number of discrete modules studied in A/L Mathematics, number of points scored at the A/L, the examination board who certified the student at A/L being the Assessment and Qualification Alliance (AQA) exam board, or the Oxford, Cambridge and the Royal Society of Arts (OCR) examination board or the Welsh/Northern Irish exam board. Also, whether the student studied overseas or at home and whether the student visited the Mathematics Learning Support System (MLSS) or not in the first year of study

The results from the study of Lee et al, (2008), revealed that from all these 14 predictors, only three were significant predictors to students' academic performance in the mechanic's module and their overall performance in the first year. These three variables were; the Mathematics diagnostic test results, the number of statistics modules studied in A/L Mathematics and whether the students visited the MLSS or not. From the results, two regression models were brought forth. One for predicting performance in mechanics and the other to predict overall performance in the first year. The R^2 value for the 107 students who had data on all three significant predictors to overall academic performance in the first year was 0.392, and the R^2 value of the overall performance for the 66 students who had complete data set was 0.185. The R^2 value for the performance in mechanics for the 107 students was 0.316 and for the 66 students, the R^2 value was 0.476

James & John (1995) carried out a study to determine the predictors of persistence and success in an engineering program. The study arose from two interrelated problems in engineering education, which were the attrition rate nation-wide, which had risen to about 50% and in appropriate advising provided to engineering students. The study made use of 10 cognitive and 9 non- cognitive variables as predictors of student's persistence and success in engineering. The sample of the study was made up of 1045 freshmen entering into a mid-Atlantic research university. The data was analyzed using logit models. The CATMOD procedure with maximum likelihood estimation was used to build the model. The results revealed that students who performed academically in Mathematics and science courses and who were interested in engineering genuinely were more likely to persist and succeed. Moreover, the predictor variables changed as students progressed through the first and second year of study. Thus, the variables were not constant over time. With the best predictors emerging as performance in prerequisite science and Mathematics courses.

Liberty et al, (2015) carried out a study on the readiness level of engineering fresh men students in college. The study was aimed at finding out the readiness level of newly admitted engineering students in college Physics at Rizal technological university of the academic year 2013-2014.The study made use of 11 research questions and tested two hypotheses. The research design used for the study was the descriptive method through correlational survey technique. Data collected was analyzed using percentages, as well as analysis of variance (ANOVA), the spearman rank correlation coefficient. The results of the study showed that the level of proficiency of the respondents in High School Physics is proficient, developing in college algebra, plane and spherical trigonometry and in Hewett's basic content in Physics. When grouped according to profile variables, there is no significant variations in the college Physics performance of respondents. There was negative correlation between the respondents' performances in Hewett's basic content physics test and a positive correlation in college algebra. The positive correlation between the respondents' performance in Hewett's Basic content physics test and in plane and spherical trigonometry with a computed value of 0.12 is found to be significant at the 0.05 level of significance. Based on the findings might, researchers recommended to identify other factors that might affect students' readiness in college physics aside.

Bingolbali, Monaghan & Roper (2007), carried out a study to explore mechanical engineering students' conceptions of the derivative and to determine some implications for their Mathematical education. Data for the study was collected via a preference test pre-, post-, and delayed post-test, an analysis of calculus courses and interview with students. Mechanical engineering students were compared with Mathematics students using data collected from mathematics students. The results for the study revealed that the conceptions of and preferences for the derivative for mechanical engineering students develop in the direction of the rate of change aspects while the development for mathematics students was in the direction of tangent aspects. The results also reveal that mechanical engineering students see mathematics as a tool for application in their subject. Thus, in this study, the developing conceptions of students together with their views are taken into consideration in order to make mathematical education for engineering students better.

Huang and Fang (2013) presented a research work which they carried out to predict students' academic performance in an engineering dynamic course by four types of predictive Mathematics models. In this study, four types of Mathematics modelling techniques were used which here; multilayer perception (MLP) network, support vector machine (SVM) multiple linear regression (MLR) and radial basis function (RBF) were used for the study to develop 24 mathematical predictive models based on data collected across four semesters from 323 undergraduates. The students' scores on the final dynamic comprehensive exam were the outputs of the models. The inputs of the models or the predictor variables were, the GPA, Grades scored in four pre-requisite courses that is (static) Calculus I, Calculus II and physics and three dynamic mid-term scores. From these six combinations of the above predictor, variables were formulated. Data from the study was collected from students of various engineering courses such as civil and environmental engineering, Biological engineering, general engineering, Mechanical and Aerospace engineering and also from pre-engineering and non-engineering majors.

The results of the research of Huang and Fang (2013) revealed that the support vector machine models (SVM) have the highest percentage of accurate predictions (PAP). The findings also revealed that the Average prediction accuracy (APA) was affected only slightly by the types mathematical models. The combination of the predictor variables in effect had only a slight effect on the Average prediction accuracy but a significant effect on the percentage of accuracy predictions (PAP). The findings of this research further revealed that if an instructor wants to predict the performance of his or her learners, he or she should preferably use the multiple linear regression models as the mathematical model and with the cumulative grade point Average (GPA) as the only predictor variable. But if the goal of the instructor is to predict individual students' academic performance, the instructor should preferably use the support vector machine (SVM) model using the first six predictor variables as the input.

Also, Lee, Harrison and Robinson (2006) carried out a study to evaluate students, knowledge of mechanics upon arrival at engineering schools. Taking into consideration the expectation of lecturers or instructors and the realities at hand. This study was carried out because there has been increase awareness to the fact that engineering students lack knowledge in mechanics. Many methods were employed in carrying out this research. The survey way used in which 497 schools in England out of the 2,717 schools where students study for the A-level, received questionnaire. Only 242 schools replied to the questionnaire administered, thus giving a return rate of 49%. The questionnaire was answered by over 1000 engineering students. A mechanic diagnostic test was also administered to 451 engineering students and a science and follow up interviews was administered to the lecturers.

The findings from this study of Lee et al (2006) indicated that the diagnostic test discriminated significantly between the students in terms of the number of mechanics models they had studied. Also, from the questionnaire to the schools, to the students and from the diagnostic test, students' knowledge on mechanics upon entry into an engineering school is known. The result also revealed that only 17% of the lecturers were aware of the mechanics models which their students studied at A-level mathematics 15 out of 26 lecturers which is 58%, assumed generally a knowledge of mechanics which the students are not equipped with. The academics or lecturers also showed a lack of awareness of developments in A- level. Summarily, the finding from the study shows clearly that there is a difference between academic expectation and the reality of prior knowledge of mechanics possessed by students.

Furthermore, Hans, Black, Hernandez- Martinez, Pepin and Williams. (2015) carried out a study to determine or find out about engineering students experiences in terms of how they see mathematics to be important in their engineering program and also how the lecturer go about teaching the students mathematics however and what problems are encountered by the student. Two research questions guided this study. The first question was out to identify the problems encountered by the engineering students due to the way they unexpectedly found mathematics in the engineering program and the second research question sought to identify the way the students find the separation of engineering from mathematics as a problem. The research employed the qualitative research approach and made use of interviews as a technique for data collection. The students alongside some lecturers were interviewed.

From the findings, one of the lecturer and some of the students interviewed, talked about the lack of information made at the disposal of the students before they engaged into engineering studies at university. Thus, the high mathematic content of some of the engineering programs is minimized to the detriment of the students. The result from this study of Hans et al (2015) thus revealed that many of the students deemed it necessary to succeed in Mathematics but are faced with difficulties because in many cases, Mathematic is taught differently from engineering. Thus, the students perceived that there is a lack of cohesion between the Mathematics taught them and the engineering it is ought to support. Therefore, from this study, it was concluded that mathematics in engineering is still a central problem and that mathematics should be a basic concern in the practice and design of engineering in the first year.

Cole (2014) carried out a study in the United Kingdom on the effect of the choice of A-level Mathematics model on students' performance in the first year of an engineering degree. He was motivated to carry out this study due to the decline in students' Mathematics skills in the UK since the early 199o's. The flexibility which is given students to choose the models to do at A/L opens the gateway for students to enrol into engineering when they are not well apt in Mathematics courses like mechanics. Thus, in the U.K six models could be done by the students in high school from the following courses, C_1 (core Maths 1), C_2 (core maths 2), C_3 (core maths 3), C_4 (core maths 4), M_1 (mechanic 1), M_2 (mechanics 2), S_1 (statistic 1), S_2 (statistic 2), D_1 (decision maths 1), and D_2 (Decision maths 2). Therefore, the 6 possible modules which be considered optional are M1-M2, M_1-S_1, S_1-S_2, D_1-D_2, M_1-D_1, S_1-D_1 (Cole,2014).

They study involved a survey of aerospace and mechanical engineering students who began their degree studies in September 2011 and 2012 at Queen's University at Belfast and who have successfully completed the first year. In the year, 2011/2012 there were 52 aerospace students and 95 mechanical students while in the year 2012/2013 had 120 mechanical students and 46 aerospace students. A survey of these students revealed that the mechanical and statistic module was the most popular choice of optional module in

A- level mathematics, indicating that just about a quarter of the students had studied mechanics beyond the basic module.

In carrying out the analysis for this study using the T-test in order to compare the relationship between students' performance in solid and structures and engineering dynamics in the first year with A level mathematics grade in the different optional mechanic module sampling was done in order to exclude students who have had often exposure to mechanic compared with those coming directly from the A-level maths program. Thus, for the 2011/2012 class the sample was reduced to 60 of these, 45 had done M_1-S_1 and 15 had done M_1-M_2. The data was also restricted for the 2012/2013, to 77 students, 25 of them had done M_1-M_2 and 52 had done M_1-S_1.

The result of the study of cole (2014) revealed that A-level mathematics grade did not significantly predict students' performance in solid and structures and engineering and dynamics courses in the first year. In general, for student who scored a particular A-level grade in mathematics the students who offered M_1-M_2 in A-level are better averagely than those with M_1-S_1 background, though the difference between the corresponding mean values were small. The score range of the M_1 -M_2 and M_1-S_1 students were use generally spread out over a wide range, meaning that any benefits for those who had focused on mechanic (M_1-M_2) at school was relatives small. Therefore, the results give feedback about the depth of understanding in mechanics gained from offering the A-level mathematic program

Goold and Devitt (2012). Carried out a study on the role of mathematics in engineering practice and in the formation of engineers. The researchers were motivated to carry out this research because of the diminished interest of young people to pursue careers as engineers and in Ireland, a grade of C_3 (55-59.9%) or higher in mathematics in the higher level leaving certificate is required for entry into level 8 engineering programs. The study was out to get the answers of two research questions which were to determine the role of mathematics in engineering practice and to determine if there is a relationship with students' experience with school mathematics and their choice of engineering as a career.

The population for this study was made up of professional engineers who meet the criteria as prescribed by 'engineers Ireland' for chattered Engineers. That is for an engineer to be considered a chattered engineer in Ireland he should be a holder of a level 8 degree in engineering and at least a 4year professional experience. The study made use of a mixed method (triangulation) research design whereby on the quantitative survey is proceeded by quantitative interview when build on the survey findings. An online survey in the form of questionnaires was distributed by email to 5,755 of which 424 were women chartered engineers. The valid responses received amounted to 365 valid ones from a variety of roles position and disciplines in engineering. Thus, a response rate of 6.3% was registered and was widely representative of the population across gender discipline and geography. The quantitative data was collected from 20 chatered engineers through semi structured interviews.

The findings of the research work of Goold and Devitt (2012) had five major findings. Firstly, in relation to the engineer's feelings about mathematics as a major influence on them choosing engineering as a career, 75.9% of the engineers who took part in the survey asserted that their feeling for maths influence their choice of engineering as a career was in the range "quite a lot'' or a very great deal where the options were rated 4 and 5 respectively on a scale of 5. Interview analyses also fall in line with this finding. Secondly on the influence of teacher's affective factors and some cultural influence as main contributor to engineer interest in and their learning of maths, 80% of the engineers had enjoyed maths in school that the teacher is the main factor contributing to the engineers learning maths and that affective factors strongly influenced their learning of maths. Thirdly in relation to engineer's usage of curriculum maths and their thinking abilities the findings revealed that the engineers are their curriculum mathematics as well as mathematics at the B.A/BSc level and that they also employ their thinking capabilities in their day to day work as engineers.

Fourthly, whether their usage of curriculum maths and thinking capabilities linked to their individual discipline and control the findings revealed that engineers use mathematics curriculum could depend discipline and control individually and engineer's mathematical thinking usage is independent of engineering discipline, role and interaction of both. Fifthly on how the engineer's affective engagement with mathematics and their usage of mathematics in engineering is influenced by their value or worth given to mathematics within their organisation. The findings revealed that almost 75% of the engineers who took part in the survey confirmed they enjoy using maths at work, while 80% of them asserted they feel confident in using maths at work. Interview analysis also revealed that the engineer’s confidence in their mathematical ability grew from their recognition of success in school mathematics. Summarily, the findings of this study revealed that mathematics is a subject which is highly affective where past emotional experiences with maths at school, value and expectancy influence engineer’s engagement with mathematics in their work.

Shrestha and Shields (2015) did a study in which they correlated students’ performance in a fundamental of construction science course with their performance (GPA) of mathematics and physics. Thus, the aim of the study was to find the correlation between students’ GPA in Mathematics and Physics and their performance in a fundamental construction science course. It is believed that performance in mathematics and physics has a strong bearing on students’ performance in construction management (CM) this is because mathematics and physics are embodied deeply into the program and fundamental construction science offered to freshmen. The study also investigated the effect of the fundamental construction science course on students’’ performance in mathematics and physics.

The study made use of the data of 27 students enrolled during spring of 2007 and 2008 into the Fundamental Construction Science Course. The questionnaire for the study was distributed to students on their first day in class in order to measure their knowledge in Mathematics and Physics prior to taking the course. The questionnaire assessed knowledge in Mathematics and Physics courses. The questionnaire was not returned to the students nor their results revealed. The same questionnaire was then administered to the students at the end of the course in order to ascertain their improvement in Mathematics and Physics after taking the course. The data was analysed using many statistical tests. ANOVA was used to determine if there was a significant difference in the students’ performance in Mathematics and Physics before and after taking the course. The linear correlation analysis was also used to determine the extent to which students’ performance in Mathematics and Physics before engaging into the construction Management course is related to their performance after the course. Finally, multiple regression analyses were conducted in order to get a regression model for the prediction of students’ performance in Mathematics and Physics after taking the construction management course.

The findings of the study of Shresting and Shields (2015) revealed that there is a positive correlation between GPA scored in Mathematics and Fundamental Construction Science (FCS) course grade, and students' knowledge in Mathematics and Physics was significantly improved after taking the Fundamental Construction Science course.

Also, O'Dwyer (2012) carried out a study to compare the academic performance in Mathematics, Physics and Electricity of first year electrical engineering students of the Dublin Institute of Technology in Ireland. The students' examination performances in Mathematics, Physics and Electricity were compared using the Pearson product moment correlation coefficient. The findings revealed that there is a strong significant positive correlation between the performance in electrical principle and engineering science subjects in the module examination ($n= 115$, $p<0.001$, $r=0.68$). There is a weak significant positive correlation between the electrical principles and mathematics subjects in the module examinations ($n=115$, $p<0.001$, $r=0.4$). Also, there is a highly significant positive correlation between students' academic performance in engineering science subjects in the terminal examinations ($n=159$, $p<0.001$, $r=0.4$). Finally, that there is a highly significant positive correlation between students' performance in the electrical principles and mathematics subjects in the terminal examinations ($n=153$, $p<0.001$, $r=0.65$)

A study was also carried out by Bothaina et al, (2019) on the modelling of students' academic achievement in engineering education using cognitive and non-cognitive factors. The study was carried out to identify the factors which are responsible for the success of undergraduate engineering students. The study sought to determine the prediction of students' performance in engineering through the use of the knowledge, attitude and behavioural skills (KAB) model. The study made use of two theories which are; the interactionist theory of Tinto's (1993) emphasized that students' persistence and retention could be predicted by the extent to which the students are academically and socially integrated within the said institution. The second theory used in this study is the expectancy value of achievement theory by Eccles and Wigfield (2002) which dwells career, motivation, academic self efficacy and confidence in mathematics and science skills in general. The study also made use of variable selection and dimensionality reduction which are methodologies used to improve on the modelling accuracy of students' performance. Data set of ten critical to success factor focusing on skills and attitude in order to measure the performance of the aforementioned methodologies. The study made use of 320 first year students. In this study, two statistical models were used for analyses. The exploratory factor analysis was used as the first model and regression model selection was used as a second model, with the ridge regression used as a second step in each of the models.

The findings of the study of Bothaina et al, (2019) revealed that both the cognitive and non-cognitive factors accounted for about 30 to 40 percent of the variance in students' academic performance measured by the GPA, with the non-cognitive factors accounting for about 25% in the variance in students' academic performance and the cognitive factors accounting for about 15% in students' academic performance. Thus, it was concluded that the non-cognitive factors were better predictors of students' academic performance. From the two models used, the second model led to a more significant R^2 value, while the first model led yielded a more significant adjusted R^2 value.

Also looking at other studies which determined the relashionship between high school results and results in higher institutes, Geiser and Santelices (2007) affirmed that high school grades are significantly the best predictors of students' performance in institutes of higher learning as he came out with the findings that high school grade point average (HSGPA) was seen as the most prominent predictor of students' performance in the four year programs in universities across all programs in the University of California sample which he used in his study, secondly, that the the extent of prediction of university performance by HSGPA was greater with the cumulative four year GPA than that of the first year. That is, the HSGPA predicted CGPA better than first year GPA. Their findings were in accordance with those of Anderson et al (1994) who also asserted after carrying out a research work in order to determine the determinants of students' performance in university. Contrarily to their findings, Huw et al (2006) after carrying out a study on the prediction of students' academic performance by their previous academic performances concluded that the subjects offered at the Advanced level along side with the grades students obtain in those subjects do not predict students' academic performance at university.

Akoko (2010), did a study in Cameroon on the effect of student's affective characteristics and their educational background on their achievement in Mathematics at higher education as measured by semester grades in top Mathematics courses. The background characteristics involve gender, age, students' performance in Mathematics in end of course certificate examinations such as the grades scored in the GCE and BAC examination while the affective characteristics was made up of, students' locus of control, their Mathematics self-efficacy, and anxiety. Questionnaire was designed for high school teachers, students. The data was collected from two institutions, being the National Advanced School of Engineering department of Mathematics of the university of Buea. The data was analysed using SPSS version 17.0. The results indicated that the internal locus of control, high Mathematics self-efficacy, and Mathematics anxiety significantly affected performance in Mathematics in higher education. The results also revealed a significant difference in the in the performance of students from the two educational backgrounds, with the students from the French subsystem outperforming those from the English sub system of education. The GCE A/L Further Mathematics syllabus which was aimed at preparing students for higher education Mathematics did not significantly have an effect on students' performance in Mathematic at higher education. The results also revealed that there was an acute shortage of high school Mathematics teachers in the English subsystem of education compared to the French subsystem.

Review of Studies on Students' Motivation for Engineering and their Choice for the Engineering Career

Benson and Morkos (2013) carried out a study in the United States of America with the aim of identifying potential factors which affect students' motivation for engineering and how these factors affect students' performance. They carried out this study in view of getting solutions to problems engineering educators were facing such as deriving strategies for improving students interest for engineering, developing more diversified engineers and making students ready to face a world of rapid technological growth. The study was guided by four research questions. The study was anchored on the Expectancy value theory of motivation. A quantitative survey was carried out using the Motivation and Attitude in Engineering(MAE) survey which was developed using the achievement value theory of motivation in order to identify constructs underlying students' motivation for engineering. Through factor analyses, three constructs were recognized which were; Expectancy, present perceptions and future perceptions. The results of comparing constructs over the first year of engineering studies revealed that there is a decrease in expectancy in the first year while there is an increase in present perception as well as future perception. The results of Binomial regression also revealed that present and future perceptions significantly affected persistence in engineering positively. Along side the MAE survey, a Beginning of Semester (BOS) survey was used in order to determine students' motivation for their choice of their Engineering major. This informal BOS as well as the MAE were analysed for differences in Engineering students' choice for their major. The findings revealed that no differences were observed in any of the MAE constructs while differences were observed in the case of the BOS students of interdisciplinary majors placed great importance in distinguishing them selves and making use of the available scholarship money and students of traditional engineering majors placed more value in carrying out engineering works as well as designing and building structures.

Kolmos et al (2013) carried out a study in Denmark in order to determine the motivational factors for educational choice with the prime aim of determining the male and female's students' reasons for choosing engineering as a career. The study made use of the survey research design and made use of the full student population who were enrolled engineering education in Denmark in the Autumn of 2010. The findings revealed that women's choice for the engineering profession is more influenced by mentors while men's choice for engineering studies is more influenced by social standing of the engineering profession. With regards to parental influence, it was quite low across all the engineering programs. The findings further revealed that amongst the various motivational factors, social motivation and intrinsic motivation were the most pertinent with respect to influencing students' choice for particular engineering programs. The study recommended that gender and the nature of the different engineering programs should be taken into consideration while fine tuning strategies for attracting students into engineering education.

Kim (2014) also did a study in which he aimed at determining the effect of engineering students' motivation on their short-term tasks and long-term goals. The study also sought to find out how effectively engineering students' long-term motivation influence their present tasks. This study was carried out taking into cognisanze the fact that though students' academic performance is a measure of their success, it does not consider the underlying motivations which underpin the extent to which students apply their intellectual capabilities. The study was fragmented into five phases. The first phase of the study examined the extent to which salient aspects of students' motivation for engineering such as expectancy, value as well as future time perspectives are related to students' goals in the long term and their tasks in the short term. The second phase of the study examined the correlations between three different motivation constructs which are; expectancy of success in a particular engineering major, their present perceptions of their present state as engineering students and their future perspectives as engineers. The third phase was out for the creation of groups for participants using upper level students' motivation profile. The fourth stage adopted the qualitative approach in which the engineering students were interviewed in order to get relavant information pertaining to their future goals and their present actions. The fifth phase examined students' perceptions towards problem solving in engineering and their and how these perceptions could be influenced by their motivation. The results of the first phase revealed that engineering student's perceptions and expectations of the future differentiate between students whose long-term goals are different. The findings from the second phase revealed that the steps which students take in solving problems in engineering is correlated to students' future perception. From the fourth phase, the results revealed that some of the engineering students had long term goals which were defined in their future while others had no plans after graduation. The results from the fifth phase showed that students' perceptions for problem solving could be influenced by their motivation.

Pablo-Lerchundi et al, (2015) did a study in Spain which was out to determine the effect of students' motivation on their choice of various engineering majors as well as to find out the level of their present satisfaction in their various engineering courses as well as their developmental plans pertaining to their future professions. The study was carried out in the Universidad Politecnica de Madrid (UPM). The study made use of 89 students sampled through the incidental sampling technique from the Architecture, Computer science and Forestry engineering departments. The data was collected with the use of an adapted inventory. The data collected was analysed with the use of parametric tests such as Pearson's Chi squared test. Non-parametric tests were also used to determine the difference of the engineering students' satisfaction with respect to their gender and the type of engineering degree offered. The results of the study revealed that students' motivation for engineering and their satisfaction in their various engineering majors were dependent on each other as well as with their future professional plans. The results also revealed that gender and the engineering degree major are also dependent on professional development plans and significant difference was found with respect to satisfaction.

Furthermore, Shehab et al, (2016) carried out a study in order to determine factors which motivate students to choose engineering as a program of study in the university and how these motivations are related to their professional goals. The study was anchored on the Social Cognitive Career Theory (SCCT) which explains how a students' self efficacy, interests as well as outcome expectations, social support and barriers affect their choice of various career paths. Interview sessions were carried out with students from various ethnicities, the interviewed population comprised of; 37 African Americans, 35Asian American, 37 Hispanic American and 29 native Americans. In order to analyse the data collected, the interviews were transcribed and later cheked to avoid anonymity. The data was analysed using NVivo qualitative data analysis software. From the results of the study, the general trends revealed that interest was one of the most powerful factors that affected students' choice of a career goal, with the lowest being self efficacy. Specifically, for Hispanic American students, the theme of social support was found to be the more important construct which influenced students, while there was a lack of motivation from social recognition as well as financial goals. For Native Americans, the findings were similar to those of the Hispanic Americans with the influence from social support and interest being more pertinent while the outcome expectations and self efficacy had moderate influences on students' choice. For Asian American students, the both factors of interest which are their interest in STEM and in industry were the strongest factors influencing students' choice, while social supports were the lowest factors which influenced Asian American students' choice of choosing engineering as a field of study in the university. Nevertheless, outcome expectations influenced Asian American students more than the students of the other groups. The African American students were more influenced by interest, as it was revealed that the African American students were more influenced by interest in STEM and in pre- college activities.

Moreover, Gero and Abraham (2016) did a research work in Israel with the aim of identifying the factors which make students to choose to study science and engineering. The study made use of students in academic preparatory programs. The study adopted both the qualitative and quantitative approach and was anchored on the self determination theory. The sample of the study was also made up of 60 students who were about to begin the academic preparatory programs. The findings of the study revealed that the students are most influences to study science and engineering by intrinsic motivational factors, which are indicated by their interest and by recognizing the value study science and engineering (identified regulation). In addition to these factors, the findings also revealed that some of the students were motivated to study science and engineering because they want to satisfy the expectations of people who are of great importance to them and also for personal prestige (introjected regulation).

Baytiyeh and Naja (2020) also carried out a study in Lebanon in which they sought to determine students' motives of choosing various engineering majors. Three universities in Lebanon were used for the study. The study adopted the survey research design and a questionnaire with iterms on a likert scale was administered to 387 engineering students from these three different universities. From the survey, it was revealed that genuine interest in the field of study was the major factor influencing students' choice of an engineering major. In order to generate and group various intrinsic and extrinsic motivational factors, factor analysis was carried out and the factors were gouped into personal growth, professional growth, social growth and financial growth. Results from one one-way repeated measure ANOVA also revealed that factors that improves on students' creativity in challenging environments such as professional growth as well as job satisfaction are the main motivating factors which affect students' choice of engineering.

Review of Studies on Predictive Validity

Willingham (1985) carried out a fascinating study in which he used thirty different predictors in order to identify those which significantly predict students' performance at college. From his study, he found out that only six predictors amongst the thirty used for the study significantly predicted students' academic achievement at College. He further concluded that amongst the six significant predictors, the strongest was the students' high school GPA and the second predictor with respect to its strength of prediction were the standardized test scores. Willingham (1985) in his study did not only use those factors which he considered to be potential predictors, but he made use of almost all the predictors at his disposal. This made the study quite comprehensive though diversed in its orientation.

Wilson (1983) did a compresed longitudinal study on the prediction of college GPA by admission criteria such as the SAT. The study made use of classes which graduated between 1930 and 1980. The study made use of about 12000 students from 40 institutions. From the study, it was discovered that a combination of both SAT and high school results were better predictors than either the SAT results or grades scored alone predictors. Though the predictors were more significant when combined, the SAT results were SAT results made a more substantial contribution in predicting students' GPA. This study made use only of cognitive variables as predictors to students' performance. The study was also remarkable because it covered a 50year span of students' results and made use of 12000 students which is relatively a very large sample of students.

Henrysson (1985) as cited in Ali and Ali (2010) carried out a study on the predictive validity of traditional criteria which are used for selection of students into higher technical studies. In the study he used 200 mechanical engineering students and 400 students of the electrical engineering program. The findings of the study revealed that the correlation coefficient between the GPA and scores of the technical courses was 0.4 while the correlation coefficient between students' scores in Physics, Mathematics and Chemistry obtained in upper secondary school and their performance in the higher technical courses was morethan 0.4. The findings of this study further revealed that students' grades in Chemistry, Mathematics and Physics could be used to better predict their academic performance in engineering courses like electrical and mechanical engineering at university.

Moreover, Lovegreen (2003) did a study on the prediction of female engineering students' academic performance in the first year of college by their SAT results and other non-cognitive variables. The results of the study revealed that the cognitive variables such as the SAT results as well as the non-cognitive variables significantly predicted students' academic performance. The findings were quite unique because they asserted that the SAT as well as non-cognitive factors significantly predicted students' academic performance.

Karakaya and Tavgancil (2008) researched on the predictive validity of pre-admission measures to freshman GPA in higher education. The study made use of 2103 students from six programs which were; civil engineering, agricultural engineering, social studies education, law, business administration, Turkish language and literature. The data collected was analysed using step wise regression analyses. The findings of the study revealed that placement scores which were used for placement into civil engineering, agricultural engineering and social studies education program were the significant predictors of freshman GPA (FGPA)

Also, Ali and Ali (2010) carried out a study in Pakistan in which they aimed at determining the predictability of engineering students' performance in the university of Engineering and technology in Peshawar by admission tests conducted by the educational testing and evaluation agency (ETEA). The study made use of a cohort of 203 engineering students in the various engineering departments who were admitted into the University of engineering and technology in Peshawar. Amongst the 203 engineering students used for the study, 74 of them were students of electrical engineering, 43 were students of Mechanical engineering, 60 were students of civil engineering, 6 for Agriculture, 15 were students of Chemical engineering and 5 were students of Mining engineering. The instrument used for data collection was the standardized entrance examination organized by the ETEA for the selection of students into engineering. The questions in the examination were based on three science subjects which were; Physics, Chemistry and Mathematics in which 60 multiple choice items were used to assess each subject and English which was a fourth subject which comprised of 20 multiple choice items. The predictors were; FSc, Entry test scores and overall merit while the criterion was students' academic achievement in engineering from the first year to the final year. The data collected was analysed using SPSS version 10.0. The results revealed that the FSc marks had significantly relationship at the 0.05 level of significance with students' performance from the first to the third year. The entry test marks, and the overall merit was significantly related to students' performance from the first to the third year, with the relationship significant at both the 0.05 level of significance and the 0.01 level of significance. For some female students in some engineering departments, the results instead revealed a negative relationship between the predictor variables and criterion which is their performance in engineering. Contrarily the relationship between the predictors and students' performance in the final year was found to be negative for the male students and overall students, but it had a positive relationship with respect to the female students.

Vulperhorst et al, (2018), carried out a study on disentangling the predictive validity of high school grades for academic success in university in the Netherlands in order to refine selective admission measures into the university. They embarked on the study in order to determine which measure of prior achievement has the best predictive validity for academic success in the university. The predictive validity of three core subjects in high school was compared to the predictive validity of GPA scored in high school for academic achievement in a program of liberal arts at university. The predictive validity was also compared between the Dutch pre- university and the International BACalaureate (IB) diploma. The study final investigated the extent to which the final GPA is predicted by prior achievement after students completed their first year at university. The samples used for the study were:314 students from the VWO background and 113 students from the IB background. Path models were run separately for students from the two respective backgrounds. The results of the study revealed that for VWO graduates, high school GPA explained more variance in first year GPA and final GPA than the results of the core subjects, for IB, the findings were opposite, that is, the results of the core subjects in high school explained more variance in first year GPA and final GPA than the overall GPA scored in high school. Subsequent path models in the analyses showed that after students successfully complete the first year, final GPA is best predicted by a summation of the first year GPA and the high school GPA. Based on the small-scale results from this study, Vulperhorst et al (2018), cautiously challenge the use of high school as the norm for measuring prior achievement. Conclusively the type of diploma students enter university with could definitely define which measure of prior achievement predicts academic success in university.

Lawal, Badu & Chukwuemeka (2015), carried out a study to determine the predictive validity of first year GPA and final degree classification among management and social sciences students. The population of the study was comprised of 372 students who studied and graduated in B.Sc. Accounting, B.Sc. Business Administration and B.Sc. Economics in the year 2012 from the university of Abuja. The research design used for the study was the ex-post factor research design. This design was used because all the variables involved in the study had already happened or data already collected and thus they were not manipulated. Records of the graduate's first year GPA and their final end of course degree classification was obtained from the records in school. The Pearson correlation analysis was conducted to examine the strength of relationships between the variables. The first hypotheses which postulated a significant relationship between the GPA scored in the first year and the final degree classification among management and social sciences graduates was rejected and the second hypothesis was accepted which revealed that there was a significant but negative correlation the GPA scored in the first year and the final degree classification amongst management science graduates. Also, the results revealed that there is no significant difference in the GPA scored in various courses amongst students of management sciences. The results also suggest that students in different courses of study scored slightly different GPA's in the first year with those offering B.Sc. Accounting scoring the highest GPA's and those of Business Administration scoring the lowest GPA's in the first year.

Omirin and Ale (2008), did a study on the predictive validity of English and Mathematics mock results to students' performance in the West African School Certificate Examination (WASCE) in Ekiti state, Nigeria. The study made use of 360 students randomly selected from 12 public secondary schools from six local government areas. The results of the study revealed that mock English and Mathematics results significantly predicted students' performance in the WASCE exams. Moreover, the results also revealed that though English and Mathematics mock results predict students' performance in the WASCE exams, English mock results were a better predictor to performance in the WASCE than Mathematics.

Faleye & Afolabi (2006), researched on the predictive validity of Osun State junior secondary certificate examination in Nigeria. The study was carried out to determine if there is a significant relationship between students' overall performance in JSCE and their performance in the Senior School Certificate Examination (SSCE). The sample of the study was made up of 505 students from six secondary schools which were selected by the purposive sampling technique. Three of the six schools were the best in the sciences and the remaining three were public secondary schools. The students used for the study were those who had their academic records intact. The students' Promotion examination scores in the senior secondary school (SSS) 1 and senior secondary (SSS) 2 and their SSCE scores in six major subjects were compared with their corresponding JSCE scores using correlation analyses procedures. The findings of the study showed that Osun state JSCE predicts poorly students' performance in SSCE. Despite this, students' scores in JSCE English language and Mathematics better predict students' performance in SSCE English language and Mathematics respectively compared to the other subjects that is ($r = 0.32$, $p<0.05$ and $r = 0.22$ $p<0.05$ respectively). Faleye & Afolabi (2006) concluded that the six subjects at the JSCE examinations do not significant predict of students' performance in SSCE except for the result of English language and Mathematics which significantly predict performance in SSCE English language and Mathematics respectfully. They suggested that this could be due to constraints which the MOE, performing the function of an examination board are facing.

Also, Zujovic (2018) did a study on the predictive validity of Florida's Post-secondary education readiness test in the United States of America. The Postsecondary readiness test (PERT) was instituted in the state of Florida in the year 2010 and is used as means of determining students' readiness for college, High school and university studies. This test according to this study assesses students' skills in reading, writing and Mathematics. The aim of this study was to determine the extent to which the PERT scores predict students' performance in four college mathematics courses offered amongst community colleges in Florida which were; Developmental Math I, Developmental Math II, Intermediate Algebra and College Algebra. The sample for the study comprised of 727 students from 64 sections for developmental math 1, 900 students in 197 sections for developmental math II, 713 students in 328 sections for intermediate Algebra, and 270 students in 204 sections for college Algebra. Five models were used to ascertain the predictive validity of PERT with final results in the already mentioned Math courses. These models also analyzed the interaction between the PERT scores and student level predictors as well as the PERT scores and the course level predictors.

The result of the study of Zujovic (2018), revealed that the PERT significantly predict students' performance in developmental Math I, developmental Math II and College algebra, indicating a positive relation with students' final grade in each of the courses. There was no significant interaction between PERT with race and PERT with gender, indicating that there was no differential predictive validity. The results of the analyses of student and course level variables indicated that Black students had lower final grades than white students, and also older students performed better than younger students in developmental Math 1, In developmental Math II female students outperform the male students and the older students had higher final grades than younger students. Full time students performed better than part time students in intermediate algebra, likewise older students performed better than the younger. In the prediction of students' performance in college algebra in the final model, only the PERT score was identified as a significant predictor.

Atieno (2012), did a research work in the school of education of the university of Nairobi in partial fulfillment of the award of a master's degree in Measurement and Evaluation on the predictive validity of internal examinations in secondary schools in Kenya. The aim of this study was to determine the relationship between teacher made or internal summative examinations and external summative public national examinations. The study also sought to identify which subjects in the internal examinations predicted students' performance in the summative examination, that is in the KCSE and to identify the year with the more weight in the prediction of students' performance in external summative examination. The study made use of the descriptive research design. The target population of the study comprised of students of four secondary schools. From this target population, 60 students were sampled from each of the four schools, making a total sample of 240. The instrument used for data collection was an inventory. The inventory was used to collect the scores in the various subjects in the internal examinations used for the study. Quantitative statistical techniques were used to analyze the data collected. Correlation coefficients were used to extent of the relationship between the internal examination scores and the scores of external examinations. The results of the study revealed that there is a significant relationship between the external examination scores and the internal examination scores, that Mathematics is a significant predictor of students' performance in the external examination, and also that the students' performance in internal examinations in the first year cannot be used to predict their performance in summative external examinations. The major predictor was the fourth year, followed by that of the third year and that of the second year. Recommendations were made to the Kenyan National Examination Council (KNEC), for this organ to standardize internal summative examinations so that the scores could be used to award student in case they could not take the summative external examinations

Review of Studies involving Differential Predictive Validity

Research works on differential predictive validity and differential prediction started gaining prominence in the 60’s and 70’s. A considerable number of these studies have been carried out on differential prediction as well as on differential validity or even a combination of both in order to better elucidate differential predictive validity. One of such researhers who carried out works on differential predictive validity in that era was Thomas (1972). He set out to determine the differential prediction of admission test scores to students’ GPA at college. His findings revealed that female’s GPA were underpredicted by the prediction equation which was used for both male and female students. Also, Breland (1979) carried out variety of studies on differential predictive validity between the years 1964 and 1974. The main predictor variables which he used in his studies were SAT scores in Mathematics, verbal scores in the SAT examination as well as high school grades and the criterion variable used was the GPA scored in the first year. Breland’s findings revealed that with respect to differential validity, the median for the various predictors for the female were either the same with those of male or higher than those of the male, with respect to differential prediction, the findings revealed that there was over prediction of GPA for the minority students.

Also, Maxey and Sawyer (1981) did a study where they sought to determine the differential predictive validity with respect to ethnicity of ACT scores in all of its four subsets and high school GPA to students’ academic performance in College. The findings revealed that black students’ grades at college were over predicted while the grades scored by the Hispannic students were not significantly different with respect to group prediction. The findings also revealed that the validity coefficients for whites were higher than those of black students and Hispanics which was reflected by the higher absolute errors for blacks and Hispanics.

Gamache and Novick (1985) did a study in order to determine the differential prediction of a two-year cumulative GPA by Sub sets of ACT scores and composite scores with respect to gender. The study was carried out using 2160 students who were entering into liberal arts, the field of business, those who are still to embark on differential courses since they are listed as undecided and those for pre- medicine. The researchers assessed regression equations for differential prediction using the Johnson Neymar technique. The results for differential prediction showed that the GPA for women were underpredicted while those for the men were over predicted.

Jones and Vanyur (1985) set out to determine the differential validity of MCAT and undergraduate GPA to students' GPA scored in the first and second year at medical school in terms of gender. Their findings revealed that the correlation coefficients between MCAT scores, undergraduate GPA with students' GPA for the first and second year was higher for the women than for men.

Furthermore, Crawford, Alferink, and Spencer (1986) carried out a study in West Virginia college where they set out to determine the differential predictive validity of ACT scores and HSGPA to students' FGPA and their 'postdicted' GPA with respect to gender and race. The sample of the study was made up of 1,121 students who were in freshman cohort of 1985. The researchers instead of considering regression residuals intead carried out the chi square test of independence on frequency counts in order to determine under prediction and over prediction. The findings revealed an increase in 'postdiction' accuracy with an inclusion of HSGPA into the prediction equation equation having ACT scores. The results for differential prediction revealed that the performance for the male students were overpredicted while the results of their female counterparts were underpredicted. Also, Johnson et al (1986) assessed the validity of the scores in MCAT and UGPA for students from 30 different colleges to students' performance in a predominantly black medical school. The findings revealed that the correlation coefficients between the predictors and the criterion were similar to those of students in predominantly white schools.

Noble et al (1996) investigated on the differential prediction of ACT and high school grades with respect to gender and ethnicity on students' performance at college. The essence of the study was to access college grades which were B or higher and C and higher. Data was collected from students of 80 different institutions and from eleven different subjects. The data collected was analyzed using linear regression analyses. The researchers found out that the grades were slightly underpredicted for the female students compared to their male counterparts and that the grades scored in English were slightly over predicted for African American students compared to the white mates. Moreover, the differential prediction in relation to both gender and ethnicity were both reduced when the grades scored in various disciplines were introduced.

Koeing et al, (1998). Researched on the predictive validity and differential predictive validity of MCAT across gender and ethnicity. The criterion used for the study was the cumulative GPA the students scored in the first two years of their medical studies. The study was carried out using students who got admission into 14 different medical schools. The results of the study revealed that the coefficient of prediction of performance at medical school by MCAT scores were almost the same for the male and female students. In terms of differential prediction, the performances of white students were slightly underpredicted while the performances of the Asians, the Blacks and the Hispanics were over predicted with those of Asians and the Hispanics being more significantly overpredicted.

Furthermore, Brigeman et al, (2000) carried out research with the aim of identifying the difference in the differential validity and differential prediction between the revised version of the SAT examination and the old version. Since the SAT examinations were revised in 1995, the sample of the population used for the study comprised of 100,000 students who got admission into 23 post secondary schools between 1994 and 1995. The study exploited differential validity and differential prediction of the SAT examinations with respect to gender and ethnicity. The findings of the study revealed that the SAT results were over predictive for the male students with negative residuals while and under predictive for the female students with positive residuals. Overall, the revised and old versions of the test was over predictive for African American students. With the older version of the SAT examinations the over predictuion was greater for the African American males than the female African Americans, meanwhile the new version of 1995 indicated underprediction for African American females. Male and female Hispanic students' performances were over predicted by the two versions of the SAT examinations with the over prediction higher for the male Hispanis students. With respect to Asian American students, the tests in the two versions underpredicted female students' performance and overpredicted the performance of the male Asian American students.

Another study on predictive validity and differential predictive validity was carried out by Kyei-Blankson (2005). She did a study on the predictive validity, differential validity and differential prediction of the subsets of the medical college admission. The study was carried out in order to ascertain the validity of the MCAT and undergraduate GPA which are two screening devices used for the selection of students into medical schools. Therefore, the study addressed three important aspects of validity which are; predictive validity, differential validity and differential prediction. An index of the relationship between the predictor variables which are the MCAT subset scores and the criterion variable which is students' academic performance in the first year at medical school, measured with the GPA scored was used to evaluate the predictive validity. The differential validity was obtained by comparing the validity coefficients obtained from the correlation between the MCAT sub set of scores and the first year GPA for the various sub sets within the population such for men and women, for white, black, Hispanic, Asian students who are studying medicine. Testing for differences in the regression systems obtained for the various sub groups was used to the differential prediction.

The research permit for this study was obtained from the Ohio university Institutional review board. The data used for the study was obtained from the data base of MCAT Predictive Validity Research (PVR) with the acceptance of the MCAT section of the Association of American Medical colleges. Pre-admission information which was used as data for the study was collected from 1992 and 1993 matriculants to 14 US based medical schools. The choice of these 14 medical schools out of the 125 medical schools was done in such a way so as to respect geographical, ethnical and administrative representativeness of the medical schools. Data was collected for 3187 students for the two cohorts in the 14 medical schools. The sample comprised of 58.8% men and 41.2% women. From the sample too, 67.7% of the students were whites, 13.4% were Asians, 10.6% were Blacks, 6.0% were Hispanics and 1% were American Indians. The ethnicity of 8.3% of students of the total sample were not identified.

The data in the research work of Kyei-Blankson (2005) was analyzed using statistical procedures such as regression analyses, Fisher's z transformation, F-ratio test of quality of standard errors of estimate and the ANCOVA tests which analyze the quality of regression slopes and intercepts. The results revealed that the previous grades and MCAT subsets of scores were each significantly good predictors students' performance in medical school. But, a more powerful indicator of performance in the first year in medical school was a combination of the undergraduate GPA and MCAT subtest scores. For differential validity, the results indicated that women had higher validity coefficients than men. For differential prediction, the regression equations derived from the sample of students used for the study indicated that underpredicted students' academic performance in the first year at medical school for whites and the regression equation over predicted academic performance in first year at medical school for Blacks and Hispanics

Furthermore, Mattern et al (2008) working with the SAT examinations verified the psychometric properties of differential validity and differential prediction. These properties were assessed across gender and ethnicity and best language. The study made use of 196,364 students from 110 different undergraduate institutes The findings with respect to differential validity revealed that the SAT results were more predictive for the female than for the male students and also that the results were more predictive for white students than non white students and finally in terms of language the findings revealed that the test was most predictive for students whose first language was English, followed by those whose best language was English and another language and least with those whose best language was not English. The findings with respect to differential prediction revealed that the test over predicted for male students with a negative mean residual while it underpredicted for female students with a positive mean residual. With respct to ethnicity, the findings revealed that the results of Asian American students, white studets and students who selected no response were underpredicted with positive mean residual values, while the results of American Indian students, African American students and the Hispanics were over predicted with each of the subgroups having negative mean residual values.

Also, Al-Hattami (2012) did a study on the in Yemen on the predictive validity of both high school GPA and college entrance test scores which were used in the admission process to students' academic performance in university. The study was also out to determine the differential predictive validity of high school results and college entrance scores with respect to gender and high school location. The study was guided by five research questions. The first research question was out to determine the reliability from internal consistency of the college admission test. The second research question was to determine the extent to which high school GPA predict students' performance across various universities in Yemen and the effect of the addition of the college entrance test score on the prediction of students' performance in the university. The third research question focused on the differential predictive validity of high school GPA and college entrance scores across gender and high school type. The fourth research question was to determine the predictivity of both the high school GPA and college entrance exam scores to students' long term academic performance like that of the fourth year. The fifth research question was out to find out the extent to which both high school GPA and college admission test scores affect students' persistence to graduation. The sample of the study was made up of 881 students who enrolled in the 2006/2007 academic year in two universities in Yemen. From amongst these students, 764 students completed their studies within the timeframe of four years. The information of all the students admitted in 2007 were used for the study. The sample summarily comprised of 52.33% females and 47.67% male and amongst the students, 36.44% were from rural high schools and 63.56% of the students were from urban high schools. In order to collect data, the researcher obtained permission from the presidents of the two universities. The data which comprised of students' high school GPA, their college entrance score, university first year GPA and the cumulative GPA for the four years, was then collected from the data bases the universities.

Al-Hattami (2012) in his study analyze the data collected, with the use of reliability coefficient, multiple and logistic regression analyses and Gulliksen and Wilks (1950) test for differential prediction. The results revealed that students' high school GPA and the college entrance scores significantly predicted students' academic performance as measured in the first year GPA and the four-year cumulative GPA. Differential predictive validity was observed across gender and also across urban and rural population. Furthermore, high school GPA was not a significant predictor of persistence but when college admission scores was added to the regression equation, the predictive validity was enhanced. In this study, the researcher concluded that a comprehensive review of the usage of high school GPA for admission should be done, taking into consideration the fact that high school GPA explained a very small portion of the total variance of students' academic performance in the first year and in the cumulative four-year university program.

Treadney (2019) assessed the performance of students in order to determine the differential predictive validity of ACT science sub scores with respect to gender, ethnicity and students' major to students' performance in college. With the use of quantitative methods, differential validity and differential prediction. The results of this study revealed that there was differential predictive validity of the various independent variables with respect to gender, ethnicity and students' major. In terms of differential prediction, there was absolute differential prediction in terms of student major and ethnicity but not absolutely across gender, pell eligibility and first-generation status. The resuts of female Students were underpredicted while the results of the non-white students were over predicted.

Furthermore, with respect to studies on differential predictive validity of students' academic performance with respect to the type of high attended.

Davis and Norman (1954) did a study on the prediction of freshman grades by first term high school average and SAT-V results for students from both public and private schools. The findings of the study revealed that the prediction of freshman grades by first term high school average and SAT-V results was different for students from public schools and private schools and it was recommended that freshman grades can be better predicted more accurately by considering graduates from public and private school separately Also, Jimenez and Cox (1990) researched on the relative effectiveness of private and public schools. The study was carried out in two developing countries whch were Tanzania in Africa and Columbia in South America. The result of the study from the two countries revealed that private schools offer an achievement advantage over public schools and thus students from private schools have higher achievement test scores than those from public schools.

Also Sabitu, Babatunde and Oluwole (2012) did a study on the effect of school types and facilities on students' academic performance. The types of school considered in the study were public and private schools. They made use of the descriptive survey design in the study and with the proportionate sampling technique, they made use of 5o different schools in Ondo state Nigeria. The research instruments used were a questionnaire for principals and a questionnaire for teachers. The data collected was analysed using the T- test and the hypothesis were tested at the 0.05 level of significance. The findings of the study revealed that there was no significant difference in academic performance of students from the public and private schools.

Mburu (2013) also did a research work in Kenya on the assessment of the effect of different types of school attended on students' academic performance. Unlike the other studies where the types of high school waa looked upon on the main sponsors and denominations like public, private and mission schools, this research work was focused on coeducational and single sex schools. The study made use of the descriptive research design. The major findings of the study revealed that single sex schools affected students' academic performance differently from coeducational schools and students' academic performance from these schools is different with respect to gender, as majority of the girls who qualified to join tertiary education were from single sex schools.

Hahn, Kim and Seo (2014) researched on the effects of Public and private schools on students' academic performance in India. They hpothesized that differences between students' academic performance from private and public schools is as a result of the efforts towards students' academic achievement. The findings of the study indicated that the academic performance of students from private schools was different from the academic performance of students from public schools with students from private schools performing better than those from public schools.

Banai and Perin (2016) carried out a study to determine the effect of different high school types on students' academic performance. The type of high schools considered in the study were; a gymnasium high school, a general education type of high school and the vocational type of high school. The study made use of the students' final year high school results and their university performance upon graduation. The findings of the study revealed that students from gymnasium had greater chances of performing better at the university, but they concluded that students from different types of high schools do not profit from certain individual characteristics.

Thiele and Singleton (2016) carried out a study to determine the effect of school type, school grades, gender amongst other factors to students' academic performance in a

British University. The findings of the study revealed that there was a significant difference in academic performance in the university with respect to the type of high school attended with students from low performing schools more liable to have better results while independent school student performed lower than comprehensive school students.

Appraisal of Literature

From the literature presented above, one could clearly see that research works have considerably been carried out in many Western countries in order to determine the relationship between students' high school results and their academic performance in engineering. One of such is that which was carried out by De Winter & Dodou (2011) in the Netherlands in a Dutch technical university, to determine the extent to which students' high school results from the VWO and HBO programs predict students' academic performance in various branches of engineering. Taking the Cameroonian context into consideration, very little research has been done to ascertain the relationship between high school results examinations such as the GCE A/L and BACalaureat examinations and students' academic performance in engineering. A study in the Cameroonian context which made use of engineering students and their performances in Cameroonian high school examinations was that of Akoko (2010), which was out to assess the extent to which students' affective and background characteristics determine their performances in mathematics at university, thus amongst some of the background characteristics were students' results in GCE A/L Mathematics. Further Mathematics and students' results in Mathematique in the BAC examinations and how these respective results predict students' performance in Mathematics at university. His study made use of only the grades students scored in Mathematics and Further Mathematics in the GCE and the grade they scored in Mathematics in the BACalaureat examinations and with respect to students' performance in engineering, his study was not focused on the general performance of students at engineering school, but was only focused on their performance in Mathematics at engineering school. Therefore, his study never took the grades scored in other science subjects in high school into consideration and did not also take students' overall academic performance at engineering school into consideration but it instead made use only of students' performance in Mathematics at engineering school. Thus, his focus was on students' achievement in Mathematics at University vis a vis their performance in Mathematics in the end of course high school examinations, and he simply used engineering students as a sample. This current study on its own part takes into consideration the grades students score in all science subjects related to engineering studies in high school in both the GCE A/L and BACalaureat examinations and also in relation to students' performance in engineering in takes into consideration students' overall performance in all the courses offered at enginnering school at each level of study and in various engineering departments. All these done with the aim of identifying the subjects whose grades best predict students' academic performance in the various branches of engineering. Moreover, this study goes ahead to ascertain some psychometric properties of the GCE A/L and BAC examnations in the sciences such as predictive validity and differential predictive validity which could be seen through differential validity and differential prediction.

Also from the literature reviewed, many studies have been done on predictive validity. In the United States of America, most studies on predictive validity were out to ascertain the predictive validity of examinations such as the Scholastic Aptitude Test (SAT), the American College Testing (ACT), Medical College Admission Test (MCAT), Graduate Record Examinations (GRE), High School Grade Point Average (HSGPA) to students' academic performance in various higher institutes. In other Western countries like the Netherlands, predictive validity studies have been carried out using the International BACalaureat Examinations like that of Vulperhost et al, (2018). In the African continent, most predictive validity studies were based on secondary school internal and end of course examinations such as the predictive validity of mock examinations to students' performance in end of course examinations, Junior Secondary Certificate Examination (JSCE) to students' performance in Senior Secondary Certificate Examination (SSCE) and Results of internal secondary school examinations to students performance in Kenya Certificate of Secondary School Examination (KCSE) in Kenya. The predictive validity of end of course High school examinations in Cameroon which are the GCE A/L and BACalaureat examinations have not yet considerably be done particularly pertaining to students' academic performance in engineering. Thus, this study comes in to fill that gap.

Studies on differential predictive validity have also considerably been done, with most of the studies carried out in the United States of America. Most of the studies assessed the differential predictive validity of examinations such as SAT, ACT, MCAT amongst others across gender, ethnicity and some studies assessed the differential predictive validity with respects to variables such as school location and best language. Kyei-Blankson (2005) in his study in which he assessed the differential predictive validity of MCAT across gender and ethnicity suggested that differential validity studies should be carried out across types of high school attended. From the studies reviewed which were conducted after Kyei Blankson study, none has assessed differential prediction of students' academic performance by their high schools such as GCE A/L or BAC results in the sciences with respect to type of high school attended. Moreover, student's different levels of motivation have never been used as a factor for differential predivtive validity studies. Thus, this study in order to fill these gaps, assessed the differential predictive validity of GCE A/L and BACalaureat results in general sciences across gender, type of high school attended and students' degree of motivation for engineering studies.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

This chapter focuses on the methodology used to carry out this research work. It lays emphasis on the research design used, the area of the study, the population of the study, the sample and the sampling techniques, the instruments used for data collection, the validity and reliability of the instruments used, methods used for data collection methods used for data analysis and the ethical considerations observed in the study.

Research Design

According to Mbua (2003) a research design is a guide or plan which a researcher has to scrupulously follow as long as a particular study is concerned. This study aimed at determining the extent to which GCE and BAC results predict students' performance in engineering and the extent to which these results predict students' academic performance differently in terms gender, type of high school and degree of motivation for engineering studies was carried out using the correlation survey research design with a quantitative approach. The correlation survey research design is aimed at determining the extent to which two or more variables are related in a given population. The degree of relationship is expressed as a correlation coefficient. (Amin,2005) or the extent to which one variable predicts the other. Therefore, the correlation survey design in this study is used to determine the extent to which or how effectively high school results, that is, the BAC and GCE results in sciences predict students' academic performance in engineering. That is GCE and BAC results in some science subjects will be assessed as predictors of students' performance in various branches of engineering such as civil engineering and architecture, computer engineering, electrical and electronics engineering, mechanical and industrial engineering, mining and mineral engineering and petroleum and chemical engineering in Cameroon

Area of the Study

This study was carried out in five Regions in the Republic of Cameroon. The Republic of Cameroon is found along the Gulf of Guinea and is located in Central and West Africa in a strategic position known as the hinge of Africa. Cameroon lies between lattitudes 1^0 and 13^0 N as well as on Longitudes $8^0$and 17^0E. Cameroon has under its control, 12 nautical miles of the Atlantic Ocean. Cameroon has a total surface area of 475440 Km^2 and a total water surface area of 2730Km^2 which span across ten geographical regions. Specifically, this study was carried out in the Engineering school of the University of Bamenda which is found in the North-West Region of Cameroon, in the Faculty of Engineering and Technology of the University of Buea and the Catholic University Institute Buea which are both found found in the South West Region of Cameroon, the Engineering school of the Catholic University of Cameroon (CATUC) in Baham which is found in the West Region of Cameroon, the department of Architecture and civil engineering of the National Advanced school of Public works which is found in Yaounde in the Centre region and the Catholic University Institute of Buea, Douala campus which is found in the coastal city of Douala in the Littoral Region of the country.

The National Higher Polytechnic Institute (Engineering school) of the university of Bamenda is located on the University's campus in Bambili which is located at latitude 5.989 and longitude 10.251 of the Green witch meridian. Bambili is in the Tubah subdivision and covers about a fifth of the total surface area of Tubah subdivision which stands at 365 square kilometers. Tubah subdivision is one of the seven subdivisions found in Mezam division of the North-west region of Cameroon. The village of Bambili is found along the ring road of the North- west region and located North East to the city of Bamenda. The University of Bamenda is located in the Western part of Bambili. The school of engineering of the University of Bamenda where this study is to be carried is one of the twelve schools and faculties found on the main campus of the University of Bamenda in Bambili. Amongst these schools and Faculties found on the main campus of the university of Bamenda in Bambili are: the Faculty of Arts, the Faculty of Education, the Faculty of science, the Faculty of Economics and Management Sciences, the Faculty of health sciences, the Faculty of law and political science, the College of Technology, the Higher Institute of Commerce and Management, the school of Transport and Logistics, the Higher Teacher Training College and the Higher Technical Teacher Training College. The school of Engineering of the University of Bamenda is made up of seven departments which are; the department of Civil engineering and Architecture, the department of computer engineering, the department of electrical and electronics engineering, the department of mechanical and industrial engineering, the department of mining and mineral engineering and the department of petroleum engineering and the department of Biomedical Engineering and medical equipment maintenance which was created in 2020.

The Faculty of Engineering and Technology of the university of Buea and the Catholic University Institute of Buea (CUIB) are found in the mountain town of Buea which is located between latitudes $4^0$14’’ North of the equator and longitude 9^0 20’’ east of the Greenwich meridian and found on the eastern slopes of Mount Cameroon. Buea is found in the Fako Division and it is the capital of the South west region of Cameroon. The University of Buea is found in the Molyko neighbourhood of Buea. The university campus lays host of various schools and faculties such as the Faculty of Arts, the Faculty of science, the Faculty of Education, the Faculty of Social and Management sciences, the Faculty of Law and Political Science, Faculty of Agriculture and Veterinary medicine, the Advanced School of Translators and Interpreters (ASTI) the College of Technology and the Faculty of Engineering and Technology. The FET of the University of Buea is made up of five departments; the the department of computer science, the department of electrical engineering and the three new departments which were created in 2020 which are the de departments of civil and Architectural engineering, mechanical and industrial engineering, and chemical and petroleum engineering.

The CUIB campus in Buea is located in Molyko adjacent to the Government Technical High School in Buea. The campus in Buea lays host of a business and Management school, and Information and Technology school and the Engineering school. The Engineering school is made up of the departments of civil engineering, the departments of mechanical engineering, the department chemical engineering and the department of petroleum engineering.

CUIB Douala is located in the Bonamoussadi neighbourhood in the city of Douala. Douala is a coastal city found in Cameroon and it is the capital of the Littoral Region and the capital of the Wouri division. Douala is 13m above sea level and located 4^0 03’ North of the Equator and 9^0 42’ east to the Green witch meridian. The city of Douala has a population of above three million people and it is quite commercial and cosmopolitan, being the economic capital of Cameroon. The engineering school of CUIB Douala operates 4 engineering departments and Douala being a great metropolis and the main economic hop of the Central African Sub Region, the students of this engineering school could actually have a great exposure.

The Catholic University of Cameroon of Baham is found in the centre town of Baham, few metres from the SDO's office. Baham is the Divisional head quarter of the Upper Plateau Division of the West Region of Cameroon. Baham is situated 250km from Douala and 20km from Bafoussam and it is found 1,644m above sea level. Baham is relatively cold climate wise since it is found in the Western Highlands of the Republic of Cameroon in which the grassfield vegetation is the main type of vegetation. Baham being a relatively small town free from much hustle and buzzle and with a good climate, students of engineering would probably be quite suited to the environment and thus would easily be more judicious with their academic work.

Population of the study

The population of the study comprised of all the engineering students with a background in GCE A/L general sciences and BAC general sciences. The target population of the study was comprised of all the engineering students with a background in GCE A/L general sciences and in BAC general sciences who are in engineering schools which begin specialization into various engineering departments from the first year of study. The accessible population was made up of all the students with a background in GCE and BAC in the general sciences of the National Higher Polytechnic Institute (school of Engineering) of the University of Bamenda., the Faculty of Engineering and Technology (FET) of the university of Buea, The Engineering school of the catholic University Institute of Buea (CUIB), the department of Architecture of the National Advanced school of Public works in Yaounde, and the Catholic University Institute Buea, Douala campus (CUIB Douala). The sample population stood at 952 which comprised of the Engineering students of the above-mentioned engineering schools in the third and fourth year who have the backgrounds in GCE A/L and BAC general sciences. It is from this sample that the sample used for this study was selected.

Table 1

Sample Population

ENGINEERING SCHOOL	ENGINEERING DEPARTMENTS												
	CIVIL & ARCH		**MECH**		**ELEC**		**COMP**		**MINING**		**PETROLEUM&CHEMICAL**		**TOTAL**
	L3	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	
NAHPI	45	40	38	40	46	40	45	42	50	54	45	42	527
FET					60	55	58	55					228
CATUC	9	8	7	4	6	4					8	9	55
CUIB	6	10	10	12									38
NASPW	70												70
CUIBD'LA											16	18	34
TOTAL	**130**	**58**	**55**	**56**	**112**	**99**	**103**	**97**	**50**	**54**	**69**	**69**	**952**

Source: Field work, 2020

Sample and sampling technique:

The sample used for the study was comprised of 500 engineering students from 6 engineering departments across six different engineering schools in Cameroon. The sample of the study was selected as follows; Firstly, the purposive or the judgemental sampling technique was used to select the engineering schools used for the study. The judgemental sampling technique was also used to select the students with a background in GCE A/L general sciences and BAC general sciences from the total number of engineering students in the various departments of the various engineering schools selected. From this accessible population, the purposive or judgemental sampling technique was further used to select students of the third and fourth years from the various departments of the engineering schools. The students of the third and fourth years were selected because their results of the first and second years were to be used for the study. From amongst the students of the third and fourth year, the proportionate simple random sampling technique was used to select engineering students from both the GCE and BAC background from the various engineering departments of the six engineering schools used for the study. This was done as follows;

Small pieces of papers corresponding to the number of students of GCE and BAC general sciences background in each of the prior sampled levels were folded and placed in two separate bags, one bag for GCE background students and the other bag for BAC background students. The inscription ‘student’ was written in the number of folded papers corresponding to the number of students who were to be sampled from amongst the GCE background students and from amongst the BAC background students. The two bags were then then placed in front of the concerned classrooms, and the students were asked to each go to the bag which corresponds to their background and pick a piece of paper. The students whose pieces of folded papers had the inscription ‘student’ written were then solicited to answer the questionnaire and thus
they constituted the sample of the study.

Table 2

Sample

ENGINEERING SCHOOL	**ENGINEERING DEPARTMENTS**												
	CIVIL& ARCH		**MECH**		**ELEC**		**COMP**		**MINING**		**PETROLEUM & CHEMI**		**TOTAL**
	L3	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	**L3**	**L4**	
NAHPI	22	21	22	23	22	20	18	17	32	32	25	24	278
FET					32	25	29	25					111
CATUC	5	5	4	2	3	2					4	5	30
CUIB	4	6	7	8									25
NASPW	35												35
CUIBD’LA											10	11	21
TOTAL	**66**	**32**	**33**	**33**	**57**	**47**	**47**	**42**	**32**	**32**	**39**	**40**	**500**

Source: Field Work, (2020)

Instrument for data collection:

The instrument used for data collection was a questionnaire for students. The questionnaire comprised of four sections. Section A contained mainly questions on personal or demographic information. Section B contained questions which measures students' motivation for engineering studies. The students while answering questions in section B were required to choose from one of the ten options of the 10-point likert scale ranging from Strongly Disagree(SD), Somewhat Disagree (SWD), Somewhat Agree (SWA) and (SA). Section C was designed to collect information on the grades students scored in the various science subjects in high school and Section D measured students' academic performance in the first and second year in engineering schools from their grade point averages (GPA).

Table 3: Scoring of the instrument

Strongly Disagree (SD)		***Somewhat Disagree (SWD)***			***Somewhat Agree (SWA)***			***Strongly Agree (SA)***	
1	2	3	4	5	6	7	8	9	10

This scale will be used to measure the psychological variable called motivation for engineering studies which is used to ascertain to an extent, the differential predictive validity of high school results to students' academic performance in engineering. The variable was measured with 24 items. The first twelve items were scored normally and the last twelve items were scored in the reversed direction (reverse scored).

Validation of the Instrument

To ensure content validity, the questionnaire was read and corrected by the supervisor to avoid ambiguity and to ensure that the questionnaire is apt to grasp what it is out to grasp for the research work. The researcher then implemented the corrections, and resubmitted the questionnaire to the supervisor for final corrections and approval. After the supervisor corrected and approved the questionnaire, it was then given to three content specialists for review and for them to judge and ascertain the validity of each item on the questionnaire. From their judgements given, the validity of each item was then derived and consequently the content validity index (CVI) was calculated using the formula;

$$VI = \frac{\text{No of Judges who declared item valid}}{\text{Total No of Judges}}$$

Table 4

Content Validity

ITEM	JUDGE 1	JUDGE 2	JUDGE 3	VALIDITY INDEX (VI)
1	1	1	1	1
2	1	1	1	1
3	1	1	1	1
4	1	0	1	0.67
5	1	1	1	1
6	1	1	1	1
7	1	1	1	1
8	0	1	1	0.67
9	1	0	1	0.67
10	1	1	1	1
11	1	1	0	0.67
12	0	1	0	0.67
13	1	1	1	1
14	1	1	1	1
15	1	1	1	1
16	1	1	0	0.67
17.a	1	1	1	1
17.b	1	1	1	1
18	1	1	1	1
19	1	0	1	0.67
20	1	1	1	1
21	1	1	1	1
22	1	1	1	1
23	1	1	1	1
24	0	1	1	0.67
25	1	1	1	1
26	1	1	1	1
27	1	1	1	1
28	1	1	0	0.67
29	1	1	1	1
30	1	1	1	1
31	1	1	1	1
32	1	0	1	0.67
33	1	1	1	1
34	1	1	1	1
35	1	1	1	1
36	1	1	1	1

37	1	1	1	1
38	1	1	1	1
39	1	0	1	0.67
40	1	1	1	1
41	1	1	0	0.67
42	1	1	1	1
43	1	1	1	1
44	1	1	1	1
TOTAL	41	39	39	**40.04**

Source:Field Work (2020)

Content Validity Index (CVI) = 40.04/44 = **0.91**

Since the CVI value was greater than 0.7 (i.e. CVI = 0.91 > 0.7) it therefore means that the questionnaire is of adequate content validity.

Face validity was ensured by peer review. That is, the questionnaire was viewed by some peers for them to confirm whether the questionnaire from face look appears to be what it is supposed to be.

Reliability of the Instrument

The reliability of the instrument refers to the extent to which the instrument is stable, dependable and consistent in measuring what it is supposed to measure. The reliability of the questionnaire was ensured using the split half reliability method. The questionnaire was administered to 20 students of the department of Mechanical engineering of the second year of the the school engineering of the University of Bamenda. The questionnaire measuring the psychological variable was divided into two comparable halves or subsets, with all the odd items on one half and the even items on the other half. Each subject's score on the two halves were then computed and then correlated. The Spearman Brown prophecy formula was later applied to get the actual reliability coefficient, that is

$r_{xx} = 2r'_{xx} / 1 + r'_{xx}$

Where

r'_{xx}= the correlation between the two halves

Therefore the reliability for the construct motivation for engineering studies is derived from the data below

Table 5

Split Half Reliability for

Students (SN)	Score 1(Sum Of odd items)	Score 2 (Sum of even items)
1	68	70
2	85	74
3	83	68
4	97	93
5	88	87
6	98	97
7	78	65
8	73	77
9	79	65
10	98	97
11	88	87
12	97	93
13	83	72
14	85	74
15	80	74
16	63	62
17	50	59
18	83	64
19	78	70
20	85	71

Source: Field work (2020)

In order to calculate the correlation between these two sets of scores, the data was input in SPSS version 26.0 and computed. The results are as shown below.

Table 6

Correlations

		Score1	Score2
Score1	Pearson Correlation	1	.811**
	Sig. (2-tailed)		.000
	N	20	20
Score2	Pearson Correlation	.811**	1
	Sig. (2-tailed)	.000	
	N	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

From the table above, the correlation coefficient between the two scores is 0.81, that is,

$r'_{xx} = 0.81$

Therefore, in order to get the reliability of the questionnaire, r_{xx}

Where $r_{xx} = 2r'_{xx} / 1+ r'_{xx}$

Putting in the value of $r'_{xx} = 0.81$ in the equation above, gives

$2(0.81)/ 1+ 0.81 =$ **0.89**

Therefore, the split half reliability coefficient had a value of $r_{xy}= 0.89$ which indicates that there is a relatively high internal consistency amongst the questionnaire measuring the psychological construct.

Method of Data Collection

In order to collect data, the researcher first obtained a research permit from the Faculty of Education of the University of Yaounde I, signed by the Dean. This enabled the researcher to get access to the various engineering schools where the study was carried. In the various engineering schools, the researcher presented the research permit to the various school administrations of the engineering schools so as to get access to the students. With the aid of lecturers, some school administrators and students of the various engineering schools, the researcher was able to administer the questionnaire to the students. Before administering the questionnaire to the engineering students, the researcher read out and explained clearly the objectives of the research. The researchers also informed the respondents of some ethical issues which would be observed in the study along side their voluntary participation in the study. Later, the researcher distributed the informed consent form to the respondents and gave them some time to read carefully and give their consent, which they did. Those who gave their consent were then eligible to answer the questionnaire. The researcher used the direct method of administration in order to ensure a high return rate of the questionnaire. Thus, the respondents answered the questionnaire with the necessary directives of the researcher in their presence. After the questionnaire had been answered, the researcher then collected the questionnaire which had been answered and proceeded for data analysis.

Table 7

Return Rate of Questionnaire

Distributed	Returned	Return Rate	Incomplete	Complete	Adjusted return rate
500	500	500	00	500	100.0%

Method of Data Analysis

The data was analysed using both descriptive and inferential statistics. Pie charts, bar charts, frequency tables, Histograms amongst others were used as tools in descriptive statistics to present and analyse the data so that measures of central tendency such as the mean, the median and the mode of scores could be determined as well as the measures of variability such as the range, deviation and standard deviation. Inferential statistics will be derived through the use of multiple linear regression analyses. That is, the five hypotheses will be tested using multiple linear regression analyses. From these multiple linear regression analyses, regression models for predicting students' academic performance in the various branches of engineering by their high school results in sciences will be derived which will provide an answer to research question five.

Regression Analysis

Regression analysis is normally used to show how an independent variable predicts a dependent variable. According to Mertler and Vannatta (2002), the main purpose of regression an analysis to come out with an equation that links up the dependent and independent variables and how the dependent variable could be predicted using the aforementioned equation in a given population. The regression equations could also be used to explain how variations or differences one variable could affect the differences in another variable and consequently a person's score on one variable could be used to predict his or her score in another variable (Howell, 1995).

Linear regression is the simplest form of regression analysis, here, information about only one variable (called the predictor or independent variable) is used to predict the value of a second variable called the predicted, criterion or dependent variable. Regression analyses are bi-directional, that is, as the scores on the independent variable could be used to predict the dependent variable, scores on an already ascertained dependent variable could be used to determine the corresponding score on the independent variable (Amin, 2004). In linear regression analyses, relationship between the dependent and independent variables could be explained with a straight line (line of best fit) with the equation

$Y= a + bX$

Where Y is the predicted value of the dependent or criterion variable

X is the value of the independent or predictor variable

The values a and b are the regression constant and coefficient respectively.

In regression analyses, the mathematical equation is normally represented as follows

$Y_1= B_0 + B_i x_i + e_i \quad i= 1,2,3……n$

Where, Y is the observed or derived value of the dependent variable, B_0 represents the intercept, that is the value of the dependent variable when the independent variable is equal to zero, B_i stands for the gradient or slope of the graph of depended variable plotted against the independent or predictor variable and e_i stands for the prediction error or residual, it represents the difference between the predicted value and the actual value of the dependent variable, that is e_i represents the error margin of prediction, thus the smaller the value of e_i the closer the predicted value is to the actual value and the bigger the value of e_i the greater the difference between the predicted and actual value of the dependent variable. Consequently, regression should be done with the rational of minimising this error.

Multiple regression is employed when there are two or more predictor variables to simultaneously predict the dependent variable. Multiple regression is a special case of the general linear model, used when the dependent variable is measured on an interval or ratio scale and the predictive variables are either measured on an interval or ratio scale, or are binary variables which take values of 1 0r 0 (Amin, 2004).

The multiple regression model can be expressed as follows:

$Y = B_0+B_1X_1+ B_2X_2+…B_PX_P + E$

In the above model, X_1…., X_P are the independent variables whose values are to be used in the prediction of the dependent variable Y. B_0 is the constant, while $B_{1 \ldots} B_P$ are the regression coefficients. Even when many predictors are used in the prediction of the dependent variable, the predicted value will unlikely be equal to the actual value, thus the error term is added in order to take this limitation into consideration.

Peculiarities of Multiple Regression

Multiple correlation, multicollinearity and model selection are three issues peculiar to multiple regression (Mertler and Vannatta, 2002). Multiple correlation explains the relationship between the observed and predicted value of the dependent variable, and it is symbolized by R. The proportion of variance of the dependent variable accounted for by the independent variables is represented by the square of the multiple correlation R^2. This is also known as the coefficient of determination. It is an important statistic in regression analyses and must therefore be computed in order to determine the extent of prediction (Nworgu, 2015).

Multicollinearity occurs when two or more independent variables are highly interrelated. When this happens, the variables are providing very similar information and it becomes difficult to separate the effects of the individual variables. The correlations of some of the predictors is often revealed by the matrix plot. The tolerance for each predictor is the quantitative index which could be used for checking the collinearity among predictors

$TOL (X_k) = 1- R_k^2$

Where R_K^2 is the multiple correlation coefficient when the k^{th} independent variable is predicted from the other independent variables. A small tolerance implies that the variable X_k is almost the linear combination of the other variables (Amin, 2004). Therefore, tolerance measures the collinearity between variables, and its values range from 0 to 1, the closer the value to 0, the higher the multicollinearity. Variance inflation factor (VIF) represents the inverse of tolerance it measures and determines whether there is a strong linear association between a given predictor and the other predictors. It is generally a call for concern when VIF has values which are greater than 10. Moreover, in addition to the values of tolerance and VIF, the values of the predictors must be examined (Stevens, 1996), as cited in Kyei- Blankson (2005).

According to Tabachnick and Fidel (2001), there are three methods of model selection in regression analyses which are;

1)Standard multiple regression

This regression modeling is also referred to as full model. In this type of model, all the independent or predictor variables are put into the model at the same time, and the amount of variance accounted for by each of the independent variables are determined.

2) Sequential multiple regression:

It is also known as hierarchical multiple regression. In this case, the independent variables are entered into the regression equation in a specific order which is prescribed by the researcher. It is done this in order to determine the effect of each predictor.

3) Stepwise Multiple regression

There are basically three forms of stepwise regression. The first type is the forward selection. In this type, variables are entered into the equation in the order in which they account for the variance. That is the variable with the greatest effect on variance is first entered into the equation and its contribution to R^2 determined before the next predictor variable is entered into the equation. Next, the second variable which affects the variance most significantly is then entered into the equation and the change in R^2 determined in order to know exactly the contribution of this second variable. Other variables are the subsequently added to the occasion until the point where the addition of further variables significantly have no effect on the variance.

The second type is the step wise selection. In this case, with the introduction of each variable to the model, its effect to the model is assessed, and this is done for many variables until the best fit model is determined.

The last type is the backward selection. Here, all the independent variables are entered into the equation. Then a partial F test is conducted on each variable as if it was the last variable to be entered into the equation. R^2 change is determined at each stage.

Some of these models are widely applied in research involving prediction studies like predictive validity studies. This research work made use of the standard multiple regression method or the Enter method, where all the independent variables are put at once into the model. This method is used in this study because the students write an assemblage of subjects at a particular examination session in the GCE or BAC examinations, thus the final results come out at once bearing an overall grade or points scored in the entire examination, thus the researcher found it quite pertinent to use the standard multiple regression method in order to see the combined effect of the predictors together with their individual effects.

Assumptions of Regression Analyses

1) **Variables are Normally Distributed**

For regression analyses to be used, the variables are supposed to have a normal distribution in the population. Variables which are not normally distributed, could likely be skewed or kurtotic variables or variables with substantial outliers can upset the relationship between variables and significant tests. The information pertaining to normality could be derived by, visual inspection of data plots, skew, kurtoses and P-P plots. Through visual inspection of histograms, frequency distribution and by converting data to z- scores, outliers could be identified (Osborne and Waters, 2002). However, removal of univariate and bivariate outliers can improve upon the accuracy of estimates and can reduce the occurrence of Type I and Type II errors (Osborne, 2001) as cited in (Osborne and Waters, 2002). Also, another way of stating the normality assumption is that the conditional distribution of the response variable is normal for any given combination of values on the predictor variables, though it is not assumed that the marginal distribution of the dependent variable is necessarily normal (Williams, Grajales and Kurkiewics, 2013).

2) **Linear Relationship between the Independent and the Dependent Variable**

The relationship between the dependent and independent variable can only be conveniently determined when there is a linear relationship between these two variables. The results of the regression analyses will be under estimated if the relationship between the independent and dependent variables are not linear. This under estimation may lead to Type II error in relation to the variable and could also lead to a Type I error (over estimation) in relation to other independent variables who share variance with that particular independent variable in the case of multiple regression. According to

Williams *et al,* (2013), linear regression frameworks can be derived by modeling some types of non-linear relationships. For example, if variables X and Y have a quadratic relationship, they can be accommodated by including both X and X^2 as predictors. In this case, the regression equation will have a term in X and a term in X^2. Since the dependent variable Y is fashioned or modeled as a linear function of the regression constants, the regression equation will remain a linear regression equation.

3) **Reliability and Multiple Regression**

With the addition of each independent variable to the regression equation, the reliability of a perfect relationship between the predictors and the dependent variable certainly reduces. The inclusion of one variable with a questionable reliability will make successive variables entered to give the blame for the error variance. Thus, the respective allocations for the explained variance amongst the independent variables will then be incorrect. Therefore, the more independent variables with low reliabilities are added to the regression equation, the more the apportioning of variance to the independent variables will not be correct. Consequently, this can lead to erroneous findings and even the occurrence of Type II errors with those variables having poor reliability, and Type I errors for the other variables contained in the equation (Osborne and Waters, 2002). Therefore, assuming that measurement errors exist is quite pertinent in research. That is, knowing how to deal with or limit the effect of measurement errors will go a long way of presenting reliable findings.

4) **Assumption of Homoscedasticity**

Homoscedasticity is talked about when the variance of errors is the same across all levels of the independent variable(IV). Heteroscedasticity sets in when the error variance differs at different levels of the IV (Osborne and Waters, 2002). The model errors are assumed to have a finite variance which is unknown and constant across all levels of the predictor variable. Another name of this assumption is the homogeneity of variance assumption. If the error variance is finite but not constant at different levels of the predictor variable, that is signifying heteroscedasticity, and as long as the errors are independent, Ordinary least square will be unbiased and consistent but will not be efficient (Weisberg, 2005) as cited Williams *et al,* (2013). Moreover, there is a little effect on significance test caused by a slight heteroscedasticity, Serious distortions of the findings and weakening of the analyses may occur when there is a marked heteroscedasticity, and this could lead to a Type I error (Tabachnick and Fidell, 1996). Visual examination of a plot of standardized residuals by the regression standardized predicted value could be used to check the assumption. Normally, residuals are relatively evenly distributed as they are randomly scattered around the horizontal line. Thus, heteroscedasticity is brought to the lime light when the residuals are not evenly scattered around the line. Also, heteroscedasticity can take the form of a bow tie or fan shape (Osborne and Waters, 2002).

Testing for Differential Prediction

According to Gulliksen and Wilks (1950), testing for differential prediction involves the carrying out of three tests which are; the tests of equality of standard errors of estimates, followed by the test of equality of regression slopes and finally the test for regression intercepts between the various sub groups in the population under consideration. Generally, differences in the gradient of the regression line or the regression slope for the different sub groups means that the predictor predicts the criterion better for one group than another while a difference in regression intercepts signify that given two groups of equal ability, the criterion predicted in one group is lower than that of the other group Sacket and Wilk (1994) as cited in Al- Hattami (2012)

Test of Equality of Standard Error of Estimate

Standard error of estimates refers to the standard deviation of the errors or residuals(R) which occurs when the predictor predicts the criterion within a sample (Reynolds, 1982). He further illustrated that there also exists the relationship between the standard error measurement with the correlation of the predictor and the criterion in the various subgroups under consideration. That is, if the correlation coefficients between the predictor and the criterion of the various sub groups in the population under consideration are equal, then the standard error estimates of the various sub groups will also be equal. Which therefore means that the errors involved in the prediction of students' performance in engineering by their high school results will be the same pertaining to subgroups of a particular factor in the population. Therefore, for the standard error to be equal for every factor of differentiation in this study, it means that the correlation of students' high school results and their academic performance in engineering should be the same for the male and the female in the case of gender, should also be the same for the various levels of students' motivation for engineering in the case of motivation as well as the same for students from public high schools and non public or private high schools in the case of school type.

Testing the Equality of Regression Slopes and Regression Coefficients

To Al-Hattami (2012), when the predictor which could be performance in a test, for different sub groups within the population predict future performance in the same way, it therefore means the slopes and the regression intercepts for the different subgroups would be the same. This could further be refered to as non-bias prediction or homogeneity. Moreover, bias sets in when the regression slopes as well as the regression intercepts are not equal, and in this case, the regression equation for the sample population under consideration cannot be used for the various sub groups. Thus, in order to assure fairness in prediction, different equations should be used in the prediction of the various sub groups (Reynolds, 1982). In this study, the regression coefficients of the different sub groups were compared in order to determine whether the regression slopes and intercepts were different for the different sub groups.

Ethical Considerations

In line with the principles of scientific research, the researcher in this study laid emphases on some ethical considerations in order to adequately protect those part taking in the research and to do no harm to them and also to respect their desires. In doing all these, the researcher took to recognition certain ethical principles such as; making use of the principle of informed consent, following the ethical principles of gaining access to and acceptance into the research setting, taking into cognisanze sources of tension in the ethical debate such as non-maleficence, beneficence, human dignity, absolutist and relativists ethics. The work also took into consideration ethical issues in line with problems and dilemmas confronting the researcher including matters of privacy, anonymity, confidentiality, betrayal and deception and finally ethical issues pertaining to the research community.

Informed Consent

The principle of informed consent arises from the subject's right to freedom and self determination. Consent thus protects and respects the right of self determination and places some of the responsibility on the participants should anything go wrong in the research (Cohen et al, 2007). Informed consent has been defined by Diener and Crandall (1978) as the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence decisions. This definition evolves around four elements which are; competence, voluntarism, full information and comprehension

Competence entails that responsible and mature individuals will make correct decisions if they are given the relevant information. It is incumbent on researchers to ensure they do not engage individuals incapable of making such decisions because of immaturity or some kind of psychological impairment. In line with this research work, the researcher made sure he gave the subjects who are university students of the school of Engineering of the University of Bamenda adequate information pertaining to the modalities of the research. The students used for the research are students at the University level and thus they are considered mature and psychologically balanced to a greater extent and so can satisfactorily make correct decisions. This then satisfies the ethical value of competence which is an element in the ethical principle of informed consent.

Voluntarism entails applying the principle of informed consent and thus ensuring that participants freely choose to take part or not in the research and guarantees that exposure to risk is undertaken knowingly and voluntarily. This is ensured in this research work by the informed consent form which is administered to the students in order to know their willingness to take part in the research, taking into consideration the fact that they have been well informed on what the research entails.

Full information which is another element of informed consent implies that the consent is fully informed. In actual terms it is quite difficult to inform the subjects about all the various aspects of the research which do not directly concern the consent like the statistical tests which would be used for analyses for example. In this study in order to be in accordance with this ethical element, the researcher made sure all the information necessary for the research subjects were given them, so that before taking part as subjects in the research, they know what the research entails.

Comprehension refers to the fact that participants fully understand the nature of the research project even when procedures are complicated and entail risks. The researcher in this study made sure the subjects fully understood the nature of the research project by giving them open verbal explanations and by the administering of the informed consent form to the participants

Access and Acceptance

The principle of informed consent seems to be more pertinent at the initiation stages of research, but as one moves into actual field activity, there is need for the researcher to get formal access to institution or organization where the research is to be conducted, and acceptance by those whose permission one needs before embarking on the risk. At this stage, the researcher has the opportunity to present his or her credentials as a proof of being a serious investigator and this further establishes their ethical position with respect to their proposed research. In doing these, the first thing is to gain official permission to undertake one's research in the target community. This would either be through contacting the person or through writing. By proper planning and foresight, both the researcher and the institution will have a good idea of the demands likely to be made on both subjects be it the teachers or the students under consideration. Also at the time of getting access into the research site through formal authorization and permission, likely problems could be anticipated and resolved especially those of the practical type. For example, the questionnaire which a researcher may be envisaging for use may be too complicated for comprehension or needing a long attention span for the respondents' age, or if a relatively inexperienced teacher is to be placed under severe scrutiny by the research. Once such previewed difficulties have been exposed and clarified, the researcher will then have the plat form to explain the various measure he or she will adopt in order to overcome the previewed difficulties. With this at hand, the researcher is now readily gain permission, acceptance and support. It is at the stage of gaining access and acceptance to carry out research that the researcher has the opportunity to look again into the appropriateness of the topic, the design adopted for the research, the methods used for the research work, as well as the guarantee of confidentiality and the fact that the analysis and dissemination of findings must be negotiated with relative openness, sensitivity, honesty, accuracy and scientific impartiality (Cohen et al, 2007).

The researcher in this research work after collecting the research permit from the Deanery of University of Yaounde I, presented it to the Administrations of the various engineering schools where the research was deemed to be carried out. Upon presentation of the research permit in the various engineering schools, the researcher was most often questioned on what the research work was all about, and the researcher explained to them explicitly what the research work entails and the kind of information he will need from the students and from the institutions. In most of the engineering schools, after further deliberations and clarifications, the researcher was then assigned to the Dean of studies who was to help the researcher technically in providing the necessary information he demanded and in paving the way for the researcher to get access to the students. Also, in most of these engineering schools, the Dean of studies asked the researcher what his research work is focused on and explanations were given to the various, the Deans of studies in the various engineering schools later asked the researcher how he will intend to collect data and he told the Deans of studies that he will be collecting information from the student through the use of questionnaire.

The researcher in this particular circumstances presented copies of the questionnaire to the Deans, where it was deemed necessary. In most cases, the Deans of studies went through the questionnaire item wise and the researcher gave him clarifications on the items where questions were raised. Generally, after the clarifications were done, the Deans of studies in the various engineering schools then took the researcher around the various lecture rooms and introduced the researcher to the students and beconed on them to cooperate with the researcher, and the secretaries of most of the school to furnish the researcher with the information he needed. All these then gave the researcher access to the subjects who were in this, case students of the school of engineering of the University of Bamenda, the Faculty of Engineering and Technology of the University of Buea, the engineering school of the Catholic University of Cameroon in Baham, the National Advanced School of Public works Yaounde, the Catholic University Institute of Buea and the Catholic university institute of Buea, Douala campus.

Furthermore, in carrying out research, some ethical considerations are taken in other to minimize the upsurge of tensions. Accoring to Cohen et al (2007), these ethical considerations involve putting in place ethical principles such as Non- maleficence, beneficence and human dignity. Non-maleficence means avoiding the causation of harm. Non-maleficence (do not harm) is enshrined in the Hippocratic oath, in which the principle of prinum non nocere (first of all do not harm) is held as a guiding precept, and this also holds in research. At first sight, this seems uncontentious as the researcher would not like to harm the subjects of the research. However, what constitutes harm is not clear because one person’s harm could be a benefit to the society and whether a little harm for a few is tolerable in the interest of a major benefit for all, or even for the person concerned. The most important concern now will be asking the question if the end justifies the means thus, as a general principle, one would advocate the application primum non nocere (first of all, do no harm). In line with this research work, the researcher made sure that each item on the questionnaire to be used for the study is well censored so that the item does not depress the respondents in any way an also making sure that what ever the findings of the research would be, the researcher would not use it against the subjects.

Beneficence on the other hand is the coronary of non-maleficence. It focuses on the benefits the research will bring and to whom. Many would be participants could be persuaded to take part in research if it is made clear that it will or may bring personal, educational and social benefits. Amongst other benefits for example, the research could lead to improvement of learning, increased funding and resources for a particular curriculum area, improved approaches to the teaching of a subject, increased self esteem for students or additional teachers in school. Moreover, the recipient of the benefit of the research has to be made clear because the benefits may be directed towards the researcher through gains such as gain in promotion, publications, a degree, research sponsorship amongst others. Thus, the research might leave the participants untouched, underpreviledged, living and working in squalid and under resourced conditions, under-supported and with no material, educational or other improvements brought to the quality of their lives and work. On the other hand, it could also be argued that research that did not lead to such benefits is unethical. At times it might be quite fanciful to believe that a single piece of research would automatically lead to improvement, and the ethical question which is posed is, who benefits? And that a selfish approach to the benefits of the research by the researcher is unethical (Cohen, 2007).

In this research work, the researcher made sure he informed the research participants and the administration of the engineering school of the benefits of the study. That is, researcher made the school administration of the engineering schools to know that the findings of the research will serve as a placement guide which they could use in orientating students and placing them into the various branches of engineering. The researcher also made the students to know that the findings of the study will help them in one way or another in orientating their younger one's or others who are passionate in engineering on what particular branch of engineering to embark on in relation to their high school results. Moreover, they were also made to know that the findings of the study would booster their drive towards working harder academically in the various branches of engineering where they find themselves.

There are also some ethical dilemmas which are brought forth when we consider that research could lead to the gain of knowledge as well as on the other hand the gain of knowledge should not compromise the rights of the participants to self determination, privacy, and dignity (Frankfort-Nachmias and Nachmias, 1992). These ethical dilemmas are considered as fundamental ethical dilemmas and the researcher in this study made sure that these fundamental ethical dilemmas were well considered and taken care of in this study. Some other ethical dilemmas which the researcher took into consideration in this study are; Privacy, Anonymity, Confidentiality, Betrayal, and Deception.

Privacy

During research, the right to privacy may easily be violated or even denied when the research has been completed. According to Diener and Crandall (1978), privacy is considered from three perspectives which are; the sensitivity of the information being given, the setting being observed, and the dissemination of the information. Sensitivity of the information refers to the extent to which the information being collected is potentially threatening. Threatening in this case refers to the extent to which the information being collected could be considered personal to the respondent or the research subject, as some information could be considered more personal than others. Therefore, the more sensitive the information is, the more the respect for the privacy of those providing the information. The setting being observed may vary from very private completely public. The home for example is considered a very private setting and so getting into someone's home for research purposes, one must obtain consent since it is considered private. Dissemination of information concerns the ability to match personal information with the identity of the research participants. Personal data or information by law refers to those data which uniquely identify the individual providing them. If such data is published with names, then it is a violation of privacy. Moreover, the participants of a research may decide whether or not they want the information given to the researcher to be made public with their names. Normally, it is through the informed consent that a research participant will formally inform the researcher if they would like certain private information of theirs should be made public or not. Furthermore, privacy also goes a little bit deeper, that is, the right to privacy means that a person has the right not to take part in the research, not to answer answer questions, not to be interviewed, not to have their homes intruded into, not to answer telephone calls amongst others (Cohen et al, 2007)

In line with this study, the researcher made sure that there were minimal sensitive issues involved in the research and those other aspects which seemed sensitive like getting access to students' scores, the researcher got the consent of the participants. Taking the research site into consideration, the researcher met the research participants on the various campuses of the engineering schools used for this study which cannot be considered as private as meeting them in their respective homes. Also observing the ethical principle of privacy, the researcher informed the research participants that their results would not be made public with their names, but will be analysed in line with the objectives of the study and the findings published without the name of any student.

Anonimity

The ethical principle of anonymity according to Frankfort-Nachmias and Nachmias (1992) underline the need for confidentiality of participants' identities and doing the contrary to this should be in agreement with the participants. The main idea behind the principle of anonymity is that the information provided by participants should in no way reveal their identity. Therefore, a research participant or a subject is will be considered as anonymous, when the information they provide does not reveal their identities. When this situation is in place, the privacy of the research participants is guaranteed no matter how personal or sensitive the information they provide is. The principal means through which anonymity could be assured is by not using the names of the participants as well any other means of identification which could easily identify them. Moreover, in addition the use of research participants' names and other information which could easily identify them, researchers could also make use of codes for identifying people and the use of password protected files (Frankfort-Nachmias and Nachmias, 1992).

The researcher in this study, the ethical principle was well respected. The researcher observed that if the engineering students write their names on the questionnaire in their identities would be revealed and thus violating the ethical principle of anonymity. Thus, the researcher in administering the questionnaire worked along side workers from the school the various school administrations. The researcher together with members of the school administration told the respondents clearly and firmly not to write their names or registration numbers or any thing which could reveal their identities on the questionnaire. The students were also later cautioned to be truthful in their responses, for, being truthful will in no way reveal their identities.

Confidentiality

Another way of ensuring the privacy of the participants is through the promise of confidentiality. This simply means that although researchers know who has has provided what so ever information, or are able to identify participants from information given, and they will in no way make the connection known publicly and that the boundaries surrounding the shared secret should be protected. The essence of the principle of confidentiality is the extent to which the researchers or investigators keep faith with those who have been of help to them. The researchers normally gain the confidence of confidentiality from the research subjects at the access stage or at the point of data collection. They will thus be quite explicit in explaining to subjects what the the meaning and limits of confidentiality are in relation to the particular research project under consideration. The level of Confidentiality to be accorded should normally be commensurate to the level of sensitivity of the information sought for (Cohen et al, 2007)

Furthermore, a number of ways have been developed in which the public could have access to data and information without betraying confidentiality. According to Frankfort-Nachmias and Nachmias (1992) some of these ways are as follows; through the deletion of identifiers such as names, addresses, or other means of identification from the data released on individuals, through the giving of crude report categories that is some sought of generalized data such as the year of birth rather than the date of birth, the profession rather than the specialty of the profession, that is general ideas rather than specificities, through the making of micro-aggregations that is constructing an average person from data on individuals and the release of these data on individuals and through error inoculation that is deliberately introducing errors into individual records while leaving the aggregate data unchanged. In some other cases, confidentiality could be ascertained by giving rights to the respondents to sign before data pertaining to them is made public.

In this study, the researcher at first encounter with the research participants assured them of absolute confidentiality of the information they are to provide. Moreover, on the questionnaire its self, emphases on confidentiality was also made for the participants to be more relaxed in providing answers to the questions. Also, since anonymity was enforced by the research methodology put in place, a certain degree of confidentiality was already assured. That is, with the identity of the research participants not disclosed, exposing the results to the public will in no great way impinge on the privacy and confidentiality of the respondents. Still, in order to ascertain absolute confidentiality, the researcher further assured the Engineering school administration that he will not disclose the data collected from the students in non-academic forums but would publish the results of the findings in academic journals without the identity of the students.

Betrayal

The term betrayal is often used in the occasions where data disclosed in confidence are revealed publicly in such a way as to cause embarrassment, anxiety, or perhaps suffering to the subject or participant disclosing the information. It could be seen as an aspect of dishonesty from a moral stand point and could also be seen as a breach of contract and a contradiction to confidentiality in ordinary sense which might have been promoted by selfish motives of either a personal or professional nature (Cohen et al, 2007).

In this study, the researcher promised the administration of the school of engineering and the students who were the research participants that he will only use the data collected and the findings of the study for academic purposes and for no other thing contrary to that.

Deception

This aspect in research can arise from so many circumstances. Deception may lie in not telling people that they are being researched, not telling the truth, telling lies or compromising the truth. It may also lie in using people in a degrading or dehumanizing way. In social psychological research, the term is applied to that kind of experimental situation where the researcher knowingly conceals the true purpose and conditions of the research, or else positively misinforms the subjects, or exposes them to unduly painful, stressful, or embarrassing experiences, without the subjects having knowledge of what is going on. Deception may be justified on the grounds that the research serves the public good, and that the deception prevents any bias from entering the research, and also that it may protect the confidentiality of a third party. The problem emanating from the concept of deception is that of striking a balance between the interest of science and the thoughtful, human treatment of people who innocently, provide the data. The pervasiveness of the issue of deception becomes even more apparent when we remember that it is built into many of our measurement devices, since it is important to keep the respondents ignorant of the personality and attitude dimensions that we wish to investigate (Cohen et al, 2007).

According to Kelman (1967) as cited in Cohen et al (2007), there are three ways of dealing with the problem of deception. First of all, the awareness of the existence of deception as a problem should be increased. Thus, we must be wary of the tendency to dismiss the question if deception exists or not as irrelevant and to accept deception as a matter of course. The second way of approaching the problem is by counteracting and minimizing the negative effects of deception. For example, subjects must be selected in a way that will exclude individuals who are especially vulnerable; any potentially harmful manipulation must be kept to a moderate level of intensity; researchers must sensitive to danger signals in the reactions of subjects and be prepared to deal with crises when they arise; and at the conclusion of the research, they must take time not only to reassure subjects, but also to help them work through their feelings about the experience to what ever degree may be required. The primary way of counteracting negative effects of research which makes use of deception is to ensure that adequate feedback is provided at the end of the research or research session. The third way of dealing with the problem of deception is to ensure that new procedures and novel techniques are developed. It is a question of tapping one's ow creativity in the quest for alternative methods.

In this study, the aspect of deception was completely out of the study from the inception of the study. The researcher honestly explained the objectives of the study to the students and to the administration of the schools where the research work was carried. In line with dealing with the data collected from the research respondents, the researcher used research instruments to collect the data which were in line with the objectives of the study, thus in answering the questions on the questionnaire, the respondents knew what their responses were supposed to be used for, and before they even concerted to answer the questionnaire and for their results to be collected by the researcher, they filled an informed consent form which signifies their consent or not for their data to be used for the study. After collecting data from the respondents, the researcher further pledged to be honest and not to be deceptive with the data he has collected from the research subjects.

In order to make all the ethical considerations considered in this study known to the research subjects, the researcher designed an informed consent document and a consent form which the research subjects were to sign before they were used as subjects for the study.

Table 8

Operationalization of the Variables used in the Study

Topic	General Hypothesis/General Question	Specific Question	Specific Hypothesis	Variables	Indicators	Modalities
The Predictive Validity and Differential Predictive Validity of High School Results to Students' Academic Performance in Engineering in Cameroon	To what extent do students' high school results in sciences predict their academic performance in engineering, and do these high school results predict students' academic performance in engineering differently in terms of gender, degree of motivation and type of high school attended?	1)To what extent does the GCE A/L results in sciences predict students' academic performance in Engineering?	Ho_1: GCE A/L results in sciences do not significantly predict students' academic performance in engineering	IV: GCE A/L results in Science subjects DV: Students' academic performance in Engineering	IV's-Grade in Bio -Grade in Chem -Grade in Phy -Grade in Maths -Grade in F.Maths -Grade inGlgy -Grade inComp.sc -Grade in ICT DV- GPA scored	A questionnaire for students was used to collect the data. The response options used to measure the construct motivation range from 1 to 10 as follows: 1,2,3=Disagree(D) 4.5= Somewhat Disagree (SD) 6,7= Somewhat Agree (SA) 8,9,10 =Agree (A) The Statistical tests used for the analysis were: 1)Multiple
		2) To what extent does the BAC results in sciences predict students' academic performance in Engineering?	Ho_2:BAC examination results in sciences do not significantly predict students' academic performance in Engineering	IV: BAC results in subjects DV: Students' academic performance in Engineering	IV's-Grade inSVT -Grade in Chimie -Grade in Phy -Grade in Math -Grade in Info DV-GPA scored	
		3)Do students' high school results in sciences predict their academic performance in Engineering differently in terms of gender?	Ho_3: High School results in sciences do not significantly predict students' academic performance in engineering differently in terms of	IV: GCE A/L and BAC results in Science subjects BV: Gender DV: Students'	IV's-Grade in Bio -Grade in Chem -Grade in Phy -Grade in Maths -Grade in F.Maths -Grade inGlgy -Grade in Csc	

			gender	academic performance in Engineering	-Grade in ICT OR IV's-GradeinSVT -Grade in Chimie -Grade in Phy -Grade in Math -Grade in Info BV's: Gender: Male, Female	Regression Analysis for hypotheses 1 and 2 2) Gulliksen and Wilks tests for Differential prediction
		4) Do students' high school results in sciences predict their academic performance in Engineering differently in terms of their motivation for engineering studies?	Ho_4: High school results in sciences do not significantly predict students' academic performance differently in terms of their motivation for engineering studies	IV: GCE A/L and BAC results in Science subjects BV: Motivation DV: Students' academic performance in Engineering	IV's-Grade in Bio -Grade in Chem -Grade in Phy -Grade in Maths -Grade in F.Maths -Grade inGlgy -Grade in Csc -Grade in ICT OR IV's-GradeinSVT -Grade in Chimie -Grade in Phy -Grade in Math -Grade in Info BV's. Motivation: -Interest -Self efficacy	

					-Outcome expectation -Social support and Barriers	
		5) To what extent do students' high school results in the sciences predict their academic performance in engineering differently in terms of the type of high school they attended?	H_{05}: High School results in sciences do not significantly predict students' academic performance in engineering differently in terms of the type of high school attended.	IV: GCE A/L and BAC results in Science subjects BV: Type of High School DV: Students' academic performance in Engineering	IV's-Grade in Bio -Grade in Chem -Grade in Phy -Grade in Maths -Grade in F.Maths -Grade inGlgy -Grade in Csc -Grade in ICT OR IV's-GradeinSVT -Grade in Chimie -Grade in Phy -Grade in Math -Grade in Info BV's: Type of High School: Public, Mission, Lay Private	
		6) What regression models could be used in the prediction of students' academic performance in various fields of engineering by their high school results?				

CHAPTER FOUR

FINDINGS

Introduction

This chapter presents the findings of the study derived from the responses of the questionnaires. The results were interpreted using both descriptive and inferential statistics. Descriptive statistics made use of frequency tables and bar chart to present demographic information and to answer the research questions. Statistical package for social sciences (SPSS version 26.0) was used to verify the hypotheses, and it made use of multiple linear regression analysis and the hypotheses were tested at the 0.05 level of significance.

This study was aimed at determining the extent to which high school results, that is the GCE A/L results and the BAC results in sciences predict students' academic performance in schools of engineering in Cameroon and the extent to which these high school results in sciences predict students' academic performance in engineering differently in terms of the degree of motivation for engineering studies, their gender and in terms of the type of high school they attended and finally to come out with regression models which will be used as placement guides of students into various branches of engineering from their high school results. The correlation survey research design was used to carry out the study and the instrument used for data collection was a questionnaire for students. The following research questions were examined in the study:

1) To what extent does the GCE A/L results in sciences predict students' academic performance in Engineering?

2) To what extent does the BAC results in sciences predict students' academic performance in Engineering?

3) Do students' high school results in sciences predict their academic performance in Engineering differently in terms of gender?

4) Do students' high school results in sciences predict their academic performance in Engineering differently in terms of their motivation for engineering studies?

5) To what extent do students' high school results in the sciences predict their academic performance in engineering differently in terms of the type of high school they attended?

6) What regression models could be used in the prediction of students' academic performance in various fields of engineering by their high school results?

The analysis carried out in this chapter was performed using data collected in the months November and December in the year 2020. The chapter is organized in two sections. The first section is a presentation of the demographic information, survey findings, descriptive statistics and frequencies of the background variables independent variables and dependent variables. The second section covers the presentation of the research findings and verification of the hypotheses.

Demographic Information

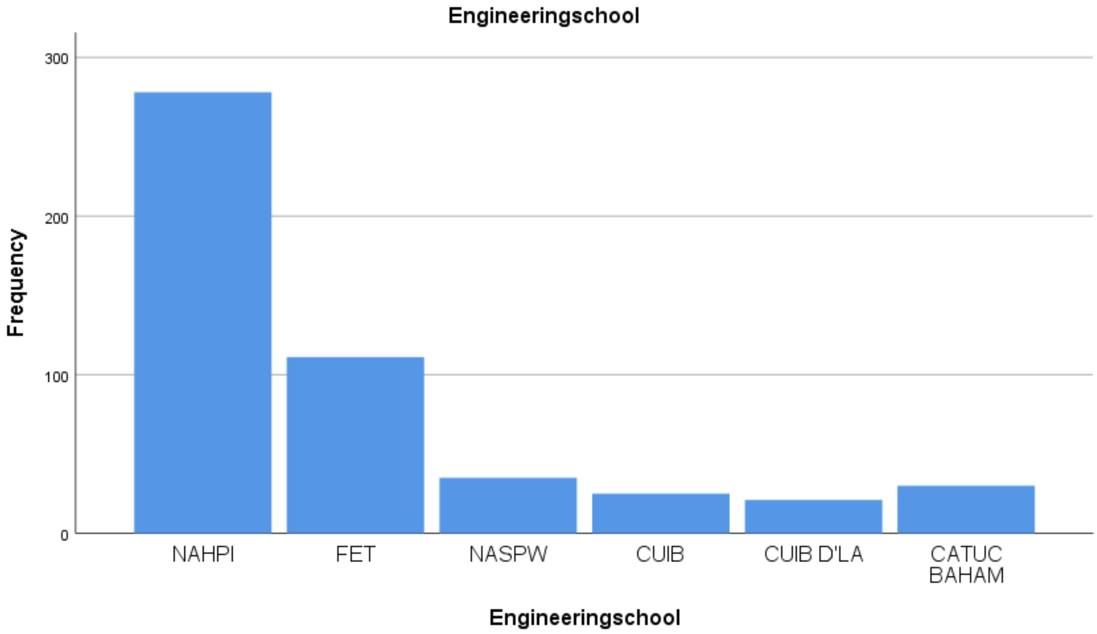
Table 9

Engineering schools

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**NAHPI**	278	55.6	55.6	55.6
	FET	111	22.2	22.2	77.8
	NASPW	35	7.0	7.0	84.8
	CUIB	25	5.0	5.0	89.8
	CUIB D'LA	21	4.2	4.2	94.0
	CATUC BAHAM	30	6.0	6.0	100.0
	Total	500	100.0	100.0	

Figure 2

Bar Chart Illustrating the Number of Engineering Student per Engineering School



From table 9 and Fig 2. the bar chart above, 278 (55.6%) of the engineering students used for the study were students of the National Higher Polytechnic Institute (NAHPI) of the University Bamenda, while 111 (22.2%) of the engineering students were of the Faculty of Technology (FET) of the University of Buea, 35 (7%) of the students were from the National Advanced School of Public Work (NASPW) in Yaounde, 25 (5%) of the engineering students came from the Catholic University Institute Buea (CUIB), 21 (4.2%) of the engineering students were from the Catholic University Institute Douala campus (CUIB D'LA) and 30 (6%) of the engineering students were from the Catholic University of Cameroon Baham (CATUC Baham).

Table 10

Gender of Engineering Students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	348	69.6	69.6	69.6
	Female	152	30.4	30.4	100.0
	Total	500	100.0	100.0	

Fig 3

Pie Chart Illustrating Proportion of Male and Female Engineering Students

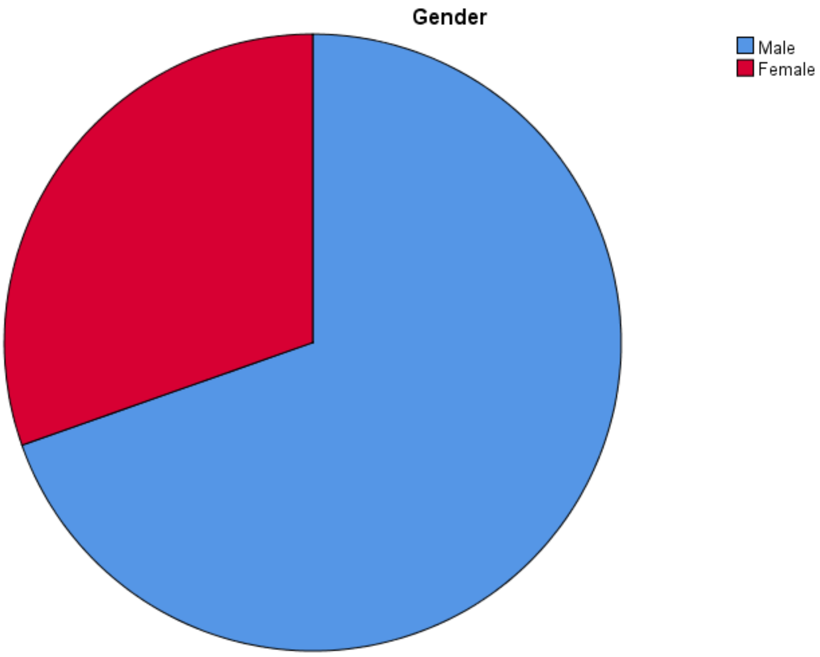


Table 10 above clearly illustrates that from amongst the 500 engineering students used for the study, 348(69.6%) of them were male while 152 (30.4%)of them were female. The pie chart also illustrates that a greater proportion of the engineering students were male while a smaller proportion were female. Though the female population of the engineering students were a minority compared to the male population it was relatively significant, taking into consideration the fact that in the yesteryear most female students shied away from science studies talkless of fields of applied sciences such as engineering.

Table 11

Age of Engineering students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 18yrs	18	3.6	3.6	3.6
	18-21yrs	362	72.4	72.4	76.0
	22-25yrs	94	18.8	18.8	94.8
	26-29yrs	17	3.4	3.4	98.2
	Above 29yrs	9	1.8	1.8	100.0
	Total	500	100.0	100.0	

From table 11 above 362 (72.4%) of the engineering students who took part in the study were between the ages of 18 to 21 years old, 94 (18.8%) of the students were between the ages of 22 to 25 years old, 17 (3.4%) of the students were between the ages of 26 to 29 years old and just 9 (1.8%) of the students were greater thann 29 years old.

Table 12

Age of Entry into Engineering Schools

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 18yrs	184	36.8	36.8	36.8
	18-21yrs	267	53.4	53.4	90.2
	22-25yrs	36	7.2	7.2	97.4
	26-29yrs	6	1.2	1.2	98.6
	Above 29yrs	7	1.4	1.4	100.0
	Total	500	100.0	100.0	

Table 12 above shows that 184 (36.8%) of the students got admission into engineering schools below the age of 18, 267 (53.4%) of them got admission between the ages of 18 to 21 years old, 36 (7.2%) of them went into engineering school between the ages of 22 and 25, 6(1.2%) of the engineering students got admission into engineering schools between the ages of 26 to 29 years old and 7(1.4%) of the students got admission into engineering schools above the age of 29 years old.

Table 13

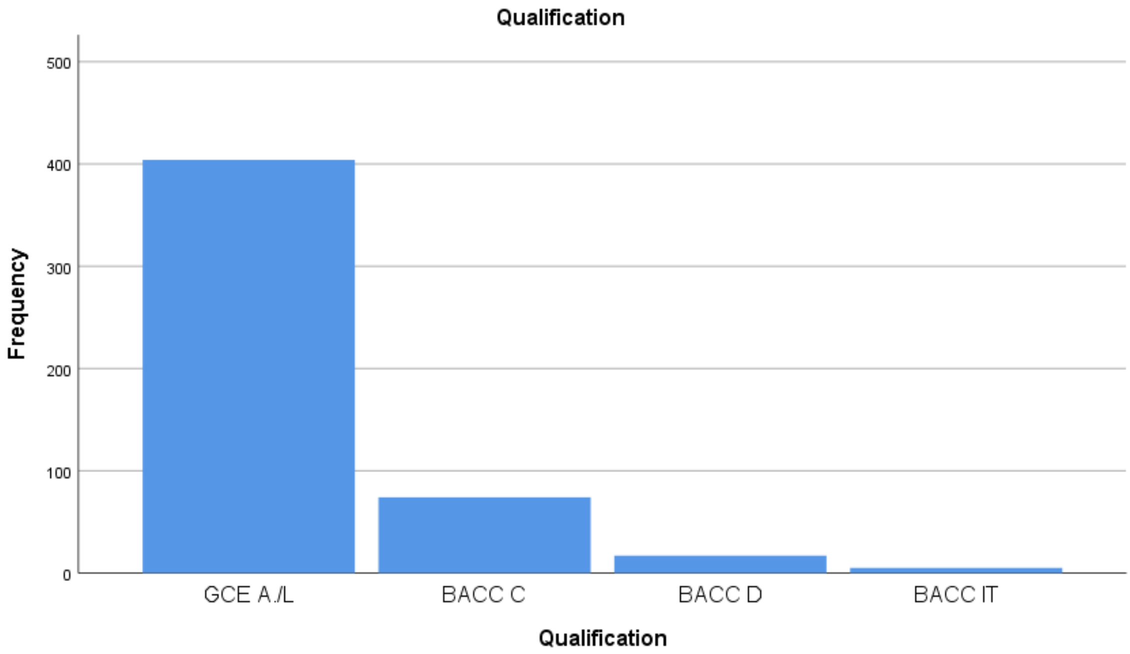
Entry Qualification

	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	GCE A./L	404	80.8	80.8	80.8
	BAC C	74	14.8	14.8	95.6
	BAC D	17	3.4	3.4	99.0
	BAC IT	5	1.0	1.0	100.0
	Total	500	100.0	100.0	

Figure 4

Bar Chart Illustrating the Proportion of Students with Different High School Qualifications



From the frequency table and bar chart above, 404 (80.8%) of the engineering students were holders of GCE A/L, 72 (14.8%) of the students were holders of BAC C, 17 (3.4%) of the students were holders a BAC D and 5 of the students were holders of a BAC IT. From the survey, no student with a BAC E was found in any of the engineering schools used for the study.

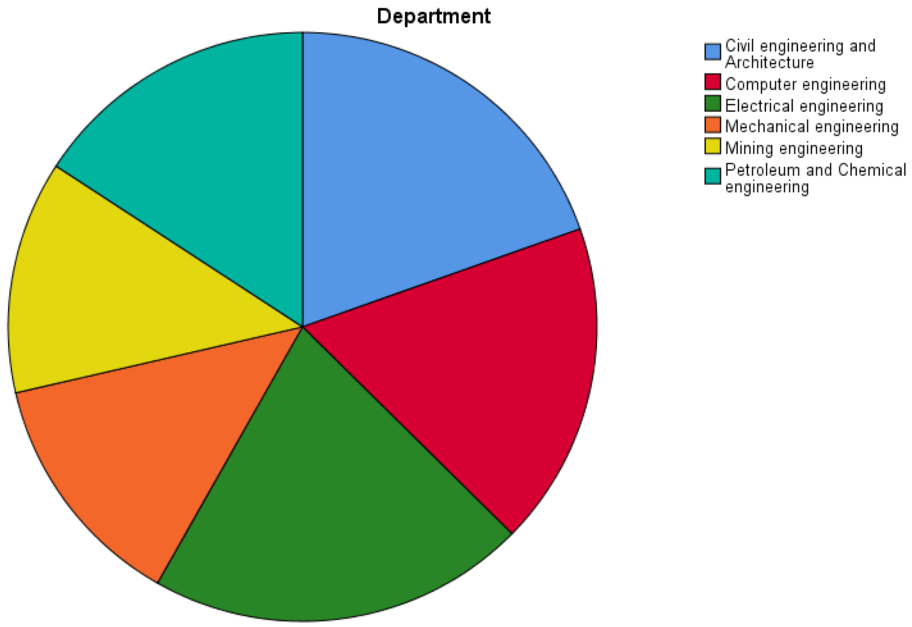
Table 14

Engineering Department

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Civil engineering and Architecture	98	19.6	19.6	19.6
	Computer engineering	89	17.8	17.8	37.4
	Electrical engineering	104	20.8	20.8	58.2
	Mechanical engineering	66	13.2	13.2	71.4
	Mining engineering	64	12.8	12.8	84.2
	Petroleum and Chemical engineering	79	15.8	15.8	100.0
	Total	500	100.0	100.0	

Figure 5

Responses Illustrating the Proportion of Students in the Various Engineering Departments



From the frequency table above, 98 (19.6%) of the engineering students were of the department of civil engineering and Architecture, 89 (17.8%) of the respondents were from the department of computer engineering, 104 (20.8%) of the engineering students were from the department of electrical engineering, 66 (13.2%) of the students were from the department of mechanical engineering, 64(12.8%) of the students were of the department of mining engineering and 79(15.8%) of the engineering students were of the department of petroleum and chemical engineering. From the pie chart, the greatest proportion of engineering students surveyed were from the department of electrical engineering and the smallest proportion of engineering students were from the department of mining engineering and this is because only very few engineering schools in Cameroon have the department of mining engineering.

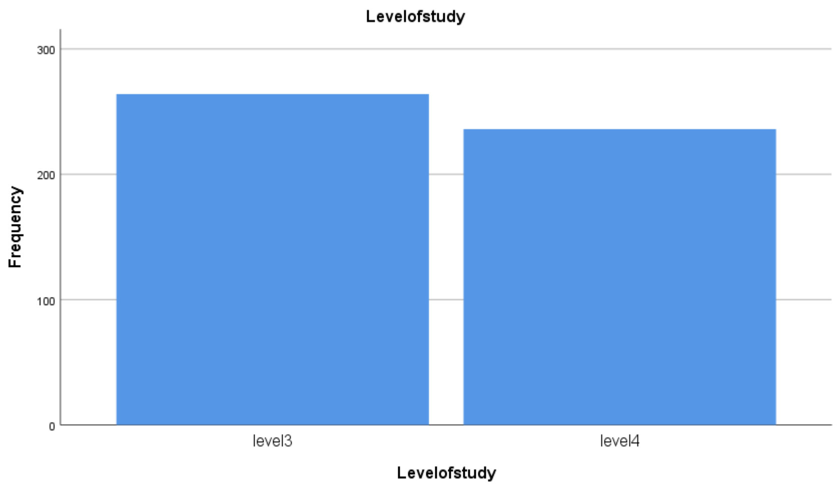
Table 15

Level of study

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	level3	264	52.8	52.8	52.8
	level4	236	47.2	47.2	100.0
	Total	500	100.0	100.0	

Figure 6

Responses Illustrating Students' Level of Study



From the frequency table above, 264 (62%) of the engineering students were students in their third year of study while 236 (47.2%) of the engineering students were in their fourth year of study.

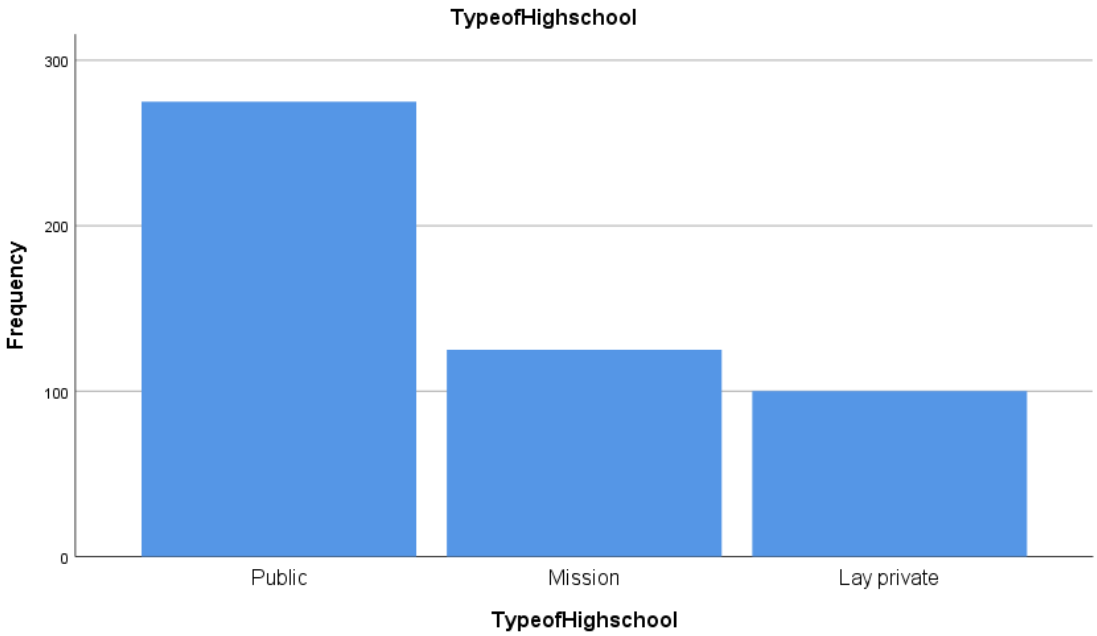
Table 16

Type of High school

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Public	275	55.0	55.0	55.0
	Mission	125	25.0	25.0	80.0
	Lay private	100	20.0	20.0	100.0
	Total	500	100.0	100.0	

Figure 7

Illustration of the Type of High School Attended by the Engineering Students.



The frequency table above illustrates that 275 (55%) of the engineering students were from public high schools, while 125 (25%) of the engineering students were from mission schools and 100 (20%) of the engineering students were from lay private schools. This implies that the majority of engineering students in Cameroon come from public schools, that is schools run by the Government.

Table 17

Location of High School

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	City	134	26.8	26.8	26.8
	Town	312	62.4	62.4	89.2
	Village	54	10.8	10.8	100.0
	Total	500	100.0	100.0	

From the frequency table above, 134 (26.8%) of the students were from high schools located in the city, 312 (62.4%) of the students were from high school located in towns, while 54 (10.8%) of the engineering students were from high schools located in villages. This finding is really a true reflection of the Cameroonian society, where there are more small towns and larger towns than the number of cities and also there are more schools in the towns and cities than in the villages.

Table 18

Years spent in Secondary School

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 7yrs	100	20.0	20.0	20.0
	7yrs	345	69.0	69.0	89.0
	8yrs	34	6.8	6.8	95.8
	Above 8yrs	21	4.2	4.2	100.0
	Total	500	100.0	100.0	

From the frequency table above, 100(20%) of the students did their secondary and high school studies for less than 7 years, while 345 (69%) of the engineering students did the regular 7 years for the secondary and high school, 34(6.8%) of the students did their secondary and high school studies for 8 years and 21 (4.2%) of the students did their high school studies for more than 8 years.

Table 19

Years spent out of High School before entering engineering school

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0yr	371	74.2	74.2	74.2
	1yr	125	25.0	25.0	99.2
	2yrs	1	.2	.2	99.4
	3yrs	3	.6	.6	100.0
	Total	500	100.0	100.0	

The frequency table above illustrates that most of the students 371 (74.2%) of them did not spent a year out of high school before getting admission into an engineering school, 125 (25%) of the students spent a year out of high school before getting admission into an engineering school, Just 1 (0.2) of the engineering students spent 2 years out of high school before getting admission into an engineering school and just 3 (0.6%) of the engineering students spent 3 years or more out of high school before getting admission into an engineering school.

Table 20

Another Engineering School

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	65	13.0	13.0	13.0
	No	435	87.0	87.0	100.0
	Total	500	100.0	100.0	

The frequency table above illustrates that 65 (13%) of the engineering students in the various engineering schools surveyed had been enrolled in another engineering school before enrolling into their present engineering school while 435(87%) of the engineering students had not been enrolled in any other engineering school before.This therefore means that 13% of the engineering students have already experienced university studies in the field of engineering before getting admission into their current engineering schools.

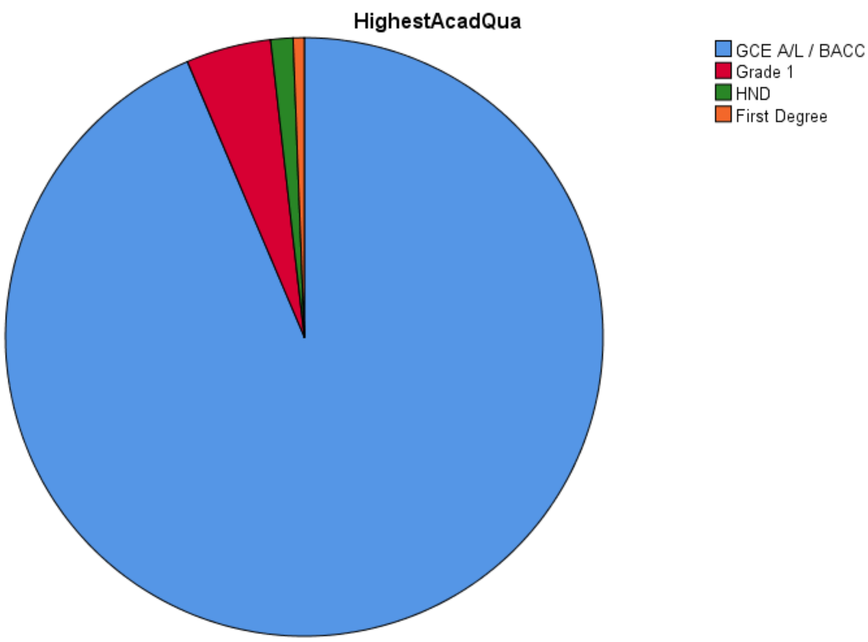
Table 21

Responses on Students' Academic Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	GCE A/L / BAC	468	93.6	93.6	93.6
	Grade 1	23	4.6	4.6	98.2
	HND	6	1.2	1.2	99.4
	First Degree	3	.6	.6	100.0
	Total	500	100.0	100.0	

Figure 8

Responses Illustrating the Highest Qualification Students Had Before Entering the Engineering School.



From the above frequency table, 468 (93.6%) of the engineering students had either GCE A/L or BAC before entering into the engineering school, 23(4.6%) of the engineering students had the grade one certificate as their highest academic qualification before coming into their various engineering schools, 6 (1.2) of the engineering students had an HND before getting into the engineering school and only 3(0.6%) of the students had a first degree before entering the engineering school. The pie chart above clearly shows us that a very great majority of the engineering students came into the engineering school with almost the same academic level that is the GCE A/L or the BAC.

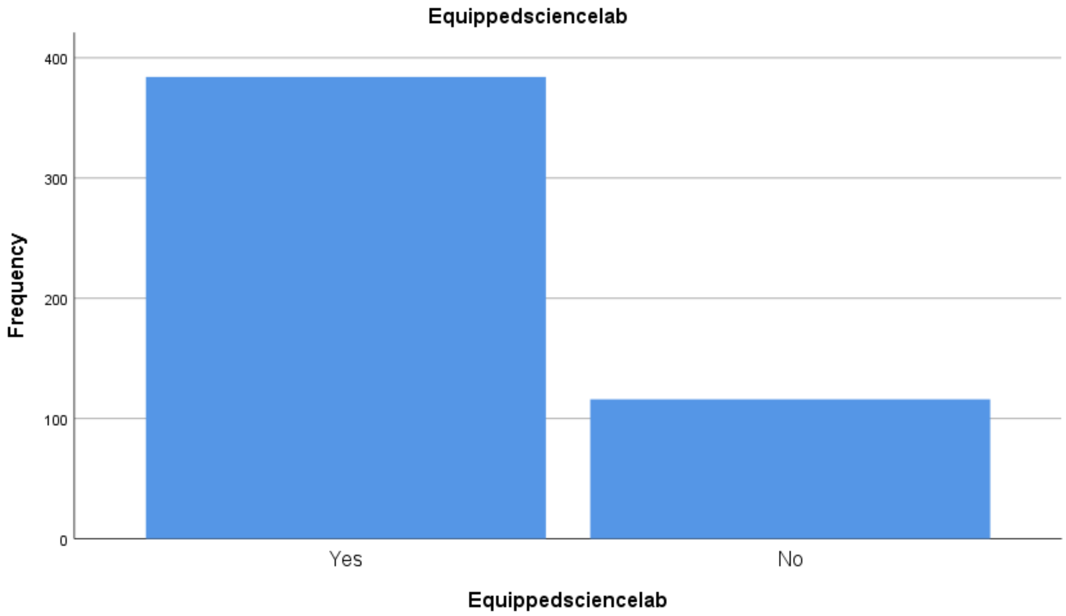
Table 22

Responses indicating if students' high school science labs were equipped or not

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	384	76.8	76.8	76.8
	No	116	23.2	23.2	100.0
	Total	500	100.0	100.0	

Figure 9

Illustration of Students' Opinion of Whether Their Science Labs in High School



The frequency table above illustrates that 384 (76.8%) of the engineering students affirmed that their science labs in high school were well equipped while 116 (23.2%) of the engineering students did not affirm to the fact that they had well equipped science labs. One can see from the bar chart above that a greater proportion of the students see their high school science labs as well equipped.

Table 23

Number of student per equipment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	238	47.6	47.6	47.6
	2	141	28.2	28.2	75.8
	3	40	8.0	8.0	83.8
	Above 3	81	16.2	16.2	100.0
	Total	500	100.0	100.0	

The frequency table above reveals that 238 (47.6%) of the students affirmed that in their high school one students was allocated to a practical equipment during practical sessions, while 141 (28.2%) of the students also affirmed that in their high schools 2 students were allocated to a practical equipment during practical sessions, 40 (8%), of the students on their own part agreed that a practical equipment in their own high schools were allocated to 3 students each and 81 (16.2%) of the engineering students revealed that above more than 3 students were allocated to a practical equipment.. This thus indicates that the allocation of practical equipment to each student is on an average level, since most of the schools could have well equipped laboratories but due to very large numbers of students especially in the big cities, it is obviously a difficult task to allocate a practical equipment to each student even when the are split up into various practical groups

Table 24

Illustrating if students were well groomed in practicals or not

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	430	86.0	86.0	86.0
	No	70	14.0	14.0	100.0
	Total	500	100.0	100.0	

From the frequency table above, 430 (86%) of the engineering students agreed that they were well groomed in practicals while 70 (14%) of the students refuted that they were well groomed in science practicals in high school.

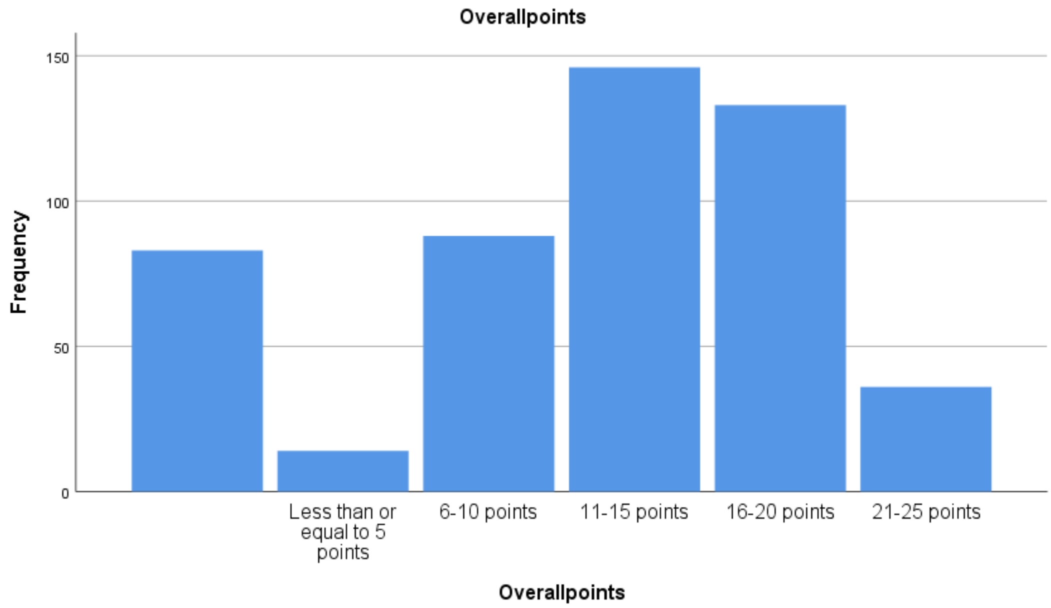
Table 25

Overallpoints

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		83	16.6	16.6	16.6
	Less than or equal to 5 points	14	2.8	2.8	19.4
	6-10 points	88	17.6	17.6	37.0
	11-15 points	146	29.2	29.2	66.2
	16-20 points	133	26.6	26.6	92.8
	21-25 points	36	7.2	7.2	100.0
	Total	500	100.0	100.0	

Figure 10

Illustration of Points Scored by Students



From the frequency table above, 14 (2.8%) of the students scored less than five points, 88(17.6%) of the engineering students scored less than ten points in the GCE A/L examinations, 146 (29.2%) of the engineering students scored between 11 to 15 points, 133 (26.6%) of the engineering students scored between 16 to 20 points in the GCE A/L examinations and 36 (7.2%) of the students scored between 21 to 25 points. From the above bar chart a majority of the students scored between 11 to 15 points and the least proportion of the students scored less than five points. This is therefore shows that most of the engineering students with GCE A/L background had relatively good points in the GCE A/L examination

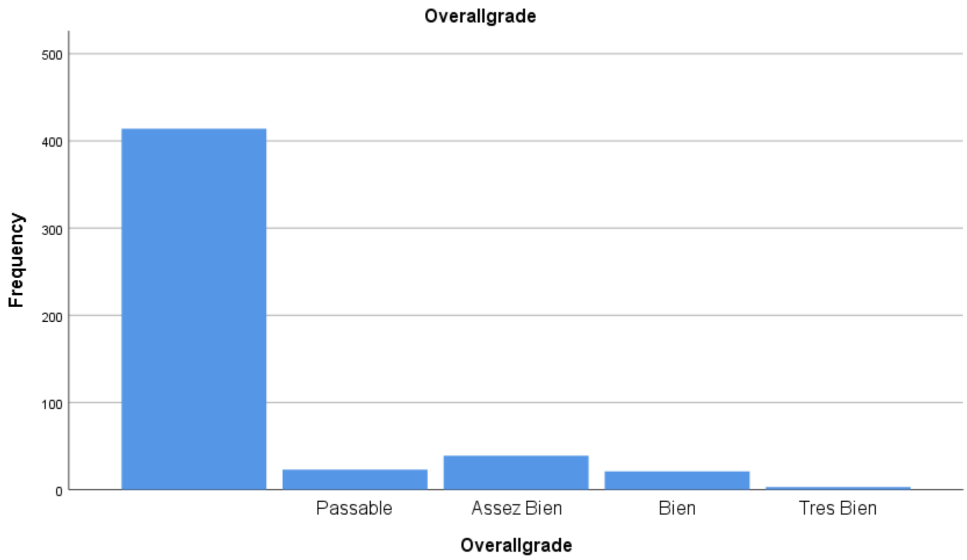
Table 26

Overall grade

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		414	82.8	82.8	82.8
	Passable	23	4.6	4.6	87.4
	Assez Bien	39	7.8	7.8	95.2
	Bien	21	4.2	4.2	99.4
	Tres Bien	3	.6	.6	100.0
	Total	500	100.0	100.0	

Figure 11

Illustration of the overall grades students scored at the BAC examinations



The frequency table above reveals that 23 (4.6%) of the en gineering students had a pass grade in the BACalaureat examinations, 39 (7.8%) of the students scored the grade ‘’ Assez-Bien’’ in their BAC examinations, 21 (4.2%) of the students scored the grade of ‘’Bien’’ in the BAC examinations, 3 (0.6%) of the students had the grade of ‘’Tres Bien’’. Like the GCE overall points evaluated above, a majority of the students did not have the minimum pass which is the grade called ‘’passable’’ but rather a majority of the students had the grade of ‘’Assez-Bien’’.

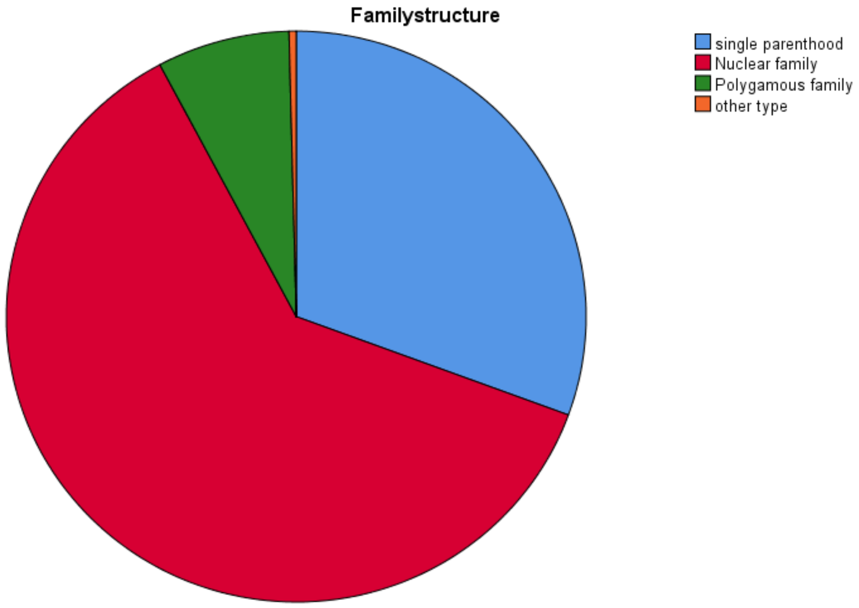
Table 2

Family structure of Engineering students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	single parenthood	153	30.6	30.6	30.6
	Nuclear family	308	61.6	61.6	92.2
	Polygamous family	37	7.4	7.4	99.6
	other type	2	.4	.4	100.0
	Total	500	100.0	100.0	

Figure 12

Illustration of Family Structure of Students



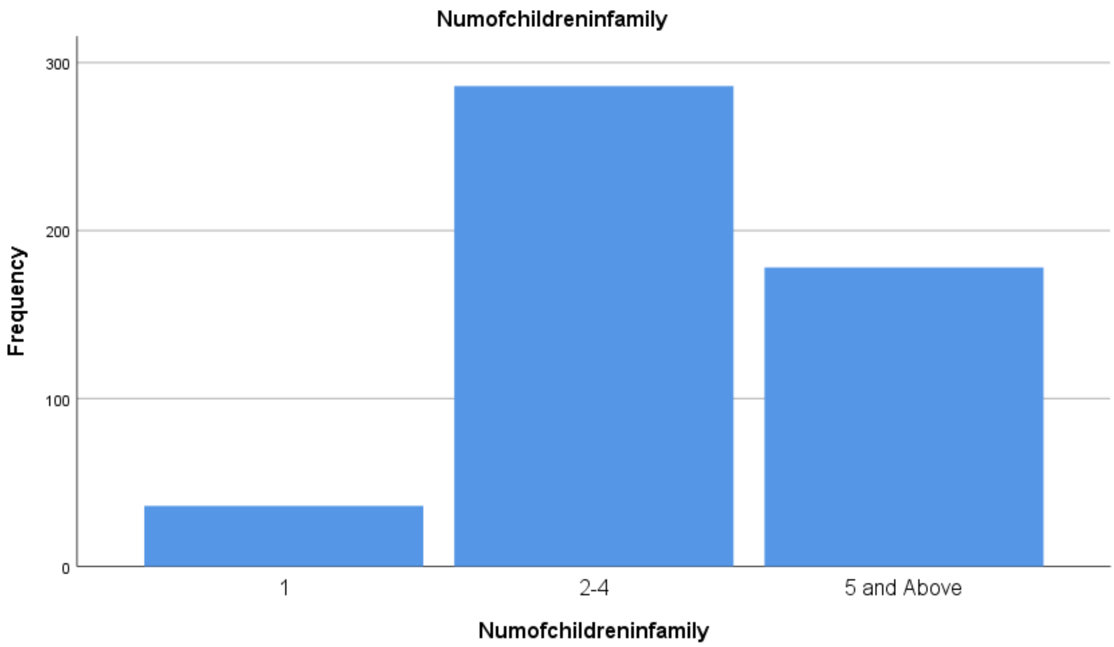
From the frequency table above, it is revealed that 153 (30.6%) of the students were from single parents, while 308 (61.6%) of the engineering students were from nuclear families, also, 37 (7.4%) of the students were from polygamous homes and 2 (0.4%) of the students claimed they came from homes of different types of marriages. Since a majority of the students were from a nuclear family, it therefore means that most of the student came from homes which could be relatively stable psychologically which could in one way or the other also aid supporting the students in achieving their academic goals.

Table 28

Number of Children per Family of the Students

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	36	7.2	7.2	7.2
	2-4	286	57.2	57.2	64.4
	5 and Above	178	35.6	35.6	100.0
	Total	500	100.0	100.0	

Fig 13: Illustration of the Number of Children per Family Of Students



The frequency table above reveals that 36 (7.2%) of the engineering students are from families where they are lone children, 287 (57.2%) of the students came from families where there are between 2 to 4 children, and 178 (35.6%) of the engineering students affirmed that they are from families with more than 5 children. The bar chart above clearly illustrates that the greatest proportion of the engineering students were from families with between 2 to 4 children.

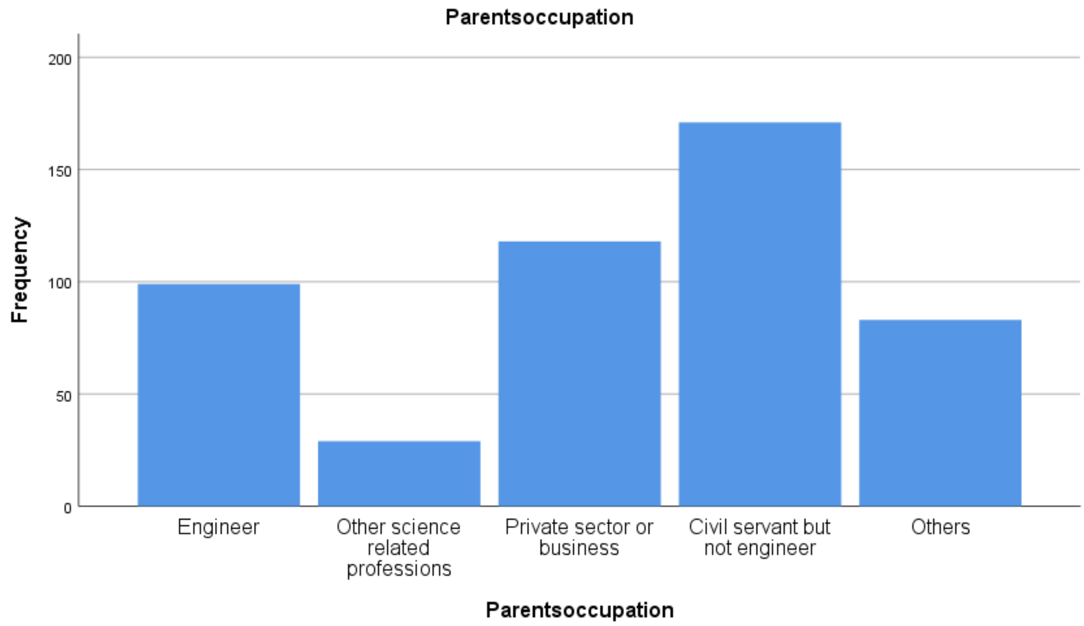
Table 29

Occupation of students' parents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Engineer	99	19.8	19.8	19.8
	Other science related professions	29	5.8	5.8	25.6
	Private sector or business	118	23.6	23.6	49.2
	Civil servant but not engineer	171	34.2	34.2	83.4
	Others	83	16.6	16.6	100.0
	Total	500	100.0	100.0	

Fig 14

Parents Occupation



From the frequency table and bar chart above, 99 (19.8%) of the students affirmed that they had at least one parent who is an engineer, in line with this, 29(5.8%) of the engineering students also confirmed that at least one of their parents were into other science related professions.118 (23.6%) of the students also confirmed that they had at least a parent who does business or, works in the private sector, 131 (34.2%) of the engineering students also affirmed that they had at least a parent who is a civil servant but not an engineer and 83(16.6%) of the students also affirmed that they have parents of other occupations.

Independent Variables

GCE A/L Results in Sciences

Table 30

GCE A/L results in Sciences

		PHYSICSGRADE	CHEMGRADE	MATHGRADE	FMATHGRADE	GEOLGRADE	ICTGRADE	COMPSCGRADE
N	Valid	360	404	367	276	65	28	42
	Missing	140	96	133	224	435	472	458
Mean		3.0361	2.9950	3.5014	2.4167	3.9538	3.7143	2.7381
Median		3.0000	3.0000	4.0000	2.5000	4.0000	4.0000	3.0000
Mode		3.00	3.00	5.00	.00	4.00	3.00[a]	3.00
Std. Deviation		1.25843	.97613	1.50205	1.68532	.79904	.71270	1.06059
Variance		1.584	.953	2.256	2.840	.638	.508	1.125

a. Multiple modes exist. The smallest value is shown

From table of GCE A/L results in sciences above, 360 of the students surveyed had a grade in A/L Physics. The mean score on a scale of 5 was 3.04, the median score was 3.0, and the modal score was 3.0. The standard deviation of the Physics scores was 1.25 and the variance was 1.58. 404 of the students surveyed had a grade in A/L Chemistry. The mean score on a scale of 5 was 2.99, the median score was 3.0, and the modal score was 3.0. The standard deviation of the Chemistry scores was 0.98 and the variance was 0.95. 367of the students surveyed had a grade in A/L Mathematics. The mean score on a scale of 5 was 3.50, the median score was 4.0 and the modal score was 5.0 The standard deviation of the Mathematics scores was 1.5 and the variance was 2.27. 276of the students surveyed had a grade in A/L Further Mathematics. The mean score on a scale of 5 was 2.42the median score was 2.5and the modal score was 0.0. The standard deviation of the Further Mathematics scores was 1.68and the variance was 2.84. 65of the students surveyed studied A/L Geology. The mean score on a scale of 5 was 3.95, the median score was 4.0, and the modal score was 4.0. The standard deviation of the Geology scores was 0.79 and the variance was 0.64. Also, 28 of the students surveyed did ICT at A/L. The mean score on a scale of 5 was 3.71, the median score was 4.0 and the modal score was 3.0 The standard deviation of the Physics scores was 0.71 and the variance was 0.51. Furthermore, 42 of the students surveyed had offered Computer Science at A/L. The mean score on a scale of 5 was 2.74 the median score was 3.0, and the modal score was 3.0. The standard deviation of the Physics scores was 1.1 and the variance was 1.13.

Below is a detail analysis of the grades scored in each of the science subjects under consideration at the GCE A/L

Table 31

Grades Scored in Physics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	17	3.4	4.7	4.7
	E	29	5.8	8.1	12.8
	D	55	11.0	15.3	28.1
	C	116	23.2	32.2	60.3
	B	109	21.8	30.3	90.6
	A	34	6.8	9.4	100.0
	Total	360	72.0	100.0	
Missing	System	140	28.0		
Total		500	100.0		

From the frequency table above, 17 (4.7%) of the engineering students who did A/L Physics scored a fail grade in the GCE examination, 29 (8.1%) of the engineering students scored an ‘E’ grade in Physics at A/L while 55 (15.3%) of the students scored a ‘D’ grade, 116 (32.2%) of them scored a ‘C’ grade, 109 (30.3%) of them scored the ‘B’ grade and 34 (6.8%) of the engineering students scored an ‘A’ grade in GCE A/L Physics. From the analysis above, a majority of the students scored, that is more than 60% of them scored the ‘C’ and ‘B’ grades in A/L Physics, and just a very small proportion of them scored the minimum pass grade which is the ‘E’ grade, which simply implies that a great majority of the engineering students in Cameroon scored a relatively good grade in Physics at A/L. Moreover 4.7% of th students though studying engineering never had a pass in GCE A/L Physics

Table 32
Grades Scored in Chemistry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	4	.8	1.0	1.0
	E	19	3.8	4.7	5.7
	D	96	19.2	23.8	29.5
	C	157	31.4	38.9	68.3
	B	112	22.4	27.7	96.0
	A	16	3.2	4.0	100.0
	Total	404	80.8	100.0	
Missing	System	96	19.2		
Total		500	100.0		

The frequency table above reveals that 4 (1.0%) of the engineering students did not have a pass in GCE A/L Chemistry, 19(4.7%) of the students scored an ‘E’ grade, 96 (23.8%) of the students scored a ‘D’ grade, 157 (38.9%) of the students scored a ‘C’ grade, 112(27.7%) of the students scored a ‘B’ grade and 16(4.0%) of the engineering students scored an ‘A’ Grade in Chemistry.

The results like that of Physics also revealed that morethan 60% of the respondents had a grade which was equal to or more than a ‘C’ grade.

Table 33
Grades Scored in Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	13	2.6	3.5	3.5
	E	41	8.2	11.2	14.7
	D	28	5.6	7.6	22.3
	C	90	18.0	24.5	46.9
	B	57	11.4	15.5	62.4
	A	138	27.6	37.6	100.0
	Total	367	73.4	100.0	
Missing	System	133	26.6		
Total		500	100.0		

From the table above 13 (3.5%) of the engineering students had a fail grade in Mathematics, 41 (11.2%) of the engineering students scored the minimum pass grade which is the ‘E’ grade in Mathematics, 28(7.6%) of the engineering students scored the

'D' grade, 90 (24.5%) of the students scored a 'C' grade, 57 (15.5%) of the engineering students scored a 'B' grade and 138 (37.6%) of the students scored an A grade. This clearly shows that more than 75% of the students scored at least a 'C' grade in A/L Mathematics. This also implies that most of the engineering students are well grounded in Mathematics.

Table 34

Grades Scored in Further Mathematics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	60	12.0	21.7	21.7
	E	23	4.6	8.3	30.1
	D	55	11.0	19.9	50.0
	C	52	10.4	18.8	68.8
	B	52	10.4	18.8	87.7
	A	34	6.8	12.3	100.0
	Total	276	55.2	100.0	
Missing	System	224	44.8		
Total		500	100.0		

From the table above, it is revealed that 60 (21.7%) of the engineering students did not pass Further Maths at the A/L, 23 (8.3%) of them scored the 'E' grade, 55 (19.9%) of them scored a 'D' grade, 52 (18.8%) of the engineering students scored a 'C' grade, 52 (18.8%) of them also scored a 'B' grade and 34 (12.3%) of the engineering students scored an 'A' grade. This further reveals that a large number of the engineering students did not pass Further Maths in the GCE A/L examinations

Table 35

Grades Scored in Computer Science

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	E	6	1.2	14.3	14.3
	D	10	2.0	23.8	38.1
	C	17	3.4	40.5	78.6
	B	7	1.4	16.7	95.2
	A	2	.4	4.8	100.0
	Total	42	8.4	100.0	
Missing	System	458	91.6		
Total		500	100.0		

From the frequency table above, 42 of the engineering students surveyed in this study did and wrote computer science in the GCE A/L and all of them had a pass grade. From among those who passed, 6 (14.3%) had an ‘E’ grade, 10(23.8%) of them had a ‘D’ grade, 17 (40.5%) of them had a ‘C’ grade, 7 (16.7%) of them had a ‘B’ grade and 2 (4.8%) of them had an ‘A’ grade. One can clearly see that though all the students in this study who did computer science at the A/L had a pass grade, most of them did not have the top grades, but rather more than 60% of them did not have more than the ‘C’ grade.

Table 36

Grades Scored in Geology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	D	4	.8	6.2	6.2
	C	10	2.0	15.4	21.5
	B	36	7.2	55.4	76.9
	A	15	3.0	23.1	100.0
	Total	65	13.0	100.0	
Missing	System	435	87.0		
Total		500	100.0		

The frequency table above reveals that 65 of the engineering students offered Geology at the GCE A/L. All the 65 students surveyed in this study had a pass grade in Geology with the ‘D’ grade being the minimum pass grade. 4 (6.2%) of the students had a ‘D’ grade, 10 (15.4%) of the students had a ‘C’ grade, 36 (55.4%) of the students had a ‘B’ grade and 15 (23.1%) of the students had an ‘A’ grade. From the analysis, more than 75% of the students scored at least a ‘B’ grade. This thus indicates that most of the students who do A/L Geology score top grades, and this further implies that the discrimination of the performance in GCE A/L Geology could be relatively low, compared to other science subjects.

Table 37

Grades Scored in ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	C	12	2.4	42.9	42.9
	B	12	2.4	42.9	85.7
	A	4	.8	14.3	100.0
	Total	28	5.6	100.0	
Missing	System	472	94.4		
Total		500	100.0		

From the frequency table above, 28 of the engineering students did ICT at the GCE A/L. All the 28 of them in this study had a pass grade, with the minimum pass grade scored being the ‘C’ grade. 12 (42.9%) of them scored a ‘C’ grade, 12 (42.9%) of them scored a ‘B’ grade and 4 (14.3%) of them scored an ‘A’ grade. From the analysis above, with all the students having at least a ‘C’ grade, indicates that students to a great extent most often score top grades in ICT, and this further reveals that may be to an extent ICT does not have a very high difficulty index compared to most other science subjects and the discrimination index of the subject could also be relatively low compared to that of most science subjects at the GCE A/L.

Table 38

Results in BAC ‘C’

		PHYBC	CHIMBC	MATHBC	INFOBC	SVTBC	CHIMTP	INFOTPBC	SVTTPBC
N	Valid	69	69	69	64	62	34	40	21
	Missing	431	431	431	436	438	466	460	479
Mean		2.6667	3.0580	2.7246	2.7656	2.6935	2.9412	3.1750	3.0000
Median		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000	3.0000
Mode		4.00	4.00	1.00	4.00	4.00	3.00	4.00	3.00
Std. Deviation		1.36841	.98345	1.47413	1.36559	1.37410	1.07142	1.10680	1.09545
Variance		1.873	.967	2.173	1.865	1.888	1.148	1.225	1.200

From the table of statistics above, 69 of the engineering students did Physique in BAC ‘C’ with a mean score of 2.67, a median score of 3.0 and with a modal score 0f 4.0 on a scale of 5. The standard deviation of the physique scores was 1.37 with a variance of 1.87. For 69 of the students who also did chimie, the mean score was 3.06, with a median score of 3.0 and with a modal score 0f 4.0. The standard deviation for the chimie scores was 0.98with a variance of 0.97. 69 of the engineering students did Mathematique in BAC ‘C’ with a mean score of 2.72, a median score of 3.0 and with a modal score 0f 1.0 on a scale of 5. The standard deviation of the Mathematique scores was 1.47 with a variance of 2.17. 64 of the engineering students did Informatique in BAC ‘C’ with a mean score of 2.76 a median score of 3.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the informatique scores was 1.37 with a variance of 1.87. 62 of the engineering students did SVT in BAC ‘C’ with a mean score of 2.69, a median score of 3.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the SVT scores was 1.37 with a variance of 1.88. 34 of the engineering students did Chimie TP in BAC ‘C’ with a mean score of 2.94, a median score of 3.0 and with a modal score of 3.0 on a scale of 5. The standard deviation of the chimie TP scores was 1.1 with a variance of 1.15. 40 of the engineering students did

Informatique TP in BAC ‘C’ with a mean score of 3.2, a median score of 3.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the informatique TP scores was 1.11 with a variance of 1.13. 21 of the engineering students did SVT TP in BAC ‘C’ with a mean score of 3.0, a median score of 3.0 and with a modal score of 3.0 on a scale of 5. The standard deviation of the SVT TP scores was 1.1 with a variance of 1.2.

Table 39:

Grades Scored in Physique BAC ‘C’

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	4	.8	5.8	5.8
	P	12	2.4	17.4	23.2
	AB	15	3.0	21.7	44.9
	B	14	2.8	20.3	65.2
	TB	20	4.0	29.0	94.2
	E	4	.8	5.8	100.0
	Total	69	13.8	100.0	
Missing	System	431	86.2		
Total		500	100.0		

The frequency table above reveals that 4 (5.8%) of the students who offered BAC ‘C’ in high school did not have a pass grade in Physique in the BAC examination. 12 (17.4%) of the students passed with the grade ‘passable’, 15 (21.7%) of them passed with the grade ‘Assez Bien’, 14 (20.3% of them passed with the grade ‘Bien’, 20 (29.0%) of the students passed with the grade ‘Tres Bien and 4 (5.8%) of them passed physique in the BAC ‘C’ examination with the grade of ‘Excellent.

Table 40

Grades scored in Chimie BAC ‘C’

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	6	1.2	8.7	8.7
	AB	12	2.4	17.4	26.1
	B	24	4.8	34.8	60.9
	TB	26	5.2	37.7	98.6
	E	1	.2	1.4	100.0
	Total	69	13.8	100.0	
Missing	System	431	86.2		
Total		500	100.0		

The frequency table above reveals that 6 (8.7%) of the students passed chimie with the grade ‘passable’, 12 (17.4%) of them passed with the grade ‘Assez Bien’, 24 (34.8%) of them passed with the grade ‘Bien’, 26 (37.7%) of the students passed with the grade ‘Tres Bien and 1 (1.4%) of them passed chimie in the BAC ‘C’ examination with the grade of ‘Excellent

Table 41

Grades Scored in Mathematiques BAC ‘C’

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	1	.2	1.4	1.4
	P	21	4.2	30.4	31.9
	AB	8	1.6	11.6	43.5
	B	14	2.8	20.3	63.8
	TB	16	3.2	23.2	87.0
	E	9	1.8	13.0	100.0
	Total	69	13.8	100.0	
Missing	System	431	86.2		
Total		500	100.0		

The frequency table above reveals that 1 (1.4%) of the students who offered BAC ‘C’ in high school did not have a pass grade in Mathematique in the BAC examination. 21 (30.4%) of the students passed with the grade ‘passable’, 8 (11.6%) of them passed with the grade ‘Assez Bien’, 14 (20.3%) of them passed with the grade ‘Bien’, 16 (23.2%) of the students passed with the grade ‘Tres Bien and 9 (13.0%) of them passed Mathematique in the BAC ‘C’ examination with the grade of ‘Excellent.

Table 42

Grades Scored in Informatique BAC ‘C’

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	17	3.4	26.6	26.6
	AB	12	2.4	18.8	45.3
	B	9	1.8	14.1	59.4
	TB	21	4.2	32.8	92.2
	E	5	1.0	7.8	100.0
	Total	64	12.8	100.0	
Missing	System	436	87.2		
Total		500	100.0		

The frequency table above reveals that 17 (26.6%) of the students passed in Informatique with the grade ‘passable’, 12 (18.8%) of them passed with the grade

'Assez Bien', 9(14.1%) of them passed with the grade 'Bien', 21 (32.8%) of the students passed with the grade 'Tres Bien and 5(7.8%) of them passed Informatique in the BAC 'C' examination with the grade of 'Excellent

Table 43

Grades Scored in SVT BAC 'C'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	4	.8	6.5	6.5
	P	9	1.8	14.5	21.0
	AB	16	3.2	25.8	46.8
	B	9	1.8	14.5	61.3
	TB	21	4.2	33.9	95.2
	E	3	.6	4.8	100.0
	Total	62	12.4	100.0	
Missing	System	438	87.6		
Total		500	100.0		

The frequency table above reveals that 4 (6.5%) of the students who offered BAC 'C' in high school did not have a pass grade in SVT in the BAC examination. 9(14.5%) of the students passed with the grade 'passable', 16 (25.8%) of them passed with the grade 'Assez Bien', 9 (14.5%) of them passed with the grade 'Bien', 21 (33.9%) of the students passed with the grade 'Tres Bien and 3 (4.8%) of them passed in SVT in the BAC 'C' examination with the grade of 'Excellent

Table 44

Grades Scored in Chimie TP BAC 'C'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	6	1.2	17.6	17.6
	AB	2	.4	5.9	23.5
	B	14	2.8	41.2	64.7
	TB	12	2.4	35.3	100.0
	Total	34	6.8	100.0	
Missing	System	466	93.2		
Total		500	100.0		

The frequency table above reveals that 6 (17.6%) of the students passed in Chimie TP with the grade 'passable', 2 (5.9%) of them passed with the grade 'Assez Bien', 14 (41.2%) of them passed with the grade 'Bien', 12 (35.3%) of the students passed with the grade 'Tres Bien.

Table 45

Grades Scored in Informatique

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	5	1.0	12.5	12.5
	AB	4	.8	10.0	22.5
	B	12	2.4	30.0	52.5
	TB	17	3.4	42.5	95.0
	E	2	.4	5.0	100.0
	Total	40	8.0	100.0	
Missing	System	460	92.0		
Total		500	100.0		

The frequency table above reveals that. 5 (12.5%) of the students passed in Informatique TP with the grade 'passable', 4 (10.0%) of them passed with the grade 'Assez Bien', 12 (30.0%) of them passed with the grade 'Bien', 17(42.5%) of the students passed with the grade 'Tres Bien and 2 (5.0%) of them passed Informatique TP in the BAC 'C' examination with the grade of 'Excellent'

Table 46

Grades Scored in SVT TP BAC 'C'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	1	.2	4.8	4.8
	AB	6	1.2	28.6	33.3
	B	9	1.8	42.9	76.2
	TB	2	.4	9.5	85.7
	E	3	.6	14.3	100.0
	Total	21	4.2	100.0	
Missing	System	479	95.8		
Total		500	100.0		

The frequency table above reveals that 1 (4.8%) of the students passed in SVT TP with the grade 'passable', 6(28.6%) of them passed with the grade 'Assez Bien', 9(42.9%) of them passed with the grade 'Bien', 2 (9.5%) of the students passed with the grade 'Tres

Bien and 3(14.3%) of them passed SVT TP in the BAC ‘C’ examination with the grade of ‘Excellent.

Table 47

Results in BAC ‘D’

		PHYBD	CHIM BD	MATH BD	INFO BD	SVTBD	CHIMTP BD	INFOTP BD	SVTTP BD
N	Valid	22	22	22	22	22	8	10	4
	Missing	478	478	478	478	478	492	490	496
Mean		1.6364		2.0909	2.8636	2.9091	3.0000	3.4000	3.0000
Median		1.0000	1.5000	2.0000	3.0000	3.0000	3.0000	4.0000	3.0000
Mode		.00	1.00	1.00[a]	3.00	3.00	3.00	4.00	2.00[a]
Std. Deviation		1.61968	1.47783	1.47710	.77432	1.71573	.75593	.84327	1.15470
Variance		2.623	2.184	2.182	.600	2.944	.571	.711	1.333

a. Multiple modes exist. The smallest value is shown

From the table of statistics above, 22 of the engineering students did Physique in BAC ‘D’ with a mean score of 1.63, a median score of 1.0 and with a modal score 0f 0.0 on a scale of 5. The standard deviation of the physique scores was 1.61 with a variance of 2.62. For 22 of the students who also did chimie, the mean score was 1.77, with a median score of 1.5 and with a modal score of 1.0. The standard deviation for the chimie scores was 1.47 with a variance of 2.18. 22of the engineering students did Mathematique in BAC ‘D’ with a mean score of 2.09, a median score of 2.0 and with a modal score 0f 1.0 on a scale of 5. The standard deviation of the Mathematique scores was 1.47 with a variance of 2.18. Also, 22 of the engineering students did Informatique in BAC ‘D’ with a mean score of 2.86 a median score of 3.0 and with a modal score of 3.0 on a scale of 5. The standard deviation of the informatique scores was0.77 with a variance of 0.6. Moreover, 22 of the engineering students did SVT in BAC ‘D’ with a mean score of 2.91, a median score of 3.0 and with a modal score of 3.0 on a scale of 5. The standard deviation of the SVT scores was 1.72 with a variance of 2.94. Furthermore, 34 of the engineering students did Chimie TP in BAC ‘D’ with a mean score of 3.0, a median score of 3.0 and with a modal score of 3.0 on a scale of 5. The standard deviation of the chimie TP scores was 0.75 with a variance of 0.57. 10 of the engineering students did Informatique TP in BAC 'D' with a mean score of 3.4, a median score of 4.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the informatique TP scores was 0.84 with a variance of 0.71. 4 of the engineering students did SVT TP in BAC 'D' with a mean score of 3.0, a median score of 3.0 and with a modal score of 32.0 on a scale of 5. The standard deviation of the SVT TP scores was 1.15 with a variance of 1.33.

Table 48

Grades Scored in Physique BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	8	1.6	36.4	36.4
	P	4	.8	18.2	54.5
	AB	3	.6	13.6	68.2
	B	2	.4	9.1	77.3
	TB	5	1.0	22.7	100.0
	Total	22	4.4	100.0	
Missing	System	478	95.6		
Total		500	100.0		

The frequency table above reveals that 8 (36.4%) of the students who offered BAC 'D' in high school did not have a pass grade in Physique in the BAC examinations. 4 (18.2%) of the students passed with the grade 'passable', 3 (13.6%) of them passed with the grade 'Assez Bien', 2 (9.1%) of them passed with the grade 'Bien', 5 (22.7%) of the students passed with the grade 'Tres Bien.

Table 49:

Grades Scored in Chimie BAC 'D'

Valid	F	5	1.0	22
	P	6	1.2	27
	AB	5	1.0	22
	B	1	.2	4
	TB	5	1.0	22
	Total	22	4.4	100
Missing	System	478	95.6	
Total		500	100.0	

The frequency table above reveals that 5(22.7%) of the students who offered BAC 'D' in high school did not have a pass grade in Physique in the BAC examination. 6 (27.3%) of the students passed with the grade 'passable', 5 (22.7%) of them passed with the grade 'Assez Bien', 1(4.5%) of them passed with the grade 'Bien', 5(22.7%) of the students passed with the grade 'Tres Bien:

Table 50

Grades Scored in Mathematiques BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	4	.8	18.2	18.2
	P	5	1.0	22.7	40.9
	AB	3	.6	13.6	54.5
	B	5	1.0	22.7	77.3
	TB	5	1.0	22.7	100.0
	Total	22	4.4	100.0	
Missing	System	478	95.6		
Total		500	100.0		

The frequency table above reveals that 4 (18.2%) of the students who offered BAC 'D' in high school did not have a pass grade in Physique in the BAC examination. 5 (22.7%) of the students passed with the grade 'passable'. Also, 3 (13.6%) of them passed with the grade 'Assez Bien', 5 (22.7%) of them passed with the grade 'Bien' and 5 (22.7%) of the students passed with the grade 'Tres Bien.

Table 51

Grades Scored in Informatique BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	2	.4	9.1	9.1
	AB	2	.4	9.1	18.2
	B	15	3.0	68.2	86.4
	TB	3	.6	13.6	100.0
	Total	22	4.4	100.0	
Missing	System	478	95.6		
Total		500	100.0		

From the frequency table above, 2(9.1%) of the students passed Informatique in the BAC 'D' series with the grade 'passable', 2 (9.1%) of them passed with the grade

'Assez Bien', 15 (68.2%) of them passed with the grade 'Bien', 3 (13.6%) of the students passed with the grade 'Tres Bien.

Table 52

Grades Scored in SVT BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	2	.4	9.1	9.1
	P	5	1.0	22.7	31.8
	B	6	1.2	27.3	59.1
	TB	4	.8	18.2	77.3
	E	5	1.0	22.7	100.0
	Total	22	4.4	100.0	
Missing	System	478	95.6		
Total		500	100.0		

The frequency table above reveals that 2 (9.1%) of the students who did BAC 'D' in high school did not have a pass grade in Physique. 5(22.7%) of the students passed with the grade 'passable', 6 (27.3%) of them passed with the grade 'Assez Bien', 6(27.3%) of them passed with the grade 'Bien' and 4 (18.2%) of the students passed with the grade 'Tres Bien and 4 (5.8%).

Table 53

Grades Scored in Chimie TP BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AB	2	.4	25.0	25.0
	B	4	.8	50.0	75.0
	TB	2	.4	25.0	100.0
	Total	8	1.6	100.0	
Missing	System	492	98.4		
Total		500	100.0		

The frequency table above reveals that from among the 8 students who took Chimie TP in the BAC 'D' examinations,.2 (25.0%) of the students scored the grade 15 (21.7%) 'Assez Bien', 4 (50.0%) of them scored the grade 'Bien', and 2(25.0%) of the students passed with the grade 'Tres Bien.

Table 54

Grades Scored in Informatique BACC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AB	2	.4	20.0	20.0
	B	2	.4	20.0	40.0
	TB	6	1.2	60.0	100.0
	Total	10	2.0	100.0	
Missing	System	490	98.0		
Total		500	100.0		

The frequency table above reveals 2(20.0%) of the engineering students who offered SVT TP in high school scored the grade 'Assez Bien', 2(20.0%) of them passed with the grade 'Bien' and 6 (60.0%) of the students passed with the grade 'Tres Bien.

Table 55

Grades Scored in SVT TP BAC 'D'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	AB	2	.4	50.0	50.0
	TB	2	.4	50.0	100.0
	Total	4	.8	100.0	
Missing	System	496	99.2		
Total		500	100.0		

From the frequency table above, 2(50%) of the engineering students who offered SVT TP as an option in the in the BAC 'D' series scored the grade 'Assez Bien', and 2 (50%) of the students scored the grade 'Bien'.

Table 56

Results in BAC 'E'

		PHYBE	CHIMBE	MATHBE	INFOBE	SVTBE	CHIMTPBE	INFOTPBE	SVTTPE
N	Valid	0	0	0	0	0	0	0	0
	Missing	500	500	500	500	500	500	500	500

The frequency table above reveals that none of the engineering students surveyed in this study did BAC 'E'.

Table 57

Results in BAC 'IT'

		PHYBIT	CHIMBIT	MATHBIT	INFOBIT	CHIMTPBIT	INFOTPBIT
N	Valid	5	5	5	5	5	5
	Missing	495	495	495	495	495	495
Mean		1.6000	2.0000	1.8000	3.8000	2.4000	3.0000
Median		1.0000	2.0000	2.0000	4.0000	2.0000	4.0000
Mode		1.00[a]	2.00	.00	4.00[a]	2.00	4.00
Std. Deviation		1.34164	.70711	1.78885	1.64317	1.14018	1.41421
Variance		1.800	.500	3.200	2.700	1.300	2.000

a. Multiple modes exist. The smallest value is shown

From the table of statistics above, 5 of the engineering students did Physique in BAC 'IT' with a mean score of 1.60, a median score of 1.0 and with a modal score of 1.0 on a scale of 5. The standard deviation of the physique scores was 1.34 with a variance of 1.80. For 5 of the students who also did chimie, the mean score was 2.0, with a median score of 2.0 and with a modal score of 2.0. The standard deviation for the chimie scores was 0.71 with a variance of 0.5. Also, 5 of the engineering students did Mathematique in BAC 'IT' with a mean score of 1.8, a median score of 2.0 and with a modal score 0f 0.0 on a scale of 5. The standard deviation of the Mathematique scores was 1.79 with a variance of 3.2. Moreover, 5 of the engineering students also did Informatique in BAC 'IT' with a mean score of 3.8 a median score of 4.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the informatique scores was 1.64 with a variance of 2.7. Furthermore, 5 of the engineering students who did Chimie TP in BAC 'IT' had a mean score of 2.4, a median score of 2.0 and with a modal score of 2.0 on a scale of 5. The standard deviation of the chimie TP scores was 1.14 with a variance of 1.3. Also, 5 of the engineering students who Informatique TP in BAC 'IT' had a mean score of 3.0, a median score of 4.0 and with a modal score of 4.0 on a scale of 5. The standard deviation of the informatique TP scores was 1.41 with a variance of 2.0.

Table 58

Grades Scored in Physique BACC 'IT'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	1	.2	20.0	20.0
	P	2	.4	40.0	60.0
	B	2	.4	40.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 1(20%) of the students who offered BAC 'IT' in high school did not have a pass grade in Physique in the BAC examination. 2 (40.0%) of the students passed with the grade 'passable' and 2 (40.0%) of them passed with the grade 'Bien':

Table 59

Grades Scored in Chimie BAC 'IT'

CHIMBIT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	1	.2	20.0	20.0
	AB	3	.6	60.0	80.0
	B	1	.2	20.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 1(20.0%) of the students who offered BAC 'IT' in high school had the grade 'passable', 3 (60%) of them passed with the grade 'Assez Bien' and 1(20%) of them passed with the grade 'Bien'.

Table 60

Grades Scored in Mathematiques BAC 'IT'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	F	2	.4	40.0	40.0
	AB	1	.2	20.0	60.0
	B	1	.2	20.0	80.0
	TB	1	.2	20.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 2(40.0%) of the students who offered BAC 'IT' in high school did not pass Mathematique in the BAC examinations. 1 (20.0%) of the students passed with the grade 'Assez Bien', 1(20.0%) of them passed with the grade 'Bien' and 1(20.0%) of the students passed with the grade 'Tres Bien'.

Table 61

Grades Scored in Informatique BAC 'IT'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	1	.2	20.0	20.0
	TB	2	.4	40.0	60.0
	E	2	.4	40.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 1(20.0%) of the students who offered BAC 'IT' in high school passed Informatique with the grade 'passable', 2 (40.0%) of the engineering students passed with the grade ' Tres Bien', and 2(40.0%) of the students passed with the grade 'Excellent'.

Table 62: Grades Scored in Chimie TP BAC 'IT'

CHIMTPBIT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	1	.2	20.0	20.0
	AB	2	.4	40.0	60.0
	B	1	.2	20.0	80.0
	TB	1	.2	20.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 1(20.0%) of the students who offered BAC 'IT' in high school passe Chimie TP in the BAC examination with the grade 'passable', 2 (40.0%) of them passed with the grade 'Assez Bien', 1(20.0%) of them passed with the grade 'Bien', and 1(20.0%) of the students passed with the grade 'Tres Bien.

Table 63

Grades Scored in Informatique TP BACC 'IT'

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	P	1	.2	20.0	20.0
	AB	1	.2	20.0	40.0
	TB	3	.6	60.0	100.0
	Total	5	1.0	100.0	
Missing	System	495	99.0		
Total		500	100.0		

The frequency table above reveals that 1(20.0%) who offered BAC 'IT' in high school passed Informatique TP with the grade 'passable', 1 (20.0%) of them passed with the grade 'Assez Bien', 3(60.0%) of them passed with the grade 'Tres Bien.

Students' Motivation for Engineering Studies

Table 64:

Motivation for Engineering Studies

S/ N	ITEM	SD		SWD			TOT	SWA			SA		TOT	X	S.DEV
		1	2	3	4	5		6	7	8	9	10			
1	I had always dreamt of becoming an engineer	54 (10.8)	4 (0.8)	22 (4.4)	19 (3.8)	121 (24.2)	220	4.6 (9.2)	64 (12.8)	38 (7.6)	19 (3.8)	113 (22.6)	280	6.28	2.82
2	I had always wished to offer the branch of engineering I am offering	48 (9.6)	0 (0.0)	3 (0.6)	43 (8.6)	16 (3.2)	110	140 (28. 0)	64 (12.8)	21 (4.2)	53 (10.6)	112 (22.4)	390	6.72	2.67
3	My love for the sciences at high school made me to embrace engineering studies	20 (4.0)	4 (0.8)	2 (0.4)	3 (0.6)	18 (3.6)	47	18 (3.6)	95 (19.0)	41 (8.2)	85 (17.0)	214 (42.8)	453	8.28	2.22
4	Even if I had passed the entrance examination into other professional schools, I would have still preferred the engineering school	17 (2.8)	14 (2.8)	26 (5.2)	54 (10.8)	0 (0.0)	111	4.4 (8.8)	8 (1.6)	85 (17.0)	76 (15.2)	176 (35.2)	389	7.67	2.60
5	I chose this particular branch of engineering because I had developed interest in aspects related to it long time ago	0 (0.0)	17 (3.4)	4 (0.8)	53 (10.6)	23 (4.6)	103	59 (11. 8)	29 (5.8)	138 (27.6)	45 (90)	132 (26.4)	397	7.51	2.23
6	I chose this particular branch of engineering because I enjoy doing the activities pertaining to it	14 (2.8)	0 (0.0)	6 (1.2)	20 (4.0)	26 (5.2)	66	16 (3.2)	90 (18.0)	41 (8.2)	136 (27.2)	151 (30.2)	434	8.1	2.05
7	I decided to study engineering because I was confident in my	6 (1.2)	26 (5.2)	4 (0.8)	0 (0.0)	28 (5.6)	64	7 (1.4)	51 (10.2)	110 (22.0	73 (14.6)	195 (39.0)	436	8.19	2.24

	ability in Mathematics and in other science disciplines									)					
8	I am studying engineering because I know I can easily design and build things	6 (1.2)	9 (1.8)	20 (4.0)	6 (1.2)	3 (0.6)	44	34 (6.8)	77 (15.4)	63 (12.6)	118 (23.6)	164 (32.8)	456	8.14	2.11
9	I chose to do engineering because I like the challenge of solving problems	48 (9.6)	0 (0.0)	4 (0.8)	6 (1.2)	3 (0.6)	61	5 (1.0)	44 (8.8)	84 (16.8)	70 (14.0)	236 (47.2)	439	8.79	2.69
10	I decided to do engineering because of my GCE A/L / BAC results	102 (20.4)	27 (3.4)	19 (3.8)	76 (15.2)	42 (8.4)	266	13 (2.6)	21 (4.2)	5 (1.0)	91 (18.2)	104 (20.8)	234	5.70	3.46
11	I am into this particular branch of engineering because I perceived I would be competent in it	21 (4.2)	5 (1.0)	5 (1.0)	13 (2.6)	12 (2.4)	56	66 (13. 2)	128 (25.6)	75 (15.0)	58 (11.6)	117 (23.4)	444	7.48	2.21
12	I am doing this particular branch of engineering because it is more related to my best subject in high school	11 (2.2)	11 (2.2)	23 (4.6)	101 (20.2)	61 (12.2)	207	27 (5.4)	89 (17.8)	17 (3.4)	62 (124)	98 (196)	293	6.54	2.56
13	I went into engineering studies because engineers are rich	15 (3.0)	49 (9.8)	13 (2.6)	54 (10.8	14 (2.8)	145	97 (19. 4)	39 (7.8)	40 (8.0)	98 (19.6)	81 (16.2)	355	6.61	2.72
14	I chose to study engineering because it is a prestigious field of study	65 (13.0)	62 (12.4)	15 (3.00)	104 (20.8)	26 (5.2)	272	16 (3.2)	24 (4.8)	114 (22.8)	26 (5.2)	48 (9.6)	228	5.34	2.99
15	I am studying engineering because I am sure of getting a lofty job upon graduation	47 (9.4)	22 (4.4)	60 (12.0)	39 (7.8)	71 (14.2)	239	44 (8.8)	49 (9.8)	104 (20.8)	14 (2.8)	50 (10.0)	261	5.69	2.70
16	I am studying this particular branch of engineering because	126 (20.2)	56 (11.2)	39 (7.8)	7 (1.4)	36 (7.2)	264	25 (5.0)	74 (14.8)	50 (10.0	65 (13.0)	22 (4.4)	236	4.87	3.18

	it will set me up more for professional success									)					
17	I am studying this particular branch of engineering because I noticed the society is facing problems which are related to this branch of engineering	121 (24.2)	33 (6.6)	28 (5.6)	33 (6.6)	95 (19.0)	310	22 (4.4)	8 (1.6)	53 (10.0)	35 (7.0)	72 (14.4)	190	5.05	3.25
18	I am studying this branch of engineering because it has more job prospects than the other branches of engineering	54 (10.8)	101 (20.2)	13 (2.6)	50 (10.0)	86 (17.2)	304	20 (4.0)	16 (3.2)	42 (8.4)	78 (15.6)	40 (8.0)	196	5.19	3.03
19	I am studying engineering because my parents want me to be an engineer	51 (10.2)	12 (2.4)	31 (6.2)	4 (0.8)	17 (3.4)	115	32 (6.4)	47 (9.4)	131 (26.2)	17 (3.4)	158 (31.6)	385	7.14	2.96
20	I decided to study engineering because a teacher or Guidance counsellor in high school advised me to pursue engineering studies	17 (3.4)	12 (2.4)	30 (6.0)	74 (14.8)	42 (8.4)	175	46 (9.2)	59 (11.8)	53 (10.6)	17 (3.4)	150 (30.0)	325	6.81	2.73
21	I am studying engineering because someone promised to sponsor me in university if I do engineering	17 (3.4)	24 (4.8)	3 (0.6)	75 (15.0)	0 (0.0)	119	40 (8.0)	14 (2.8)	5 (1.0)	58 (11.6)	264 (52.8)	381	7.98	2.73
22	I went into engineering studies because even as an engineering student I could start fetching money for my self	42 (8.4)	23 (4.6)	2 (0.4)	72 (14.4)	81 (16.2)	220	32 (6.4)	21 (4.2)	95 (19.0)	12 (2.4)	120 (24.0)	280	6.39	2.89
23	I chose this particular branch of engineering because I knew through it, I could easily get	21 (4.2)	13 (2.6)	44 (8.8)	49 (9.8)	85 (17.0)	212	79 (15. 8)	18 (3.6)	64 (12.8)	3 (0.6)	97 (19.4)	288	6.30	2.63

	scholarships														
24	I am studying this branch of engineering because I already had enough books and other materials to be used in this engineering program	34 (6.8)	4 (0.8)	93 (18.6)	0 (0.0)	24 (4.8)	155	15 (3.0)	61 (12.2)	40 (8.0)	72 (14.4)	157 (31.4)	345	7.18	2.83

The table above reveals that 280 of the engineering students affirmed that they had always dreamt of becoming engineers while 220 of the engineering students did not affirm to this assertion. 390 of the engineering students also agreed to the fact that they are currrently offereng the branch of engineering thaey had wished to offer while 110 of them did not agree with this. Also, 453 of the engineering students agreed to the fact that they embraced engineering studies because of their love of sciences from high school, while 47 of the engineering students bebunked this fact. 389 of the engineering students showed much affection for engineering studies by affirming to the fact that even if they had passed the entrance into other professional schools, they would have prefered the engineering school, while 111 of them were not in accordance with this fact. Furthermore, 397 of the engineering students also purpoted the fact that they went into the branch of engineering which they are presently studying because they had long been interested in aspects pertaining to it, while 103 of the students did not agree with this assertion. In line with this, 434 of the students also affirmed that they decided to offer the particular branch of engineering which they are offering branch of engineering which they are offering because they love to do the activities pertaining to that particular branch of engineering while 66 of them did not affirm to this fact. Moreover, 436 of the engineering students also asserted that they engaged into engineering studies because they were confident in their ablity in Mathematics and other science subjects. while 64 of them did not agree with this assertion. 456 of the engineering students used for the study affirmed that they are studying engineering because they know they can easily design and build things, but 44 of them debunked this claim. Also, 439 of the students agreed that they decided to study engineering because they love the challenge of solving problems but 61 of the students did not agree with this claim. 234 of the engineering students used for this study also asserted that they decided to study engineering because of their GCE A/L or BAC results, but 266 of them refuted this fact. 444 of the engineering students also agreed that they are offering the branch of engineering they are offering because they felt they would be competent in it, while 56 of them debunked this claim. Still, 293 of the engineering students affirmed that they are into their particular engineering specialties because it is more related to their best subject in high school. 288 of the students further affirmed that the ease with which they thought they could easily get scholarships made them to choose the branch of engineering they are studying, but 212 of the engineering students did not affirm to this claim.

Futhermore, 355 of the engineering students affirmed that they decided to study engineering because engineers are rich, while 145 of them did not affirm to this claim. 228 of the engineering students are also studying engineering because it is a prestigious field of study while 272 of them are not studying engineering because they percieved it as a prestigious field of study. Also, 261 of the engineering students further asserted that they are studying engineering because they are sure of getting a lofty job upon the completion of their studies, but 239 of the engineering students debunked this assertion. In line with ebarking in a particular branch of engineering, 236 of the engineering students agreed that they chosed to study the particular branch of engineering which they are studying because they were sure it will set them up more for professional success while 264 disagreed with this fact. Moreover, 190 of the engineering students purported that they chose to study the branch of engineering they are studying because they noticed the society is facing problems which that particular branch of engineering can provide solutions for, but 310 of the engineering students did not agree with this as a reason they are studying the branch of engineering which they are studying. 194 of the engineering students also agreed that they are studying the particular branch of engineering which they are studying because they know it has more job prospects than the other engineering branches., while 306 of the engineering students did not agree with this fact. Also, 385 of the engineering students affirmed that they are studying engineering because their parents asked them to study engineering while 115 of the engineering students did not affirm to this claim. In line with this, 325 of the students agreed with the fact that they are studying engineering because a Guidance councilor or teacher in high school asked them to study engineering, while 175 of them did not agree with this fact. 381 of the engineering students also purported that that they are studying engineering because someone promised to sponsor them in university, but, 119 of the engineering students debunked this claim. Moreover, 280 of the engineering students also agreed with the fact that they are studying engineering because even as engineering students, they could start fetching money for themselves, but 220 of the students did not agree with this assertion. Also, 345 of the engineering students also agreed that they studying the branch of engineering which they are studying because they already had books and other learning materials pertaining to the engineering program, while, 155 of the engineering students did not agree with this fact.

Table 65

Students' Level of Motivation

MOTIVATION

N	Valid	500
	Missing	0
Mean		2.8220
Median		3.0000
Mode		3.00
Std. Deviation		.80971
Variance		.656

Students' motivation was categorized into four categories, which are; Highly motivated students, Fairly motivated students, Averagely motivated students and Lowly motivated students. These categories were coded from 1 to 4 in ascending order from lowly motivated to highly motivated. From the table of statistics above, the mean motivation was 2.82 which means the mean finds itself close to fairly motivated, the median being 3.0 signifying fairly motivated and the modal category was 3.0 which stands for fairly motivated. The standard deviation was 0.81 and the variance was 0.66.

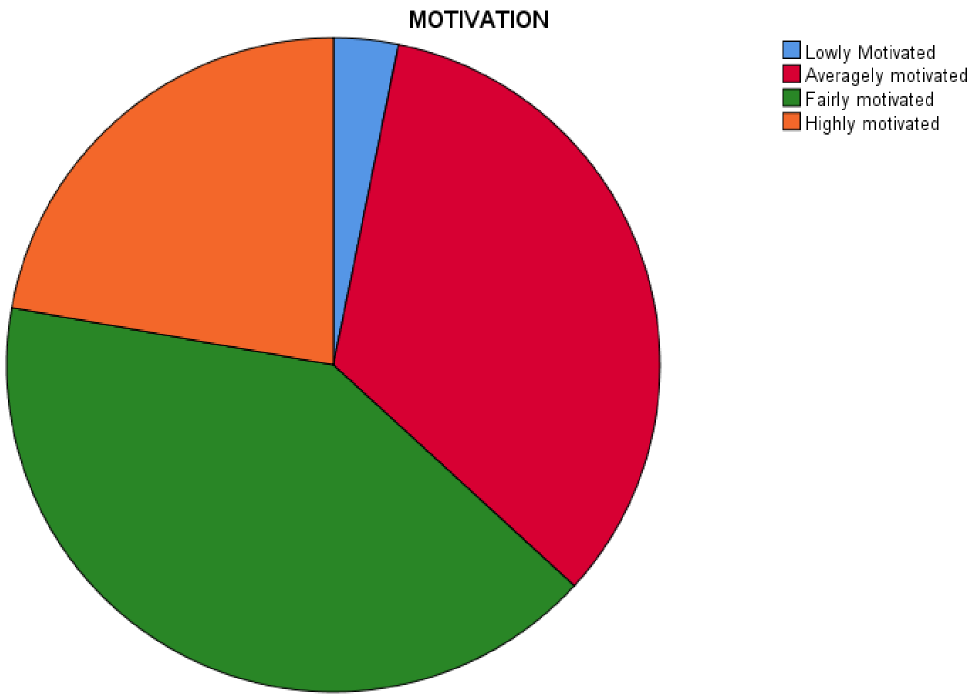
Table 65b

Students' Level of Motivation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lowly Motivated	16	3.2	3.2	3.2
	Averagely motivated	168	33.6	33.6	36.8
	Fairly motivated	205	41.0	41.0	77.8
	Highly motivated	111	22.2	22.2	100.0
	Total	500	100.0	100.0	

Figure 15

Levels of Students' Motivation



From the frequency table above and the pie chart, 16 (3.2%) of the engineering students were lowly motivated to study engineering, 168 (33.8%) of the students were Averagely motivated towards engineering studies, 205 (41%) of the students were Fairly motivated to study engineering and 111 (22.2%) of the engineering students were highly motivated to study engineering.

The Dependent Variable: Students' Academic Performance in Engineering

Table 66

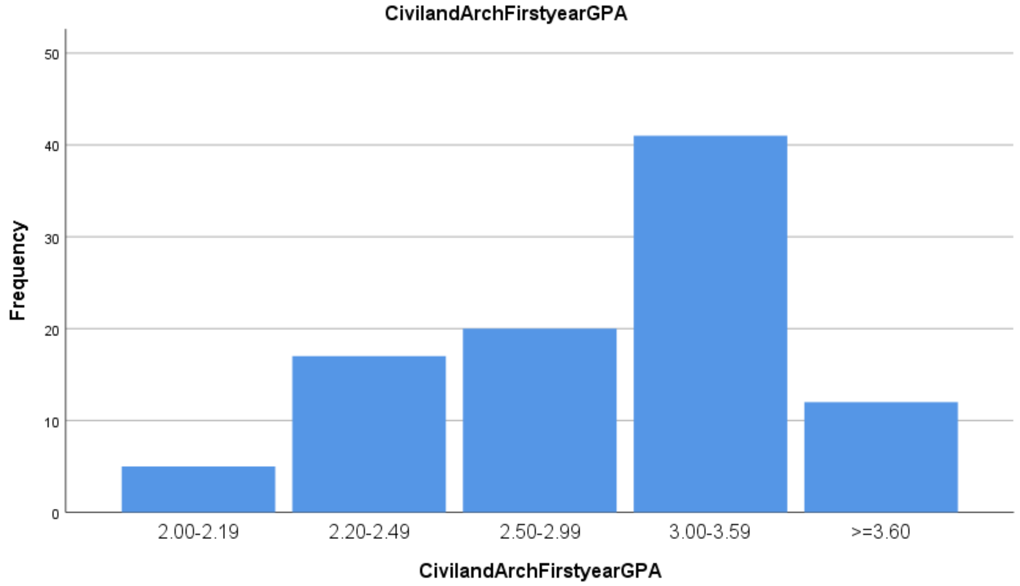
Civil Engineering and Architecture First year GPA

Civil and Arch First year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	5	1.0	5.3	5.3
	2.20-2.49	17	3.4	17.9	23.2
	2.50-2.99	20	4.0	21.1	44.2
	3.00-3.59	41	8.2	43.2	87.4
	>=3.60	12	2.4	12.6	100.0
	Total	95	19.0	100.0	
Missing	System	405	81.0		
Total		500	100.0		

Figure 16

Civil Engineering and Architecture First year GPA



The frequency table and the bar chart above makes it clear that 5 (5.3%) of the civil and Architectural engineering students scored a GPA between 2.00 to 2.19. 17 (17.9%) of the students scored a GPA between 2.20 and 2.49, 20 (21.1%) of them scored a GPA between 2.50 and 2.99, 41 (43.2%) of them scored a GPA between 3.00 and 3.59 and 12

(12.6%) of the civil engineering students scored a GPA which is equal to or greater than 3.60.

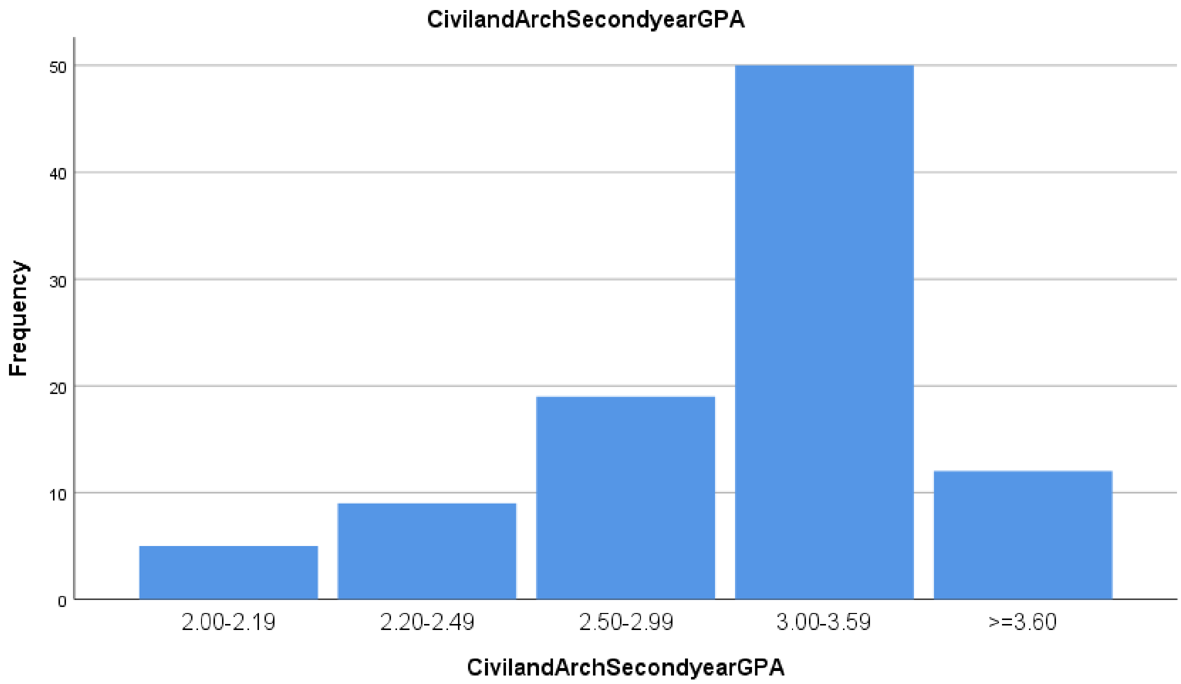
Table 67

Civil Engineering and Architecture second year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	5	1.0	5.3	5.3
	2.20-2.49	9	1.8	9.5	14.7
	2.50-2.99	19	3.8	20.0	34.7
	3.00-3.59	50	10.0	52.6	87.4
	>=3.60	12	2.4	12.6	100.0
	Total	95	19.0	100.0	
Missing	System	405	81.0		
Total		500	100.0		

Figure 17

Civil Engineering and Architecture second year GPA



The frequency table and the bar chart above reveals that that 5 (5.3%) of the civil and Architectural engineering students scored a GPA between 2.00 to 2.19. 9(9.5%) of the students scored a GPA between 2.20 and 2.49, 19 (20.0%) of them scored a GPA between 2.50 and 2.99, 50 (52.6%) of them scored a GPA between 3.00 and 3.59 and 12 (12.6%) of the civil engineering students scored a GPA which is equal to or greater than 3.60.

Table 68

Cilvil Engineering and Architecture Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	5	1.0	5.3	5.3
	2.20-2.49	10	2.0	10.5	15.8
	2.50-2.99	19	3.8	20.0	35.8
	3.00-3.59	49	9.8	51.6	87.4
	>=3.60	12	2.4	12.6	100.0
	Total	95	19.0	100.0	
Missing	System	405	81.0		
Total		500	100.0		

Figure 18.a

Civil and Architectural Cumulative GPA

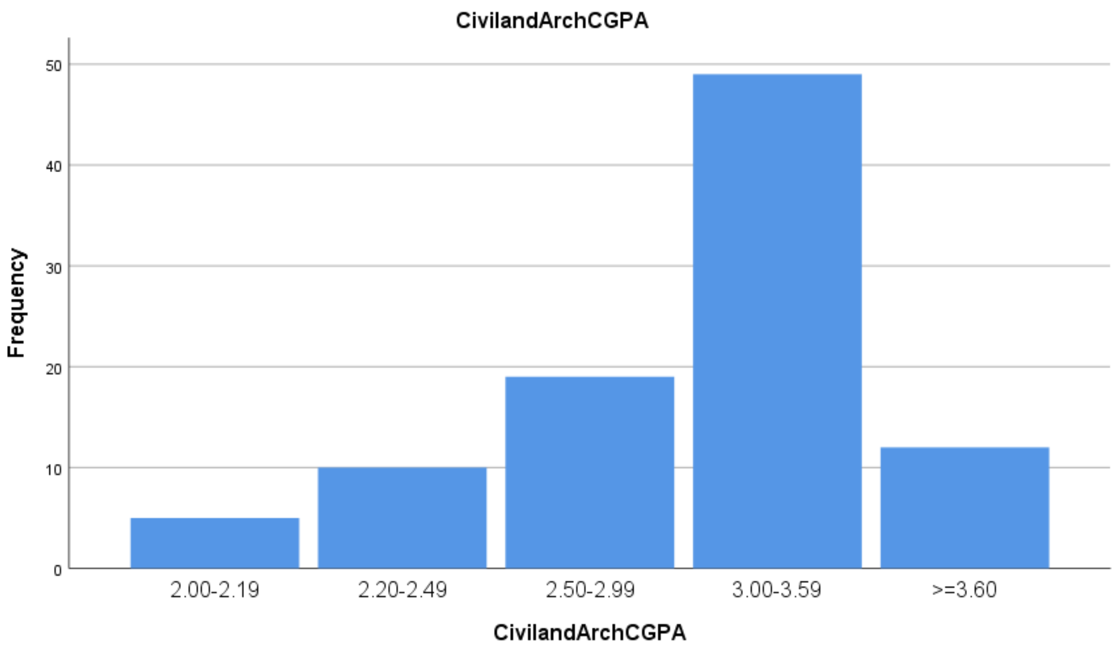
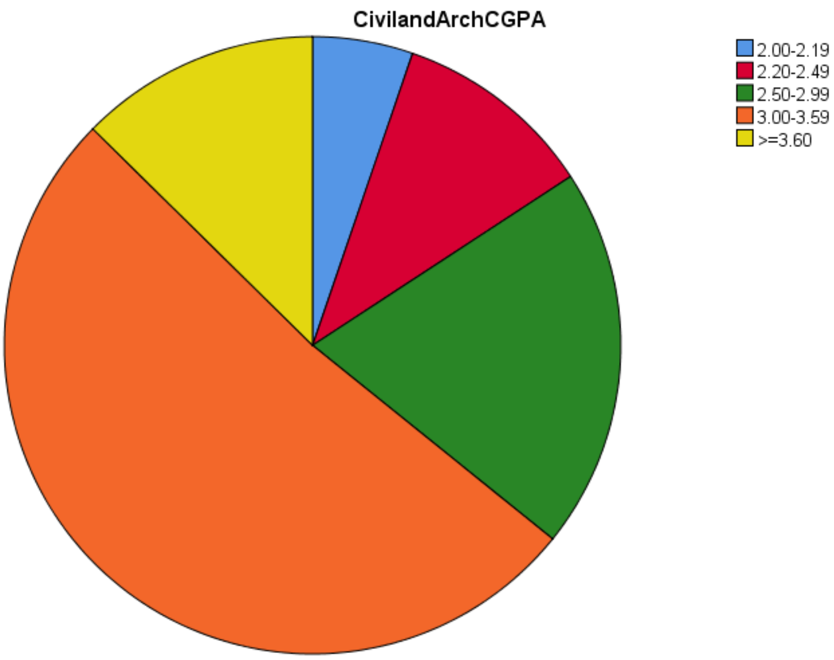


Figure 18.b

Civil Engineering and Architecture Cumulative GPA



The frequency table the pie and the bar chart reveal that 5 (5.3%) of the civil and Architectural engineering students scored a CGPA between 2.00 to 2.19. 10 (10.5%) of the students scored a CGPA between 2.20 and 2.49, 19 (20.0%) of them scored a CGPA between 2.50 and 2.99, 49 (51.6%) of them scored a CGPA between 3.00 and 3.59 and 12 (12.6%) of the civil engineering students scored a CGPA which is equal to or greater than 3.60.

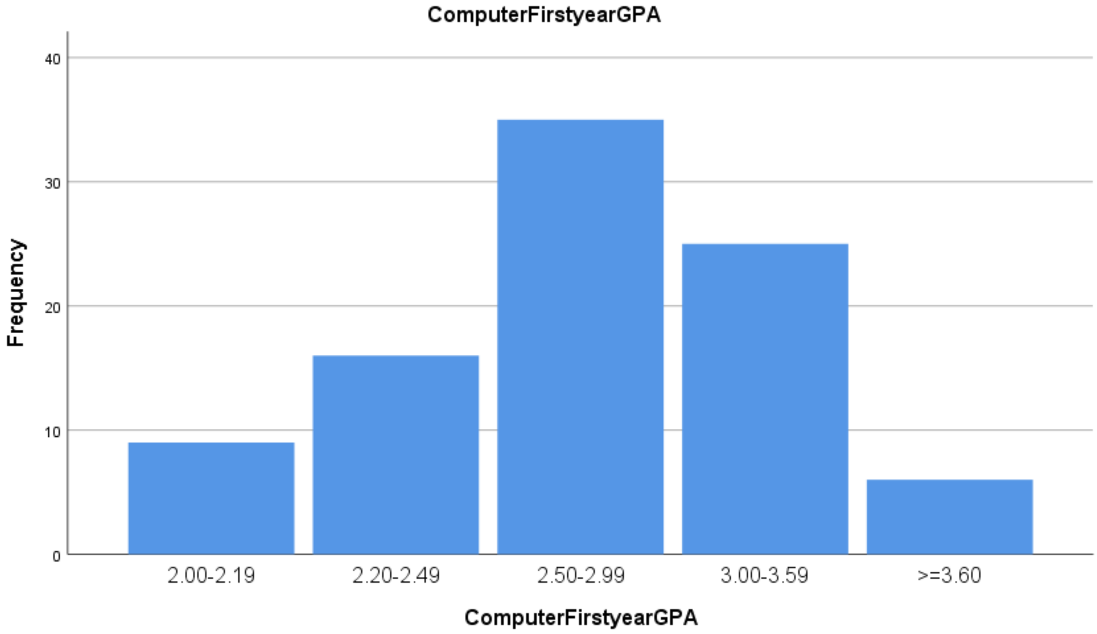
Table 69

Computer Engineering First year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	9	1.8	9.9	9.9
	2.20-2.49	16	3.2	17.6	27.5
	2.50-2.99	35	7.0	38.5	65.9
	3.00-3.59	25	5.0	27.5	93.4
	>=3.60	6	1.2	6.6	100.0
	Total	91	18.2	100.0	
Missing	System	409	81.8		
Total		500	100.0		

Figure 19

Computer Engineering First year GPA



The frequency table and the bar chart reveal that in the first year, 9 (9.9%) of computer engineering students scored a GPA between 2.00 to 2.19, 16(17.2%) of the students scored a GPA between 2.20 and 2.49, 35(38.5%) of them scored a CGPA between 2.50 and 2.99, 25(27.5%) of them scored a CGPA between 3.00 and 3.59 and 6 (6.6%) of the computer engineering students scored a CGPA which is equal to or greater than 3.60.

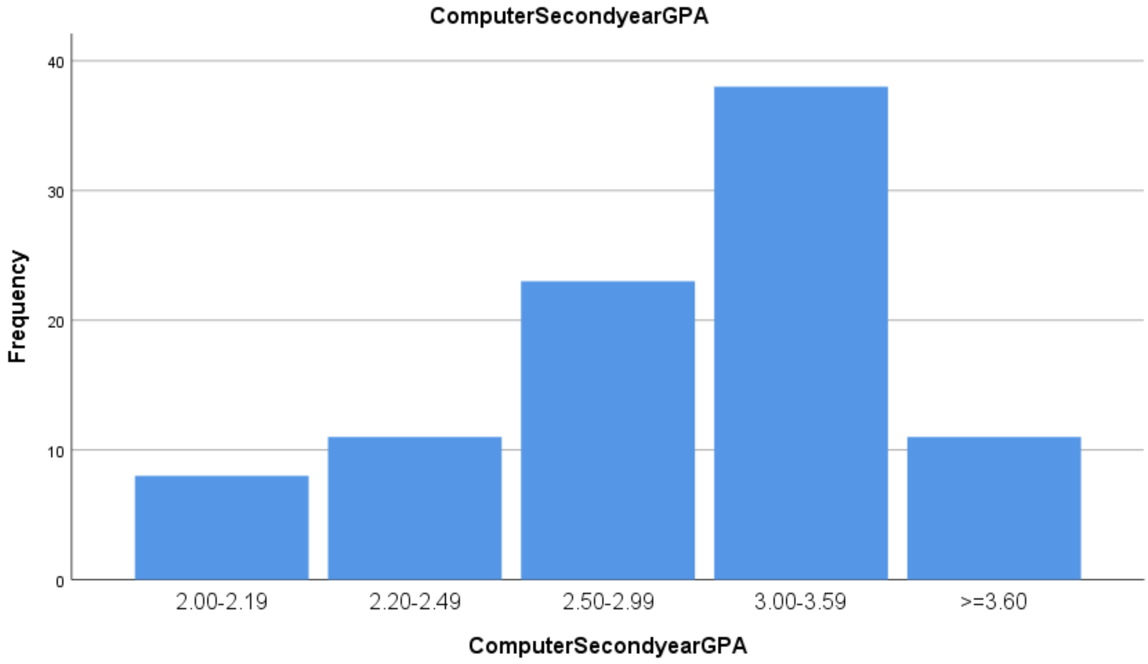
Table 70

Computer Engineering Second year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	8	1.6	8.8	8.8
	2.20-2.49	11	2.2	12.1	20.9
	2.50-2.99	23	4.6	25.3	46.2
	3.00-3.59	38	7.6	41.8	87.9
	>=3.60	11	2.2	12.1	100.0
	Total	91	18.2	100.0	
Missing	System	409	81.8		
Total		500	100.0		

Figure 20

Computer Engineering Second year GPA



From the frequency table and bar chart above, 8(8.8%) of the computer engineering students in the second year scored a GPA between 2.00 to 2.19. 11 (12.1%) of the students scored a GPA between 2.20 and 2.49, 23(25.3%) of them scored a CGPA between 2.50 and 2.99, 38(41.8%) of them scored a GPA between 3.00 and 3.59 and 11 (12.1%) of the civil engineering students scored a GPA which is equal to or greater than 3.60.

Table 71

Computer Engineering, Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	6	1.2	6.6	6.6
	2.20-2.49	11	2.2	12.1	18.7
	2.50-2.99	36	7.2	39.6	58.2
	3.00-3.59	26	5.2	28.6	86.8
	>=3.60	12	2.4	13.2	100.0
	Total	91	18.2	100.0	
Missing	System	409	81.8		
Total		500	100.0		

Figure 21.a

Computer Engineering Cumulative GPA

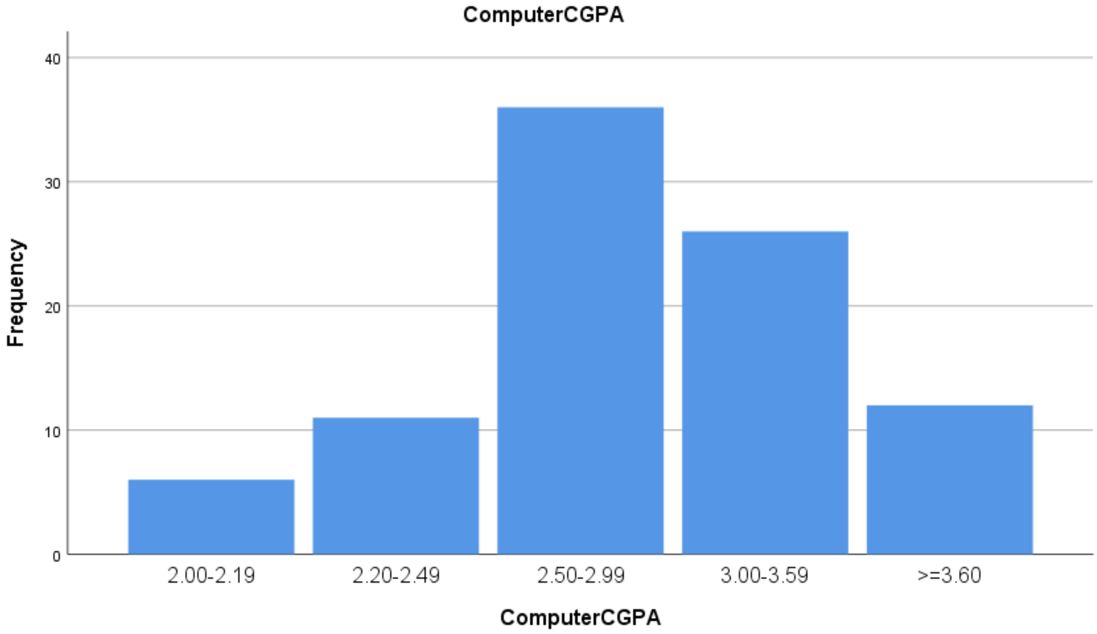
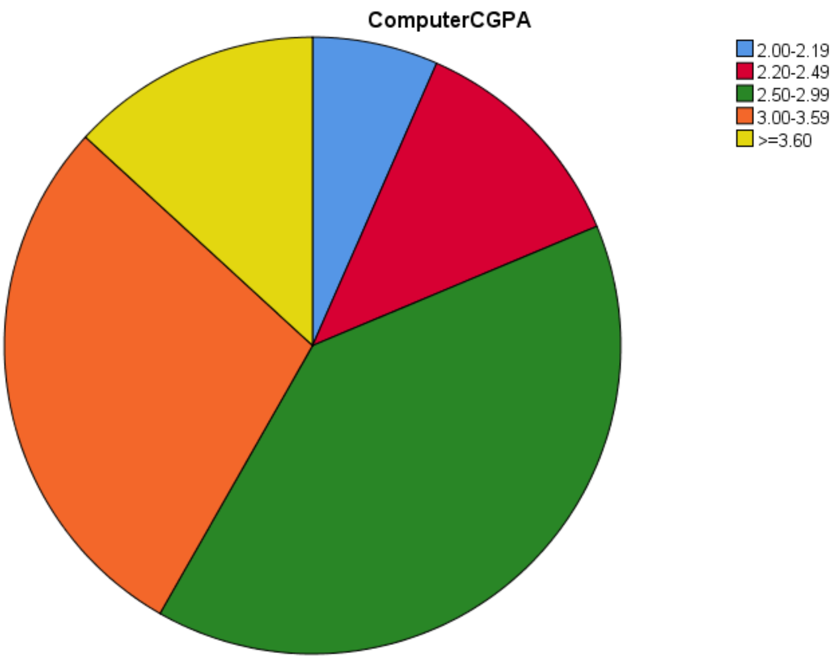


Figure 21.b

Computer Engineering cumulative GPA



The frequency table, and the bar chart reveal that 6(6.6%) of the computer engineering students scored a CGPA between 2.00 to 2.19. 11(12.1%) of the students scored a CGPA between 2.20 and 2.49, 36 (39.6%) of them scored a CGPA between 2.50 and 2.99, 26(28.6%) of them scored a CGPA between 3.00 and 3.59 and 12 (13.2%) of the computer engineering students scored a CGPA which is equal to or greater than 3.60.

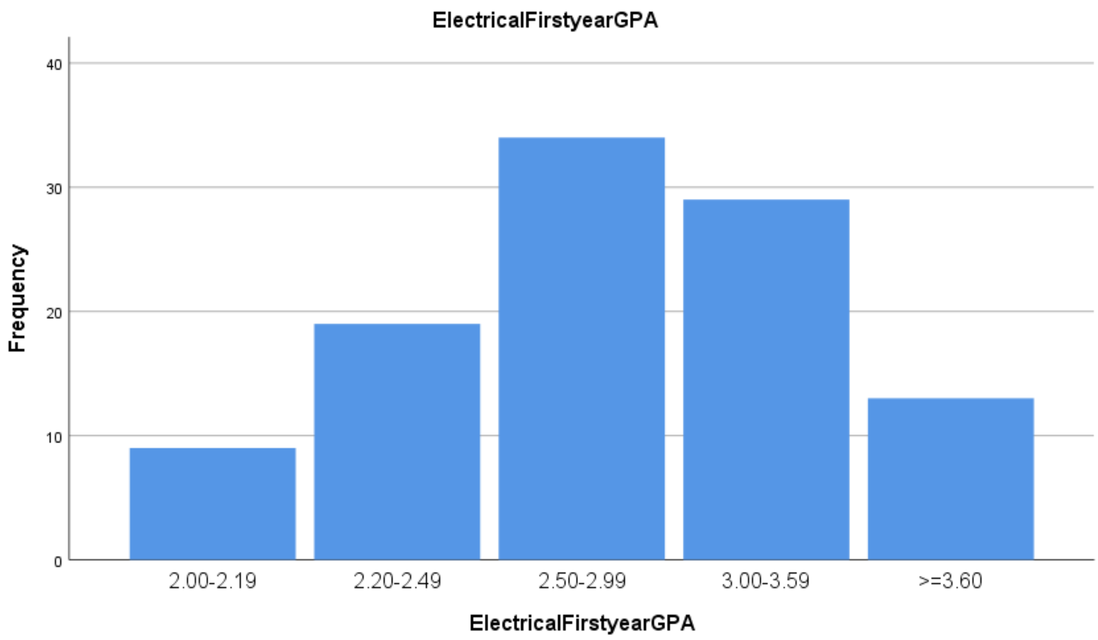
Table 72

Electrical Engineering First year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	9	1.8	8.7	8.7
	2.20-2.49	19	3.8	18.3	26.9
	2.50-2.99	34	6.8	32.7	59.6
	3.00-3.59	29	5.8	27.9	87.5
	>=3.60	13	2.6	12.5	100.0
	Total	104	20.8	100.0	
Missing	System	396	79.2		
Total		500	100.0		

Figure 22

Electrical Engineering First year GPA



The frequency table, and the bar chart reveal that 9(8.7%) of the Electrical engineering students in the first year scored a GPA between 2.00 to 2.19. 19(18.3%) of the students scored a GPA between 2.20 and 2.49, 34 (32.7%) of them scored a GPA between 2.50 and 2.99, 29(27.9%) of them scored a GPA between 3.00 and 3.59 and 13 (12.5%) of the computer engineering students scored a GPA which is equal to or greater than 3.60.

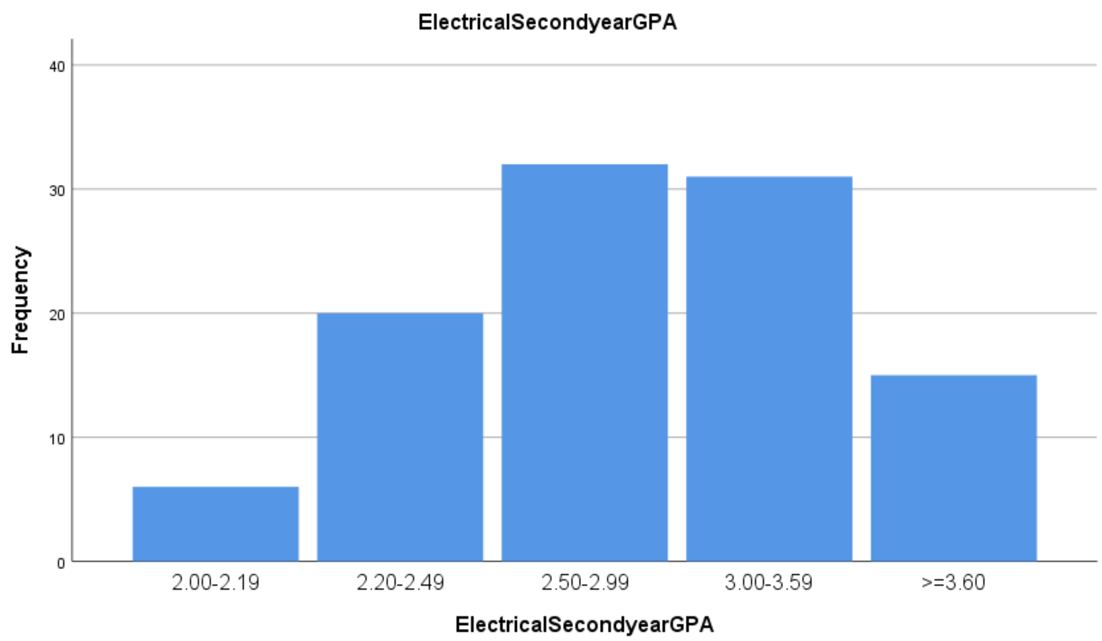
Table 73

Electrical Engineering GPA second year

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	6	1.2	5.8	5.8
	2.20-2.49	20	4.0	19.2	25.0
	2.50-2.99	32	6.4	30.8	55.8
	3.00-3.59	31	6.2	29.8	85.6
	>=3.60	15	3.0	14.4	100.0
	Total	104	20.8	100.0	
Missing	System	396	79.2		
Total		500	100.0		

Figure 23

Electrical engineering second year GPA



The frequency table, and the bar chart reveal that 6(5.8%) of the Electrical engineering students in the second year scored a GPA between 2.00 to 2.19. 20(19.2%) of the students scored a GPA between 2.20 and 2.49, 32(30.8%) of them scored a GPA between 2.50 and 2.99, 31(29.8%) of them scored a GPA between 3.00 and 3.59 and 15 (14.4%) of the computer engineering students scored a GPA which is equal to or greater than 3.60.

Table 74

Electrical Engineering Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	6	1.2	5.8	5.8
	2.20-2.49	20	4.0	19.2	25.0
	2.50-2.99	28	5.6	26.9	51.9
	3.00-3.59	33	6.6	31.7	83.7
	>=3.60	17	3.4	16.3	100.0
	Total	104	20.8	100.0	
Missing	System	396	79.2		
Total		500	100.0		

Figure 24.a

Electrical Engineering cumulative GPA

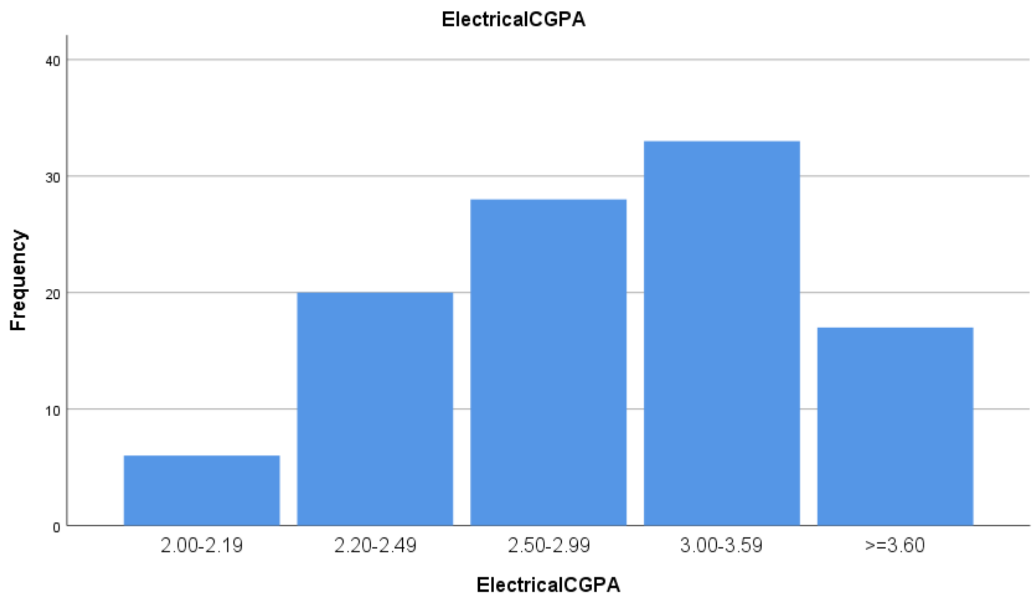
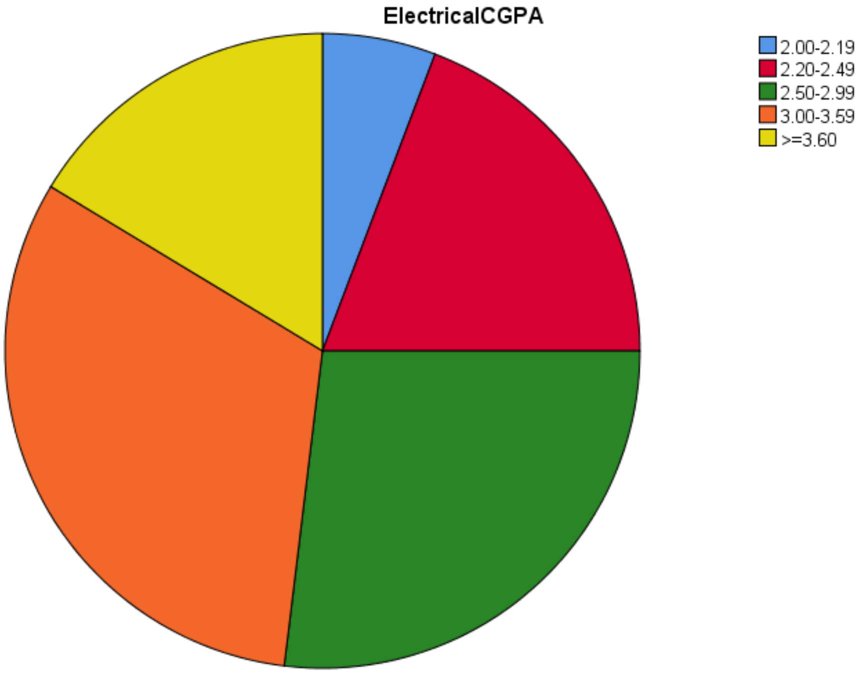


Figure 24.b

Electrical Engineering Cumulative GPA



The frequency table, and the bar chart reveal that 6(5.8%) of the Electrical engineering students in the first and second year scored a CGPA between 2.00 to 2.19. 20(19.2%) of the students scored a CGPA between 2.20 and 2.49, 32(30.8%) of them scored a CGPA between 2.50 and 2.99, 31(29.8%) of them scored a CGPA between 3.00 and 3.59 and 15 (14.4%) of the computer engineering students scored a CGPA which is equal to or greater than 3.60.

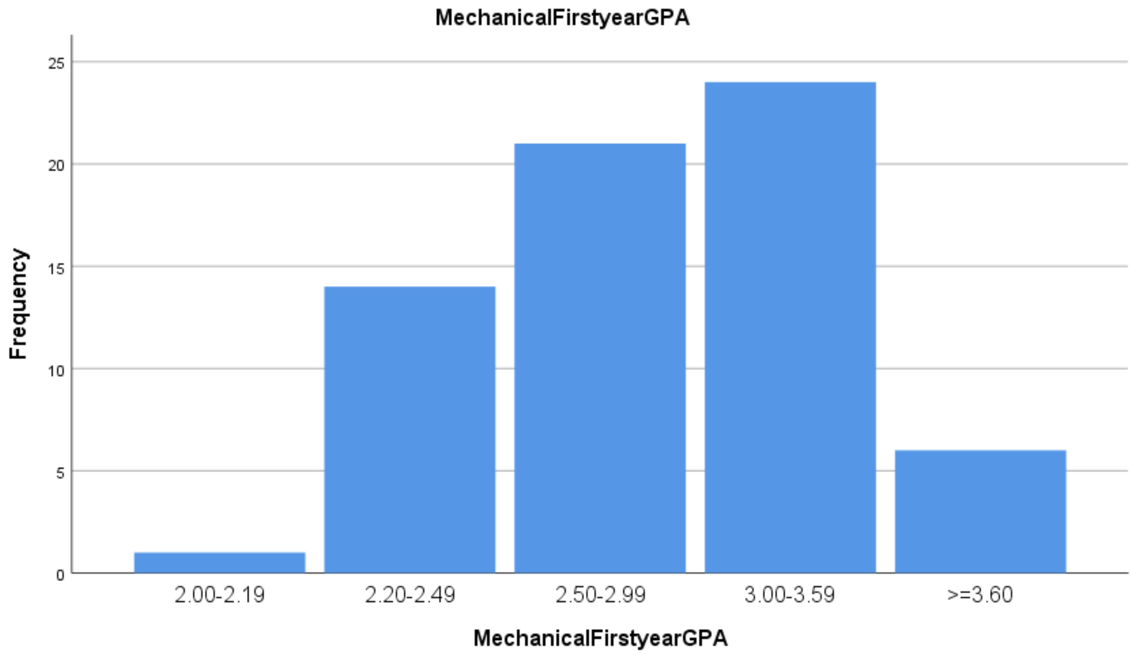
Table 75

Mechanical Engineering First Year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	1	.2	1.5	1.5
	2.20-2.49	14	2.8	21.2	22.7
	2.50-2.99	21	4.2	31.8	54.5
	3.00-3.59	24	4.8	36.4	90.9
	>=3.60	6	1.2	9.1	100.0
	Total	66	13.2	100.0	
Missing	System	434	86.8		
Total		500	100.0		

Figure 25

Mechanical Engineering First Year GPA



The frequency table, and the bar chart reveal that 1(1.5%) of the Mechanical engineering students in the first year scored a GPA between 2.00 to 2.19. 14(21.2%) of the students scored a GPA between 2.20 and 2.49, 21(31.8%) of them scored a GPA between 2.50 and 2.99, 24(36.4%) of them scored a GPA between 3.00 and 3.59 and 6(9.1%) of the computer engineering students scored a GPA which is equal to or greater than 3.60.

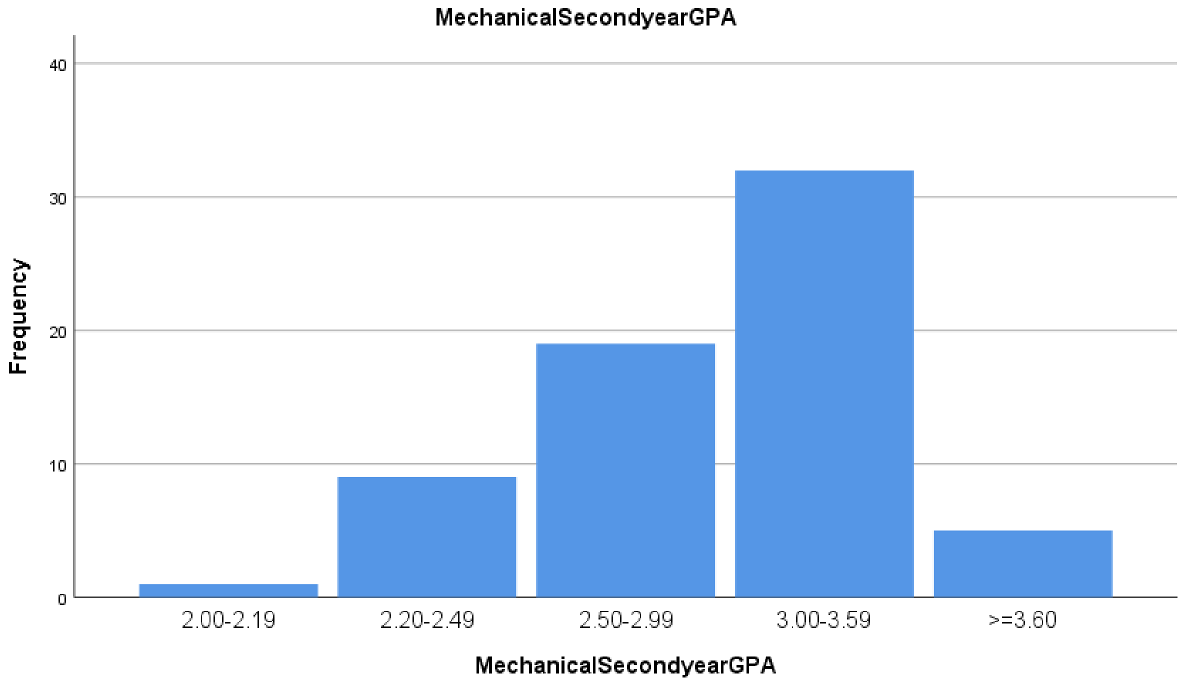
Table 76

Mechanical Engineering Second Year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	1	.2	1.5	1.5
	2.20-2.49	9	1.8	13.6	15.2
	2.50-2.99	19	3.8	28.8	43.9
	3.00-3.59	32	6.4	48.5	92.4
	>=3.60	5	1.0	7.6	100.0
	Total	66	13.2	100.0	
Missing	System	434	86.8		
Total		500	100.0		

Figure 26

Mechanical Engineering Second Year GPA



The frequency table, and the bar chart reveal that 1(1.5%) of the Mechanical engineering students in the second year scored a GPA between 2.00 to 2.19. 9(13.6%) of the students scored a GPA between 2.20 and 2.49, 19(28.8%) of them scored a GPA between 2.50 and 2.99, 32(48.5%) of them scored a GPA between 3.00 and 3.59 and 5(7.6%) of the computer engineering students scored a GPA which is equal to or greater than 3.60

Table 77

Mechanical Engineering Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	1	.2	1.5	1.5
	2.20-2.49	8	1.6	12.1	13.6
	2.50-2.99	20	4.0	30.3	43.9
	3.00-3.59	31	6.2	47.0	90.9
	>=3.60	6	1.2	9.1	100.0
	Total	66	13.2	100.0	
Missing	System	434	86.8		
Total		500	100.0		

Figure 27.a: Mechanical Engineering Cumulative GPA

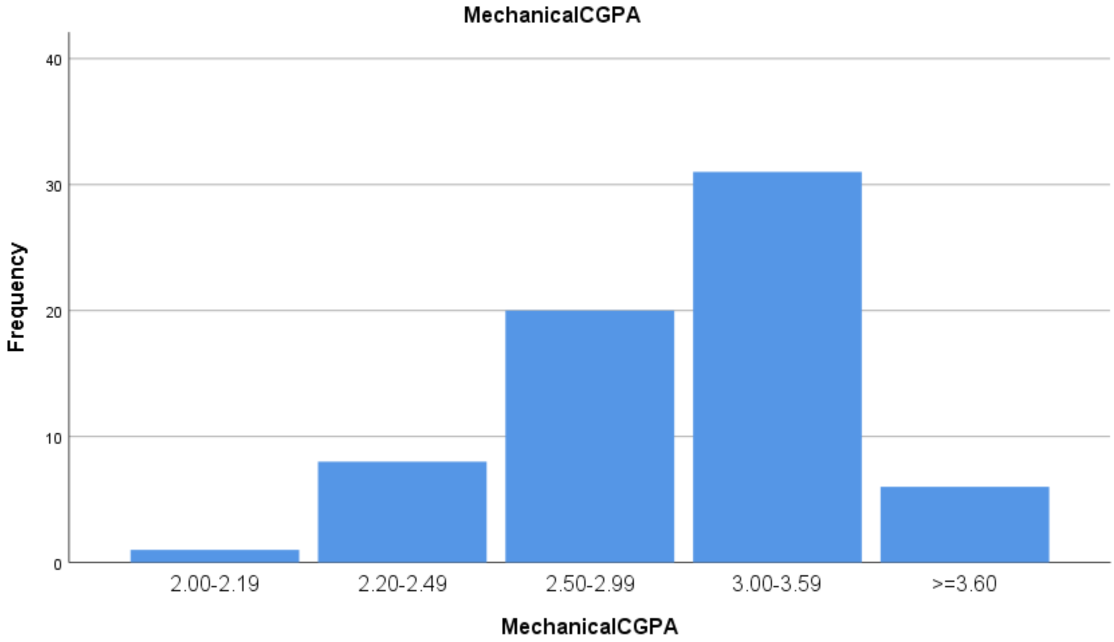
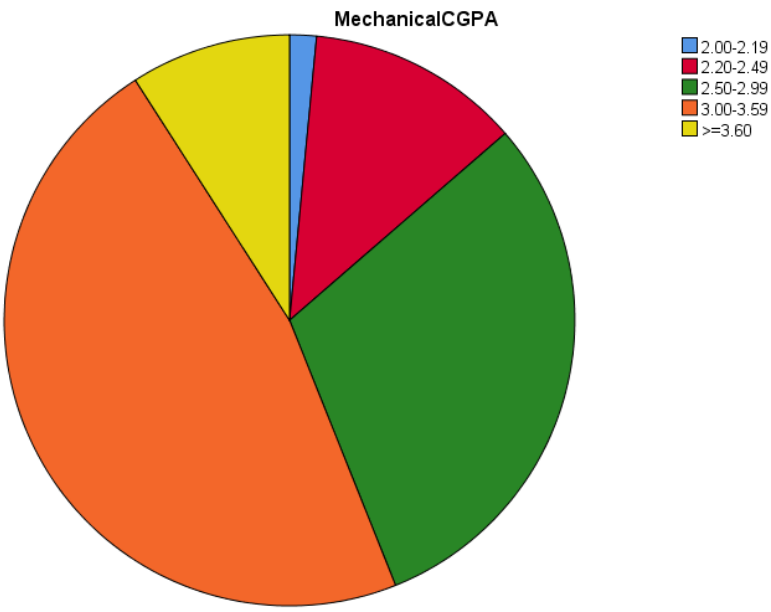


Figure 27.b

Mechanical Engineering Cumulative GPA



The frequency table, and the bar chart reveal that 1(1.5%) of the Mechanical engineering students in the first and second year scored a CGPA between 2.00 to 2.19. 8(12.1%) of the students scored a CGPA between 2.20 and 2.49, 20(30.3%) of them scored a CGPA between 2.50 and 2.99, 31(47.0%) of them scored a CGPA between

3.00 and 3.59 and 6 (1.2%) of the computer engineering students scored a CGPA which is equal to or greater than 3.60. The pie chart above also reveals that the greatest proportion of the mechanical engineering students scored between 3.0 to 3.59 CGPA and between 2.50 to 2.99 CGPA.

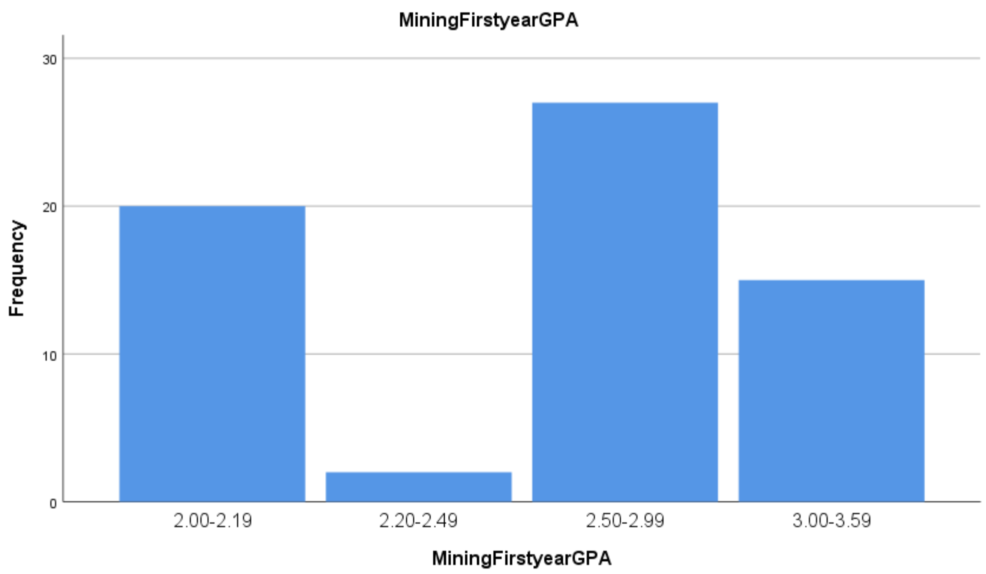
Table 78

Mining Engineering First Year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	20	4.0	31.3	31.3
	2.20-2.49	2	.4	3.1	34.4
	2.50-2.99	27	5.4	42.2	76.6
	3.00-3.59	15	3.0	23.4	100.0
	Total	64	12.8	100.0	
Missing	System	436	87.2		
Total		500	100.0		

Figure 28

Mining Engineering First Year GPA



The frequency table, and the bar chart reveal that 20(31.3%) of the Mining engineering students in the first year scored a GPA between 2.00 to 2.19. 2(3.1%) of the students scored a GPA between 2.20 and 2.49, 27(42.2%) of them scored a GPA between 2.50 and 2.99, 15(23.4%) of them scored a GPA between 3.00 and 3.59

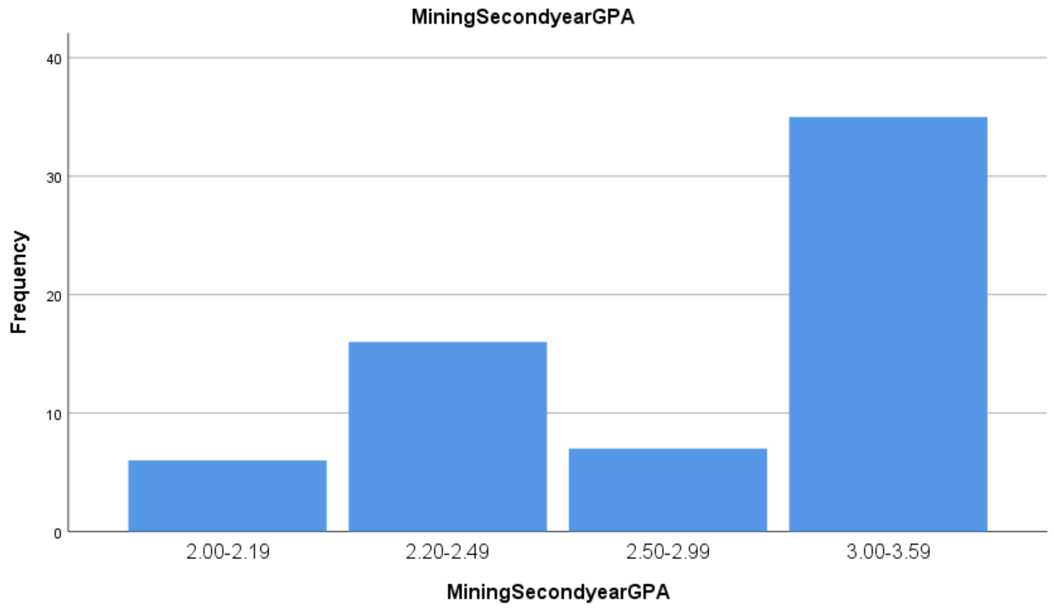
Table 79

Mining Engineering Second year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	6	1.2	9.4	9.4
	2.20-2.49	16	3.2	25.0	34.4
	2.50-2.99	7	1.4	10.9	45.3
	3.00-3.59	35	7.0	54.7	100.0
	Total	64	12.8	100.0	
Missing	System	436	87.2		
Total		500	100.0		

Figure 29

Mining Engineering Second year GPA



The frequency table, and the bar chart reveal that 6(9.4%) of the Mining engineering students in the second year scored a GPA between 2.00 to 2.19. 16(25.0%) of the students scored a GPA between 2.20 and 2.49, 7(10.9%) of them scored a GPA between 2.50 and 2.99, 35(54.7%) of them scored a GPA between 3.00 and 3.59

Table 80

Mining Engineering Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	6	1.2	9.4	9.4
	2.20-2.49	16	3.2	25.0	34.4
	2.50-2.99	5	1.0	7.8	42.2
	3.00-3.59	37	7.4	57.8	100.0
	Total	64	12.8	100.0	
Missing	System	436	87.2		
Total		500	100.0		

Figure 30.a

Mining Engineering Cumulative GPA

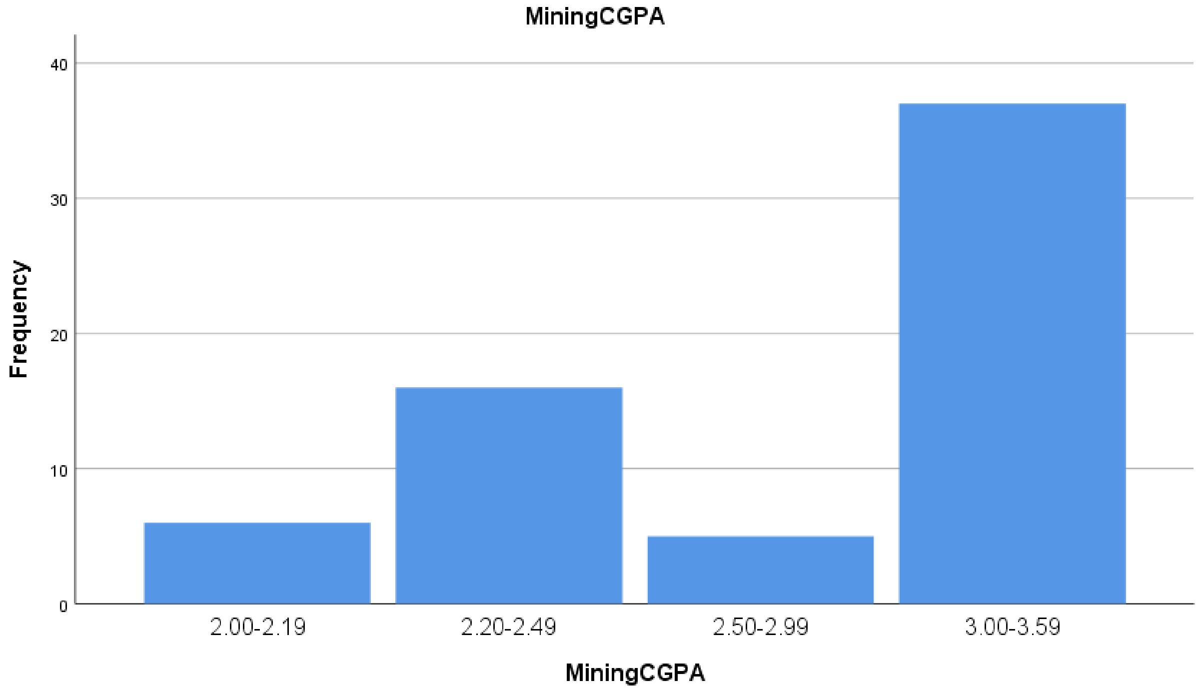
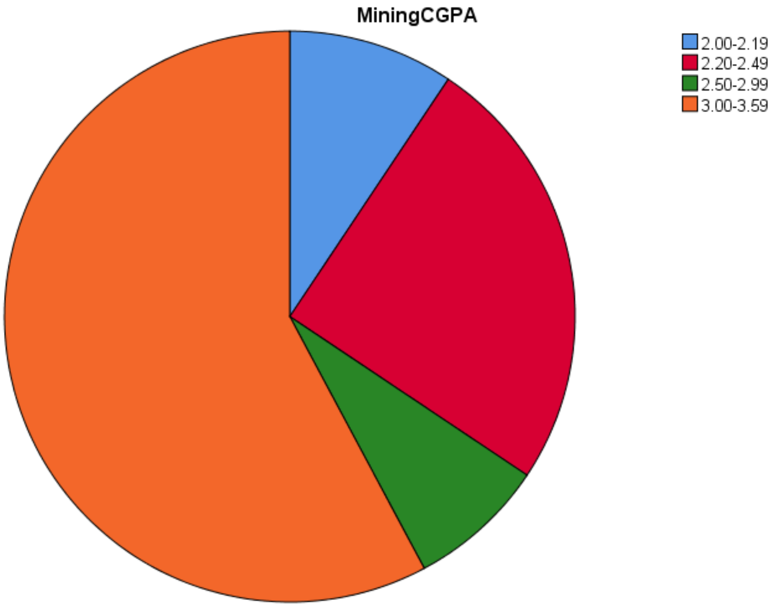


Figure 30b.

Mining Engineering Cumulative GPA



The frequency table, and the bar chart reveal that 6(9.4%) of the Mining engineering students in the first and second year scored a CGPA between 2.00 to 2.19. 16(25.0%) of the students scored a CGPA between 2.20 and 2.49, 5(7.8%) of them scored a CGPA between 2.50 and 2.99, 31(47.0%) of them scored a CGPA between 3.00 and 3.59 and 37(57.8%) of the mining engineering students scored a CGPA which is equal to or greater than 3.60. The pie chart above also reveals that the greatest proportion of the mining engineering students scored between 3.0 to 3.59 CGPA and between 2.20 to 2.49 CGPA.

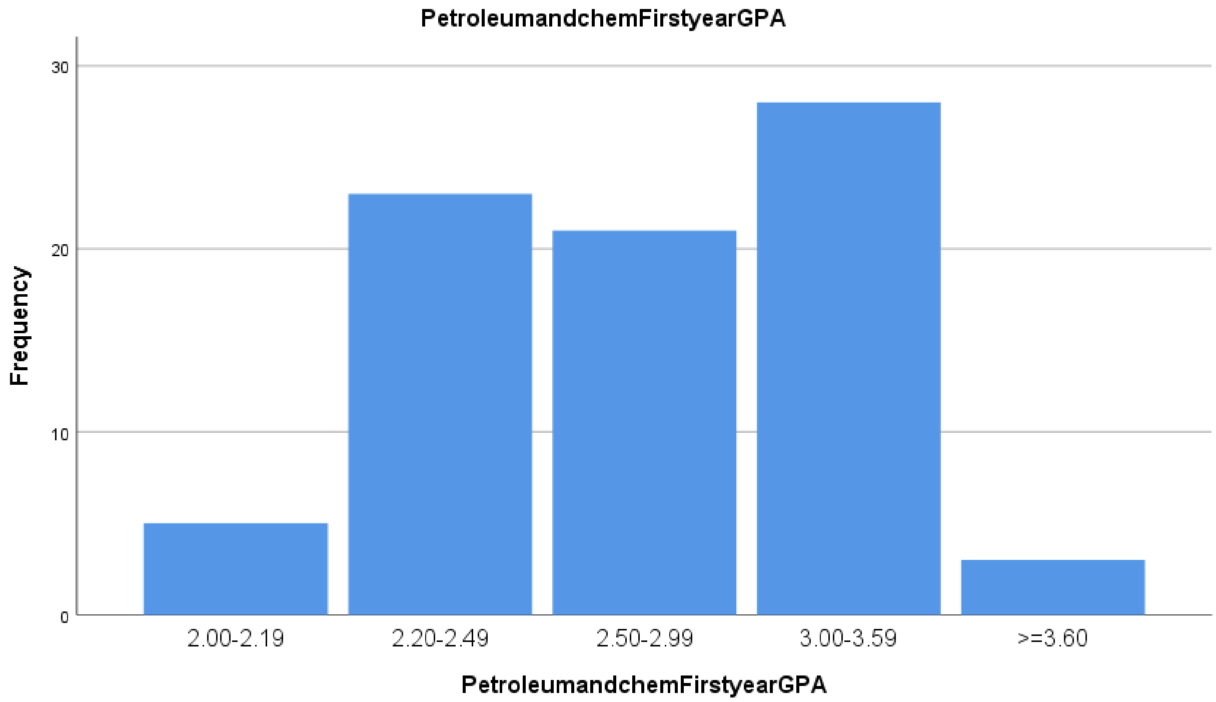
Table 81

Petroleum and Chemical Engineering First year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	5	1.0	6.3	6.3
	2.20-2.49	23	4.6	28.7	35.0
	2.50-2.99	21	4.2	26.3	61.3
	3.00-3.59	28	5.6	35.0	96.3
	>=3.60	3	.6	3.8	100.0
	Total	80	16.0	100.0	
Missing	System	420	84.0		
Total		500	100.0		

Figure 31

Petroleum and chemical Engineering First year GPA



The frequency table, and the bar chart reveal that 5(6.3%) of the Petroleum and chemical engineering students in the second year scored a GPA between 2.00 to 2.19. 23(28.7%) of the students scored a GPA between 2.20 and 2.49, 21(26.3%) of them scored a GPA between 2.50 and 2.99, 28(35.0%) of them scored a GPA between 3.00 and 3.59 and 3(3.8%) of the petroleum and chemical engineering students scored a GPA which is equal to or greater than 3.60.

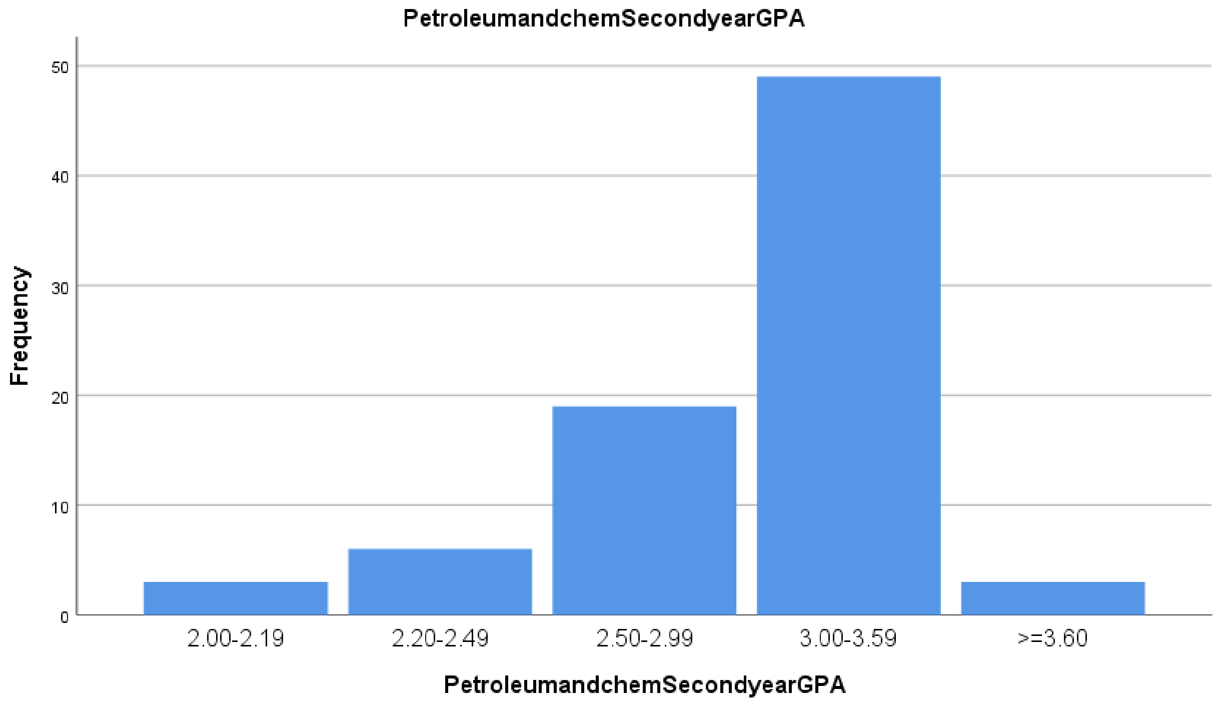
Table 82

Petroleum and Chemical Engineering Second year GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	3	.6	3.8	3.8
	2.20-2.49	6	1.2	7.5	11.3
	2.50-2.99	19	3.8	23.8	35.0
	3.00-3.59	49	9.8	61.3	96.3
	>=3.60	3	.6	3.8	100.0
	Total	80	16.0	100.0	
Missing	System	420	84.0		
Total		500	100.0		

Fig 32

Petroleum and Chemical Engineering Second year GPA



The frequency table, and the bar chart reveal that 3(3.8%) of the Petroleum and chemical engineering students in the second year scored a GPA between 2.00 to 2.19. 6(7.5%) of the students scored a GPA between 2.20 and 2.49, 19(23.8%) of them scored a GPA between 2.50 and 2.99, 49(61.3%) of them scored a GPA between 3.00 and 3.59 and 3(3.8%) of the petroleum and chemical engineering students scored a GPA which is equal to or greater than 3.60.

Table 83

Petroleum and Chemical Engineering Cumulative GPA

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00-2.19	3	.6	3.8	3.8
	2.20-2.49	7	1.4	8.8	12.5
	2.50-2.99	18	3.6	22.5	35.0
	3.00-3.59	49	9.8	61.3	96.3
	>=3.60	3	.6	3.8	100.0
	Total	80	16.0	100.0	
Missing	System	420	84.0		
Total		500	100.0		

Fig 33.a

Petroleum and Chemical Engineering Cumulative GPA

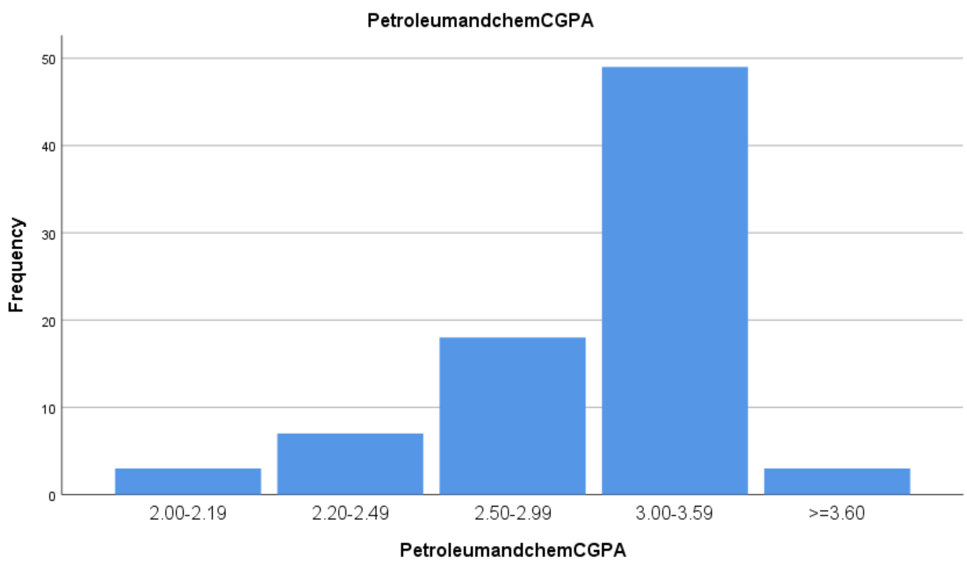
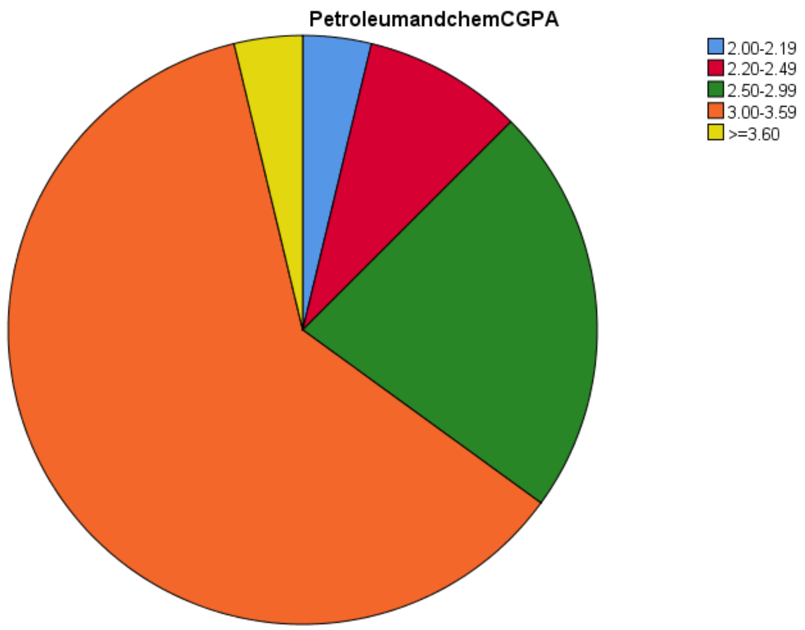


Fig 33.b

Petroleum and Chemical Engineering cumulative GPA



The frequency table, and the bar chart reveal that 3(3.8%) of the petroleum and chemical engineering students in the first and second year scored a CGPA between 2.00 to 2.19. 7(8.8%) of the students scored a CGPA between 2.20 and 2.49, 18(22.5%) of them scored a CGPA between 2.50 and 2.99, 49(61.3%) of them scored a CGPA between 3.00 and 3.59 and 3(3.8%) of the petroleum and chemical engineering students scored a CGPA which is equal to or greater than 3.60. The pie chart above also reveals that the greatest proportion of the petroleum and chemical engineering students scored between 3.0 to 3.59 CGPA

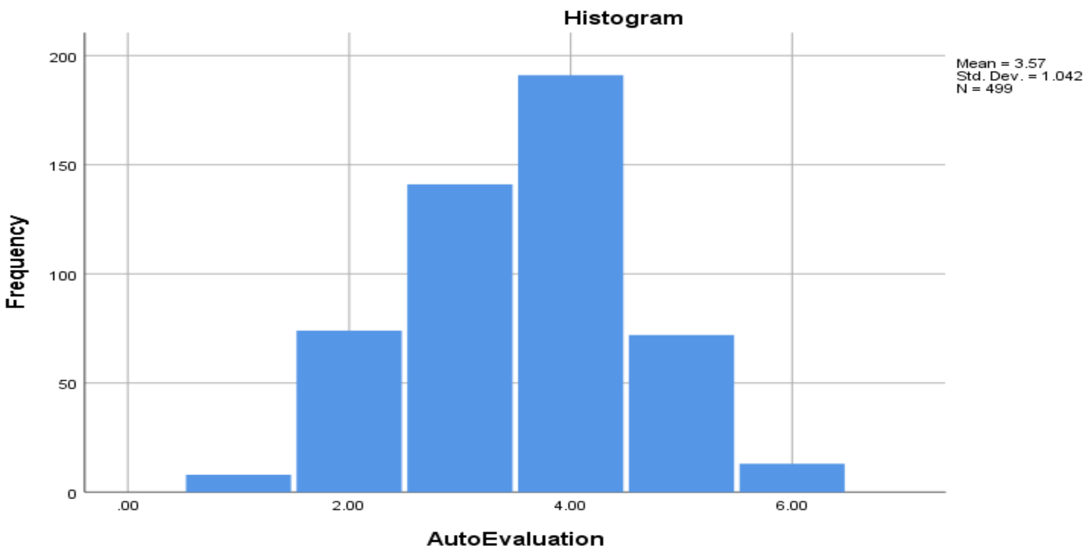
Students' Auto-Evaluation of their Academic Performance in Engineering

Table 84

Auto-Evaluation of Academic Performance in Engineering

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Poor	8	1.6	1.6	1.6
	Average	74	14.8	14.8	16.4
	Fair	141	28.2	28.3	44.7
	Good	191	38.2	38.3	83.0
	Very Goo	72	14.4	14.4	97.4
	Excellent	13	2.6	2.6	100.0
	Total	499	99.8	100.0	
Missing	System	1	.2		
Total		500	100.0		

Fig 34: Auto Evaluation of Engineering students



From the frequency table and Histogram above, 8(1.6%) of the engineering students considered their performance in engineering as' poor', while 74(14.8%) of the engineering students auto evaluated their performance in engineering as 'average'. Also, 141(28.3%) of the engineering students considered their academic performance in engineering as 'fair', 191(38.3%) of them affirmed their academic performance in engineering to be 'good', 72(14.4%) of the engineering students also affirmed that their academic performance in engineering was 'very good' and 13(2.6%) of the engineering students considered their academic performance in engineering to be excellent.

Verification of Hypotheses

Hypothesis One

Ho_1: GCE A/L results in sciences do not significantly predict students' academic performance in Engineering.

Ha_1: GCE A/L results in sciences significantly predict students' academic performance in Engineering

The multiple linear regression analyses were conducted to determine the extent to which GCE A/L results in sciences predict students' academic performance in the various branches of engineering considered in this study which are; civil engineering and Architecture, computer engineering, Electrical engineering, Mechanical engineering, Mining engineering and Petroleum and Chemical engineering.

GCE A/L results in sciences and students' academic performance in Civil engineering and Architecture

GCE A/L and First year GPA

Table 85.a.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.932[a]	.868	.857	.34739

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that 86.8% of the variability of students' performance in the first year in civil engineering is predicted by their GCE A/L results in the sciences.

Table 85.b.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	40.399	4	10.100	83.688	.000[b]
	Residual	6.155	51	.121		
	Total	46.554	55			

a. Dependent Variable: CivilandArchFirstyearGPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in sciences significantly predict students' academic performance in the first year in civil engineering F (4,51) = 83.69, *p* = 0.000

Table 85.c.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.174	.484		.360	.721
	PHYSICSGRADE	.839	.091	.627	9.252	.000
	CHEMGRADE	.213	.115	.109	1.848	.070
	MATHGRADE	-.329	.140	-.296	-2.354	.022
	FMATHGRADE	.316	.065	.621	4.855	.000

a. Dependent Variable: CivilandArchFirstyearGPA

From the table of coefficients above, the regression constant is 0.174. Physics grade, Mathematics grade and the grade scored in Further Mathematics significantly predict students' academic performance in the first year of civil engineering and the grade scored in Chemistry does not significantly predict the students' academic performance.

GCE A/L and Second year GPA

Table 86.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.932[a]	.868	.857	.34739

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that 86.8% of the variability of students' performance in the second year in civil engineering is predicted by their GCE A/L results in the sciences.

Table 86.b.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	40.399	4	10.100	83.688	.000[b]
	Residual	6.155	51	.121		
	Total	46.554	55			

a. Dependent Variable: CivilandArchSecondyearGPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in sciences significantly predict students' academic performance in the first year in civil engineering $F(4,51) = 83.69$, $p = 0.000$

Table 86.c.

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.174	.484		.360	.721
	PHYSICSGRADE	.839	.091	.627	9.252	.000
	CHEMGRADE	.213	.115	.109	1.848	.070
	MATHGRADE	-.329	.140	-.296	-2.354	.022
	FMATHGRADE	.316	.065	.621	4.855	.000

a. Dependent Variable: CivilandArchSecondyearGPA

From the table of coefficients above, the regression constant is 0.174. Physics grade, Mathematics grade and the grade scored in Further Mathematics significantly predict students' academic performance in the second year of civil engineering and the grade scored in Chemistry does not significantly predict the students' academic performance.

GCE A/L and CGPA in Civil Engineering and Architecture

Table 87.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.932[a]	.868	.857	.34739

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that 86.8% of the variability of students' performance in the first and second year in civil engineering is predicted by their GCE A/L results in the sciences.

Table 87.b.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	40.399	4	10.100	83.688	.000[b]
	Residual	6.155	51	.121		
	Total	46.554	55			

a. Dependent Variable: CivilandArchCGPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in sciences significantly predict students' academic performance in the first and second year in civil engineering F (4,51) = 83.69, p = 0.000

Table 87.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.174	.484		.360	.721
	PHYSICSGRADE	.839	.091	.627	9.252	.000
	CHEMGRADE	.213	.115	.109	1.848	.070
	MATHGRADE	-.329	.140	-.296	-2.354	.022
	FMATHGRADE	.316	.065	.621	4.855	.000

a. Dependent Variable: CivilandArchCGPA

From the table of coefficients above, the regression constant is 0.174. Physics grade, Mathematics grade and the grade scored in Further Mathematics significantly predict students' academic performance in the second year of civil engineering and the grade scored in Chemistry does not significantly predict the students' academic performance. The unstandardized coefficients for Physics is 0.89 with a standard error estimate (SEE) of 0.91, the unstandardized coefficient for chemistry is 0.115 and its SEE is 0.115, the unstandardized coefficient for Mathematics is 0.14 and the SEE is -1.29 and the unstandardized coefficient for Further Mathematics is 0.32 and its SEE is 0.65.

GCE A/L results in sciences and students' academic performance in Computer engineering

GCE A/L and first year GPA in computer engineering

Table 88.a.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.967[a]	.934	.898	.37187

a. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that 93.4% of the variability of students' performance in the first in civil engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics and Computer science.

Table 88.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	17.689	5	3.538	25.583	.000[b]
	Residual	1.245	9	.138		
	Total	18.933	14			

a. Dependent Variable: ComputerFirstyearGPA

b. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L result in Physics, in Chemistry, Mathematics, Further Mathematics and Computer science significantly predict students' academic performance in the first and second year in civil engineering F (5,9) = 25.58, p = 0.000

Table 88.c.

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.057	.325		-.176	.864
	PHYSICSGRADE	.135	.127	.169	1.065	.315
	CHEMGRADE	.162	.150	.171	1.083	.307
	MATHGRADE	.363	.192	.406	1.890	.091
	FMATHGRADE	.016	.087	.025	.185	.857
	COMPSCGRADE	.315	.292	.315	1.079	.309

a. Dependent Variable: ComputerFirstyearGPA

From the table of coefficients above, the coefficient of regression was -0.057, also, each of the science subjects were not significant predictors of students' academic performance in the first year in computer engineering.

GCE A/L and second year GPA in Computer engineering

Table 89.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.930[a]	.866	.791	.45261

a. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that 86.6% of the variability of students' performance in the first in civil engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics and Computer science.

Table 89.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11.890	5	2.378	11.608	.001[b]
	Residual	1.844	9	.205		
	Total	13.733	14			

a. Dependent Variable: ComputerSecondyearGPA

b. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in in Physics,in Chemistry, Mathematics, Further Mathematics and Computer science significantly predict students' academic performance in the second year in computer engineering F (5,9) = 11.61, p = 0.001

Table 89.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.150	.396		2.906	.017
	PHYSICSGRADE	.339	.154	.499	2.200	.055
	CHEMGRADE	.259	.182	.319	1.418	.190
	MATHGRADE	.354	.234	.465	1.516	.164
	FMATHGRADE	-.014	.106	-.026	-.134	.896
	COMPSCGRADE	-.168	.356	-.197	-.472	.648

a. Dependent Variable: ComputerSecondyearGPA

From the table of coefficients above, the constant of regression was 1.15, From amongst all the science subjects, only Physics was a significant predictor of students' academic performance in the second year in computer engineering, all the other science subjects were not significant predictors of students' academic performance in the second year in computer engineering.

GCE A/L and cumulative GPA in computer engineering

Table 90.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.927[a]	.859	.781	.44977

a. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that about 85.9% of variability students' academic performance in the first and second year of computer engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics and Computer science.

Table 90.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	11.113	5	2.223	10.987	.001[b]
	Residual	1.821	9	.202		
	Total	12.933	14			

a. Dependent Variable: ComputerCGPA

b. Predictors: (Constant), COMPSCGRADE, CHEMGRADE, FMATHGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in Physics, in Chemistry, Mathematics, Further Mathematics and Computer science significantly predict students' academic performance in the first and second year in computer engineering F (5,9) = 2.23, p = 0.001

Table 90.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.817	.393		2.077	.068
	PHYSICSGRADE	.253	.153	.383	1.651	.133
	CHEMGRADE	-.030	.181	-.039	-.167	.871
	MATHGRADE	.084	.232	.113	.360	.727
	FMATHGRADE	-.060	.105	-.113	-.574	.580
	COMPSCGRADE	.499	.354	.604	1.411	.192

a. Dependent Variable: ComputerCGPA

From the table of coefficients above, the constant of regression was 0.82, also, each of the science subjects were not significant predictors of students' academic performance in the first year in computer engineering.

GCE A/L and GPA in first year Electrical engineering

Table 91.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.911[a]	.830	.819	.47085

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that about 83% of variability students' academic performance in the first year of electrical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics.

Table 91.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	68.268	4	17.067	76.982	.000[b]
	Residual	13.967	63	.222		
	Total	82.235	67			

a. Dependent Variable: Electrical First year GPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in in Physics,in Chemistry, Mathematics, Further Mathematics significantly predict students' academic performance in the first year in electrical engineering F (4,63) = 76.98, $p = 0.000$

Table 91.c

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	.855	.247		3.458	.001
PHYSICSGRADE	.366	.078	.385	4.683	.000
CHEMGRADE	-.204	.080	-.164	-2.560	.013
MATHGRADE	.566	.077	.688	7.372	.000
FMATHGRADE	-.008	.065	-.010	-.123	.903

a. Dependent Variable: ElectricalFirstyearGPA

From the table of coefficients above, the constant of regression was 0.85. The grades scored in Physics, Chemistry and Mathematics significantly predict students' academic performance in the first year in electrical engineering while the grade scored in Further Mathematics does not predict students' academic performance in the first year in the electrical engineering department.

GCE A/L and GPA in Second Year Electrical engineering

Table 92.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.947[a]	.897	.891	.37157

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that about 83% of variability students' academic performance in the first year of electrical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics.

Table 92.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	75.817	4	18.954	137.287	.000[b]
	Residual	8.698	63	.138		
	Total	84.515	67			

a. Dependent Variable: ElectricalSecondyearGPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in Physics, in Chemistry, Mathematics, Further Mathematics significantly predict students' academic performance in the first year in electrical engineering F (4,63) = 76.98, p = 0.000

Table 92.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.571	.195		2.929	.005
	PHYSICSGRADE	.321	.062	.333	5.205	.000
	CHEMGRADE	-.029	.063	-.023	-.460	.647
	MATHGRADE	.484	.061	.580	7.985	.000
	FMATHGRADE	.103	.052	.133	2.005	.049

a. Dependent Variable: ElectricalSecondyearGPA

From the table of coefficients above, the constant of regression was 0.57. The grades scored in Physics and Mathematics significantly predict students' academic performance in the second year in electrical engineering while the grade scored in Further Mathematics and Chemistry does not predict students' academic performance in the first year in the electrical engineering department.

GCE A/L and cumulative GPA in Electrical engineering

Table 93.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.933[a]	.871	.862	.43013

a. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The model summary table above reveals that about 87.1% of variability students' academic performance in the first and second year of electrical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics.

Table 93.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.403	4	19.601	105.944	.000[b]
	Residual	11.656	63	.185		
	Total	90.059	67			

a. Dependent Variable: ElectricalCGPA

b. Predictors: (Constant), FMATHGRADE, CHEMGRADE, PHYSICSGRADE, MATHGRADE

The ANOVA table above reveals that GCE A/L results in Physics, in Chemistry, Mathematics, Further Mathematics significantly predict students' academic performance in the first and second year in electrical engineering F (4,63) = 105.94, *p* = 0.000

Table 93.c

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	.525	.226		2.324	.023
	PHYSICSGRADE	.368	.071	.371	5.162	.000
	CHEMGRADE	-.043	.073	-.033	-.593	.555
	MATHGRADE	.527	.070	.611	7.510	.000
	FMATHGRADE	.037	.060	.046	.618	.539

a. Dependent Variable: ElectricalCGPA

From the table of coefficients above, the constant of regression is 0.53. The grades scored in Physics, and Mathematics significantly predict students' academic performance in the first and second year in electrical engineering while the grade scored in Further Mathematics and Chemistry do not predict students' academic performance in the first year in the electrical engineering department.

GCE A/L results and students' Academic performance in Mechanical Engineering

GCE A/L and first year GPA in Mechanical Engineering

Table 94.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.884[a]	.782	.761	.41750

a. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The model summary table above reveals that 78.2% of the variability of students' academic performance in mechanical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics.

Table 94.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26.296	4	6.574	37.714	.000[b]
	Residual	7.321	42	.174		
	Total	33.617	46			

a. Dependent Variable: MechanicalFirstyearGPA

b. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The table of ANOVA above reveals that GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics significantly predict students' academic performance in Mechanical Engineering F (4, 42) = 37.71 $p = 0.000$

Table 94.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	1.868	.569		3.286	.002
	PHYSICSGRADE	.172	.062	.317	2.789	.008
	CHEMGRADE	.279	.069	.400	4.065	.000
	MATHGRADE	-.050	.168	-.042	-.296	.769
	FMATHGRADE	.258	.081	.385	3.191	.003

a. Dependent Variable: MechanicalFirstyearGPA

From the table of coefficients above, the regression constant for the regression model is 1.87. The table of coefficients above also reveals that the grade scored in Physics, Chemistry and Further Mathematics significantly predict students' academic performance in the first year in mechanical engineering.

GCE A/L and second year GPA in Mechanical engineering

Table 95.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.807[a]	.652	.619	.37139

a. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The model summary table above reveals that 78.2% of the variability of students' academic performance in mechanical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics.

Table 95.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.845	4	2.711	19.656	.000[b]
	Residual	5.793	42	.138		
	Total	16.638	46			

a. Dependent Variable: MechanicalSecondyearGPA

b. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The table of ANOVA above reveals that GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics significantly predict students' academic performance in Mechanical engineering, F (4, 42) = 19.67 p = 0.000.

Table 95.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.133	.506		4.218	.000
	PHYSICSGRADE	.087	.055	.227	1.582	.121
	CHEMGRADE	.234	.061	.477	3.833	.000
	MATHGRADE	.154	.150	.183	1.026	.311
	FMATHGRADE	.024	.072	.051	.337	.738

a. Dependent Variable: MechanicalSecondyearGPA

From the table of coefficients above, the regression constant for the regression model is 2.13. The table of coefficients above also reveals that the grade scored in Physics, Mathematics and Further Mathematics did not significantly predict students' academic performance in the second year in mechanical engineering while the grade scored in Chemistry significantly predict students' academic performance in the second year of mechanical engineering.

GCE A/L and cumulative GPA in Mechanical engineering

Table 96.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.807[a]	.652	.619	.37139

a. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The model summary table above reveals that 65.2% of the variability of students' academic performance in mechanical engineering is predicted by their GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics.

Table 96.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.845	4	2.711	19.656	.000[b]
	Residual	5.793	42	.138		
	Total	16.638	46			

a. Dependent Variable: MechanicalCGPA

b. Predictors: (Constant), FMATHGRADE, PHYSICSGRADE, CHEMGRADE, MATHGRADE

The table of ANOVA above reveals that GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics significantly predict students' academic performance in Mechanical engineering, F (4, 42) = 19.66 p = 0.000

Table 96.c

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.133	.506		4.218	.000
	PHYSICSGRADE	.087	.055	.227	1.582	.121
	CHEMGRADE	.234	.061	.477	3.833	.000
	MATHGRADE	.154	.150	.183	1.026	.311
	FMATHGRADE	.024	.072	.051	.337	.738

a. Dependent Variable: MechanicalCGPA

From the table of coefficients above, the regression constant for the regression model is 2.13. The table of coefficients above also reveals that the grade scored in Physics, Mathematics and Further Mathematics did not significantly predict students' academic performance in the first and second year in mechanical engineering, while the grade scored in Chemistry significantly predicted students' academic performance in Mechanical engineering in the first and the second year.

GCE A/L results and students' Academic performance in Mining engineering.

GCE A/L and first year GPA in mining engineering

Table 97a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.785[a]	.616	.590	.69474

a. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The model summary table above reveals that 61.6% of the variability of students' academic performance in mining engineering in the first yearis predicted by the grades scored in GCE A/L Chemistry and Geology.

Table 97.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	22.472	2	11.236	23.279	.000[b]
	Residual	13.997	29	.483		
	Total	36.469	31			

a. Dependent Variable: MiningFirstyearGPA

b. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The ANOVA table above reveals that the grades students score in Chemistry and Geology significantly predict their academic performance the first year in mining engineering, F (2,29) = 23.28 p = 0.000

Table 97.c

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	-.510	.508		-1.004	.324
CHEMGRADE	-.097	.178	-.078	-.541	.592
GEOLGRADE	.850	.147	.829	5.766	.000

a. Dependent Variable: MiningFirstyearGPA

The regression constant from the table above is -0.51. The grades scored in Chemistry does not predict students' academic performance in the first year in mining engineering while the grade scored in Geology significantly predict students' academic performance in the first year in mining engineering.

Table 98.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.915[a]	.837	.826	.36121

a. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The model summary table reveals that 83.7% of the variability of students' academic performance in mining engineering is predicted by the grades scored in Geology and Chemistry

Table 98.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.435	2	9.718	74.480	.000[b]
	Residual	3.784	29	.130		
	Total	23.219	31			

a. Dependent Variable: MiningSecondyearGPA

b. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The ANOVA table above reveals that the grades students score in the second year in mining engineering is significantly predicted by their high school results in Geology and Chemistry $F(2,29) = 74.48$, $p = 0.000$

Table 98.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.297	.264		1.124	.270
	CHEMGRADE	-.027	.093	-.027	-.292	.773
	GEOLGRADE	.761	.077	.931	9.936	.000

a. Dependent Variable: MiningSecondyearGPA

The regression constant from the table above is 0.29. The grades scored in Chemistry does not predict students' academic performance in the second year in mining engineering while the grade scored in Geology significantly predict students' academic performance in the second year in mining engineering.

GCE A/L and cumulative GPA in mining

Table 99.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.915[a]	.837	.826	.36121

a. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The model summary table reveals that 83.7% of the variability of students' academic performance in mining engineering is predicted by the grades scored in Geology and Chemistry

Table 99.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19.435	2	9.718	74.480	.000[b]
	Residual	3.784	29	.130		
	Total	23.219	31			

a. Dependent Variable: MiningCGPA

b. Predictors: (Constant), GEOLGRADE, CHEMGRADE

The ANOVA table above reveals that the grades students score in the second year in mining engineering is significantly predicted by their high school results in Geology and Chemistry $F\ (2,29) = 74.48$, $p = 0.000$

Table 99.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.297	.264		1.124	.270
	CHEMGRADE	-.027	.093	-.027	-.292	.773
	GEOLGRADE	.761	.077	.931	9.936	.000

a. Dependent Variable: MiningCGPA

The regression constant from the table above is 0.29. The grades scored in Chemistry does not predict students' academic performance in the second year in mining engineering while the grade scored in Geology significantly predict students academic performance in the first and second year in mining engineering.

GCE A/L results and students' academic performance in petroleum engineering

GCE A/L and students' GPA in first year of petroleum engineering

Table 100.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.972[a]	.944	.937	.20851

a. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The model summary table above reveals that 94.4% of the variability of students' academic performance is predicted by the grades they score in Geology, Physics and Chemistry at the GCE A/L

Table 100.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.000	3	5.667	130.333	.000[b]
	Residual	1.000	23	.043		
	Total	18.000	26			

a. Dependent Variable: PetroleumandchemFirstyearGPA

b. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The ANOVA table above reveals that the grades scored in Physics, Chemistry and Geology at the GCE A/L significantly predict students' academic performance in the first year in petroleum and chemical engineering F (3,23) = 5.67 $p = 0.000$

Table 100.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-2.500	.376		-6.651	.000
	PHYSICSGRADE	.167	.143	.160	1.163	.257
	CHEMGRADE	.333	.130	.357	2.563	.017
	GEOLGRADE	1.167	.115	.594	10.122	.000

a. Dependent Variable: PetroleumandchemFirstyearGPA

The table of coefficients above reveals that the constant in the regression model is -2.5 which is significant $p = 0.000$. It is also revealed that Geology and Chemistry grades significantly predict, but the grade scored in Physics at the GCE A/L does not predict students' academic performance in the first year in petroleum and chemical engineering

GCE A/L and students' GPA in second year petroleum engineering

Table 101.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.883[a]	.781	.752	.30889

a. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The model summary table above reveals that 78.1% of the variability of students' academic performance is predicted by the grades they score in Geology, Physics and Chemistry at the GCE A/L

Table 101.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.806	3	2.602	27.270	.000[b]
	Residual	2.194	23	.095		
	Total	10.000	26			

a. Dependent Variable: PetroleumandchemSecondyearGPA

b. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The ANOVA table above reveals that the grades scored in Physics, Chemistry and Geology at the GCE A/L significantly predict students' academic performance in the first year in petroleum and chemical engineering F (3,23) = 27.27 p = 0.000

Table 101.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-1.083	.557		-1.945	.064
	PHYSICSGRADE	.028	.212	.036	.131	.897
	CHEMGRADE	.056	.193	.080	.288	.776
	GEOLGRADE	1.194	.171	.816	6.996	.000

a. Dependent Variable: PetroleumandchemSecondyearGPA

The table of coefficients above reveals that the constant in the regression model is -1.08 .It is also revealed that Geology grade significantly students' academic performance predict, but the grade scored in Geology and Physics at the GCE A/L do not predict students' academic performance in the second year in petroleum and chemical engineering

GCE A/L and students' Cumulative GPA in third year Petroleum engineering

Table 102.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.899[a]	.808	.783	.32040

a. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The model summary table above reveals that 80.8% of the variability of students' academic performance is predicted by the grades they score in Geology, Physics and Chemistry at the GCE A/L

Table 102.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.935	3	3.312	32.260	.000[b]
	Residual	2.361	23	.103		
	Total	12.296	26			

a. Dependent Variable: PetroleumandchemCGPA

b. Predictors: (Constant), GEOLGRADE, PHYSICSGRADE, CHEMGRADE

The ANOVA table above reveals that the grades scored in Physics, Chemistry and Geology at the GCE A/L significantly predict students' academic performance in the first year in petroleum and chemical engineering F (3,23) = 32.26 p = 0.000

Table 102.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1.750	.578		-3.030	.006
	PHYSICSGRADE	.028	.220	.032	.126	.901
	CHEMGRADE	.056	.200	.072	.278	.783
	GEOLGRADE	1.361	.177	.839	7.685	.000

a. Dependent Variable: PetroleumandchemCGPA

The table of coefficients above reveals that the constant in the regression model is -1.75 which is significant p = 0.006. It is also revealed that the grade scored in Geology significantly predict students' academic performance, but the grade scored in Physics and Chemistry at the GCE A/L do not predict students' academic performance in the first year in petroleum and chemical engineering

Decision rule

GCE A/L results in sciences significantly predict students' academic performance in Civil engineering and Architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering and petroleum and chemical engineering. Therefore, the alternate hypothesis is retained while the alternate hypothesis is rejected.

Hypothesis Two

Ho2: BAC examination results in sciences do not significantly predict students' academic performance in Engineering.

Ha2: BAC examination results in sciences significantly predict students' academic performance in Engineering.

BACC 'C' results and students' academic performance in engineering

BAC 'C' and students' GPA in Civil engineering

Table 103.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950[a]	.902	.882	.21454

a. Predictors: (Constant), INFOBC, CHIMBC, PHYBC, MATHBC

The model summary table above reveals that of the 90.2% variability of students' academic performance in the first and second year of civil engineering could be accounted for by the grades they score in BAC 'C' in Informatique, Chimie, Physique, Mathematique.

Table 103.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.084	4	2.021	43.908	.000[b]
	Residual	.875	19	.046		
	Total	8.958	23			

a. Dependent Variable: CivilandArchCGPA

b. Predictors: (Constant), INFOBC, CHIMBC, PHYBC, MATHBC

The ANOVA table above reveals that the grades students score in BAC 'C' in Informatique, Chimie, Physique and Mathematique significantly predict students' academic performance in the first and second year in civil engineering and Architecture F (2,23) = 43.91, p = 0.000

Table 103.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.669	.408		4.093	.001
	PHYBC	.071	.093	.194	.767	.453
	CHIMBC	.304	.132	.431	2.307	.032
	MATHBC	-.297	.127	-.803	-2.346	.030
	INFOBC	.592	.092	1.306	6.448	.000

a. Dependent Variable: CivilandArchCGPA

The table of coefficients reveal that the regression constant for the prediction of students' academic performance by BAC 'C' results is 1.67 which is significant with p=0.001. The coefficient table above also reveals that the grades the students scored in Chimie, Mathematique and Informatique significantly predict students' academic performance in civil engineering and Architecture, while the grades scored in Physique does not significantly predict students' academic performance in civil engineering and Architecture.

BAC 'C' results and students' GPA in Computer engineering

Table 104.a.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.988[a]	.976	.916	.43147

a. Predictors: (Constant), CHIMBC, CHIMTP, INFOBC, PHYBC, MATHBC

The model summary table above reveals that 97.6% of the variability in students' performance in computer engineering is predicted by the grades they score in Physique, Chimie, Chimie TP, Informatique and Mathematiques.

Table 104.b.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.128	5	3.026	16.251	.059[b]
	Residual	.372	2	.186		
	Total	15.500	7			

a. Dependent Variable: ComputerCGPA

b. Predictors: (Constant), CHIMBC, CHIMTP, INFOBC, PHYBC, MATHBC

The ANOVA table above reveals that the BAC 'C' results in chimie, chimie TP, Physique, Mathematique and Informatique significantly predict students' academic performance in the first and second year of computer engineering F (5,2) = 16.25, p = 0.05

Table 104.c

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.511	.753		-.678	.567
	PHYBC	1.617	.273	1.077	5.933	.027
	MATHBC	-.287	2.222	-.231	-.129	.909
	INFOBC	.309	1.755	.288	.176	.877
	CHIMTP	-.362	.771	-.260	-.469	.685
	CHIMBC	-.064	.382	-.043	-.167	.883

a. Dependent Variable: ComputerCGPA

The table of coefficients above, reveals that the regression intercept was -0.511. The table also reveals that the grades computer engineering students score in BAC 'C' in Physique significantly predict their academic performance in the first and second year while the grades scored in Mathematique, Informatique, Chimie TP and Chimie do not significantly predict students' academic performance in the first and second year in computer engineering.

BAC 'C' results and students' academic performance in Electrical engineering

Table 105.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.598[a]	.357	-.607	1.60357

a. Predictors: (Constant), CHIMBC, PHYBC, MATHBC

From the model summary table above, 35.7% of the variability of students' performance in electrical engineering could be predicted by BAC 'C' results in Physique, Chimie and Mathematique

Table 105.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2.857	3	.952	.370	.787[b]
	Residual	5.143	2	2.571		
	Total	8.000	5			

a. Dependent Variable: ElectricalCGPA

b. Predictors: (Constant), CHIMBC, PHYBC, MATHBC

The ANOVA table above reveals that the BAC 'C' results in Physique, Mathematique and Chimie do not significantly predict students' academic performance in the first and second year of electrical engineering

Table 105.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.000	5.318		.564	.630
	MATHBC	1.429	3.090	1.557	.462	.689
	PHYBC	-.429	2.100	-.410	-.204	.857
	CHIMBC	-.857	3.534	-.606	-.243	.831

a. Dependent Variable: ElectricalCGPA

From the table of coefficients above, the regression intercept for the model is 3.00, and the grades scored in Physique, Chimie and Mathematique do not significantly predict students' academic performance in electrical engineering.

BAC 'C' results and students' academic performance in Mechanical engineering

Table 106.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.990[a]	.980	.960	.25257

a. Predictors: (Constant), INFOBC, MATHBC, CHIMBC, PHYBC

The model summary table above reveals that 98.0% of the variability of students' academic performance in mechanical engineering could be predicted by the grades students score in Physique, Chimie, Mathematique and Informatique

Table 106.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	12.634	4	3.158	49.513	.001[b]
	Residual	.255	4	.064		
	Total	12.889	8			

a. Dependent Variable: MechanicalCGPA

b. Predictors: (Constant), INFOBC, MATHBC, CHIMBC, PHYBC

The ANOVA table above reveals that the grades scored in Physique, Chimie, Mathematique and Informatique significantly predict students' academic performance in mechanical engineering with F(4,4) = 49.51, P = 0.001.

Table 106.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.644	.240		2.686	.055
	MATHBC	-.096	.106	-.108	-.903	.418
	PHYBC	.245	.125	.317	1.959	.122
	CHIMBC	.437	.148	.389	2.947	.042
	INFOBC	.373	.126	.436	2.955	.042

a. Dependent Variable: MechanicalCGPA

The table for coefficients above reveal that the regression intercept for the model is 0.64. The table also revealed that the grades scored in Chimie and Informatique significantly predict students' academic performance in mechanical engineering, while the grades scored in Mathematique and in Physique do not significantly predict students' academic performance in mechanical engineering.

BAC 'C' results in students' Academic performance in Mining Engineering

Table 107.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	1.000	.00000

a. Predictors: (Constant), MATHBC, CHIMBC, SVTBC

The model summary table above reveals that 100% of the variability of students' academic performance could be predicted by the grades students score Mathematique, Chimie and SVT in BAC 'C'

Table 107.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	9.333	3	3.111	.	.[b]
	Residual	.000	2	.000		
	Total	9.333	5			

a. Dependent Variable: MiningCGPA

b. Predictors: (Constant), MATHBC, CHIMBC, SVTBC

The ANOVA table above reveals that the grades scored in Chimie, SVT and in Math in BAC 'C' significantly predict students' academic performance in mining engineering. This prediction is excellent that is why there is no F-statistics for differences.

Table 107.c

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-.154	.000		-2576647.290	.000
	CHIMBC	-.154	.000	-.154	-16540651.227	.000
	SVTBC	.538	.000	.387	23103245.569	.000
	MATHBC	.538	.000	.580	35555144.726	.000

a. Dependent Variable: MiningCGPA

The table of coefficients above reveal the regression intercept for the regression model is -0.154 which was very significant p = 0.000 and standard error = 0.000. The table also reveals that the grades scored in Chimie, SVT and in Mathematiques in BAC ‘C’, each significantly predict students’ academic performance in mining engineering

BAC ‘C’ results in students’ Academic performance in Petroleum Engineering

Table 108.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.968[a]	.936	.904	.42576

a. Predictors: (Constant), MATHBC, CHIMBC, PHYBC, SVTBC

The model summary table above reveals that 93.6% of the variability of students’ academic performance in petroleum engineering could be accounted for by the grades they score in Mathematique, Chimie, Physique and SVT in BAC ‘C’.

Table 108.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	21.319	4	5.330	29.402	.000[b]
	Residual	1.450	8	.181		
	Total	22.769	12			

a. Dependent Variable: PetroleumandchemCGPA

b. Predictors: (Constant), MATHBC, CHIMBC, PHYBC, SVTBC

The table of ANOVA above reveals that the grades scored in Physique, Chimie, Mathematiques and SVT in BAC 'C' significantly predict students' academic performance in petroleum engineering F (4,8) = 29.402, p = 0.000

Table 108.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.623	.668		.933	.378
	CHIMBC	-.278	.197	-.162	-1.414	.195
	SVTBC	.011	.202	.013	.055	.958
	PHYBC	1.203	.207	.912	5.821	.000
	MATHBC	.130	.306	.130	.426	.682

a. Dependent Variable: PetroleumandchemCGPA

The table of coefficients above reveal that the regression intercept for the regression model is 0.623. It also reveals that from amongst all the science subjects which are predictors of students' academic performance in engineering, Physique is the only one which significantly predicts students' academic performance in petroleum engineering

BAC 'D' results and Students' Academic Performance in Engineering

BAC 'D' and GPA Scored in Civil Engineering

Table 109.a.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.971[a]	.942	.914	.44247

a. Predictors: (Constant), CHIMBD, INFOBD, MATHBD

The model summary table above reveals that the 94.2% of the variability of students' performance in civil engineering could be accounted for by the grades they scored in Chimie, Informatique and Mathematique at the BAC 'D' examinations

Table 109.b

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	19.225	3	6.408	32.732	.000[b]
	Residual	1.175	6	.196		
	Total	20.400	9			

a. Dependent Variable: CivilandArchCGPA

b. Predictors: (Constant), CHIMBD, INFOBD, MATHBD

The ANOVA table above reveals that students' grades in Chimie, Informatique and Mathematique significantly predict students' academic performance in civil engineering $F(3,6) = 32.73$, $p = 0.000$

Table 109.c

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.271	.506		.535	.612
	MATHBD	-.596	.573	-.522	-1.041	.338
	INFOBD	.434	.336	.265	1.289	.245
	CHIMBD	1.012	.307	1.299	3.295	.017

a. Dependent Variable: CivilandArchCGPA

The table of coefficients above reveal that the regression intercept for the model was 0.27. The table of coefficients also reveal that the grade scored in Chimie in BAC 'D' significantly predicted students' academic performance in civil engineering, while the grades scored in Mathematique and Informatique did not significantly predict students' performance in civil engineering.

BAC 'D' and GPA in Computer Engineering

Table 110.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.962[a]	.926	.816	.35921

a. Predictors: (Constant), CHIMBD, MATHBD, INFOBD

The model summary table above reveals that 92.6% of the variability of students' academic performance in computer engineering could be predicted by the grades they scored in Chimie, Mathematiques and Informatique at the BAC 'D' examinations.

Table 110.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.242	3	1.081	8.375	.109[b]
	Residual	.258	2	.129		
	Total	3.500	5			

a. Dependent Variable: ComputerCGPA

b. Predictors: (Constant), CHIMBD, MATHBD, INFOBD

The table of ANOVA above reveals that the grades scored in Chimie, Mathematique and Informatique did not significantly predict students' academic performance in Computer engineering.

Table 110.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.452	.470		5.220	.035
	MATHBD	-.323	.376	-.451	-.857	.482
	INFOBD	-.871	.500	-1.435	-1.743	.223
	CHIMBD	1.774	.465	2.568	3.814	.062

a. Dependent Variable: ComputerCGPA

From the table of coefficients above, the regression intercept for the model is 2.45. The table also reveal that neither Mathematique, Informatique nor Chimie were significant predictors to students' academic performance in computer engineering.

BAC 'D' results and students' GPA in Mining Engineering

Table 111.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.997[a]	.995	.987	.15811

a. Predictors: (Constant), SVTBD, MATHBD, CHIMBD

The model summary table above reveals that 99.5% of the variability of students' academic performance in mining engineering could be determined or explained by the grades scored in Chimie, SVT and Mathematique in BAC 'D'.

Table 111.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.283	3	3.094	123.778	.008[b]
	Residual	.050	2	.025		
	Total	9.333	5			

a. Dependent Variable: MiningCGPA
b. Predictors: (Constant), SVTBD, MATHBD, CHIMBD

The ANOVA table above reveals that the grades scored in Chimie, Mathematique and SVT in BAC 'D' significantly predict students' academic performance in mining engineering

Table 111.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.950	.499		-1.905	.197
	CHIMBD	.200	.173	.215	1.155	.368
	MATHBD	.150	.117	.098	1.279	.329
	SVTBD	1.200	.272	.786	4.419	.048

a. Dependent Variable: MiningCGPA

The table of coefficients above reveal that the regression intercept for the regression model is -0.95. The table also reveals that the grade scored in SVT significantly predict students' academic performance in mining engineering, while the grades scored in Chimie and Mathematique in BAC 'D' do not significantly predict students' academic performance in mining engineering.

BAC 'IT' results and students' GPA in Computer Engineering

Table 112.a

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	1.000[a]	1.000	.	.

a. Predictors: (Constant), INFOBIT, PHYBIT

From the model summary table above, 100% variability of students' academic performance in computer engineering could be explained from the grades they scored in Physique and in Informatique in BAC 'IT'.

Table 112.b

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.667	2	2.333	.	.[b]
	Residual	.000	0	.		
	Total	4.667	2			

a. Dependent Variable: ComputerCGPA

b. Predictors: (Constant), INFOBIT, PHYBIT

The ANOVA table above reveals that the grades students score in Physique and in Informatique in BAC 'IT' significantly predict their academic performance in computer engineering.

Table 112.c

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.500	.000		.	.
	PHYBIT	.500	.000	.567	.	.
	INFOBIT	.500	.000	.500	.	.

a. Dependent Variable: ComputerCGPA

The table of coefficient above reveal that the regression intercept for the regression model was 0.5. It also reveals that the grades scored in Physique and in Informatique in the BAC 'IT' examination significantly predict students' academic performance in computer engineering

Decision Rule

BAC 'C' results significantly predict students' academic performance in Civil engineering and Architecture, Computer engineering, mechanical engineering, mining engineering and petroleum and chemical engineering, but does not significantly predict students' academic performance in electrical engineering. BAC 'D' results significantly predict students' academic performance in civil engineering and architecture, in computer engineering and in mining engineering. BAC 'IT' results significantly predict students' academic performance in computer engineering.

The alternate hypothesis is retained for BAC 'C' results and all the other branches of engineering except for electrical engineering where the null hypothesis is retained. The alternate hypothesis is also retained for BAC 'D' and civil engineering and architecture, computer engineering and mining engineering. Furthermore, the alternate hypothesis is retained for BAC 'IT' and computer engineering.

Hypothesis Three

Ho3: High School results in sciences do not significantly predict students' academic performance in engineering differently in terms of gender

Ha3: High School results in sciences significantly predict students' academic performance in engineering differently in terms of gender.

This hypothesis was tested by carrying out multiple linear regression analysis for the prediction of students' academic performance in the various branches of engineering considered in this study from various high school results in the study for the male students and for the female students. From the output of the multiple linear regression analysis, the standard error of estimates (SEE) for the male and female engineering students for the various engineering departments were compared in order to test for differential prediction. That is different SEE values signify differential prediction for the male and the female while the same value of SEE signify non differential prediction. But in the case where the SEE values are similar further comparisons are made with the regression intercepts in order to determine if the predictors predict the criterion in the same way. The residuals indicate normal prediction, over prediction and under prediction. That is when the residual has a positive value, it signifies under prediction, when the residual has a negative value, it signifies over prediction and when it has a value of zero, it signifies normal prediction.

Table 113

Differential prediction of academic performance in engineering by High school results with respect to gender

		CATEGORIES							
		MALE				FEMALE			
Dept	**Predictors (GCEA/L)**	**Bo**	**SEE**	**R^2**	**Residual**	**Bo**	**SEE**	**R^2**	**Residual**
Civil&ArcHit	Phy,chem,math,F.Math	1.33	0.42	0.86	6.0	-1.0	0.000	1.0	0.000
Comp.	Phy,Chem,Math,Fmah,compSc	0.4	0.55	0.81	8.9	0.45	0.19	0.98	0.17
Elec	Phy, Chem, Math,Fmath	0.67	0.44	0.88	8.5	2.3	0.27	0.95	0.92
Mech	Phy, Chem, Math, Fmath	2.45	0.17	0.89	0.80	5.5	0.000	1.000	0.000
Mining	Chem & Gll	0.39	0.45	0.83	3.2	3.0	0.000	1.000	0.000
Petro&cheM	Phy,chem,Gl	-0.80	0.22	0.87	0.8	0.000	0.000	1.000	0.000
	BAC 'C'Predictors								
Civil&ArcH	Phy,Chim,Math,Info	8.0	0.000	1.000	0.000	3.5	0.5	0.9	0.85
Comp	Phy,Chim,Info,Math,ChTP	-5.1	0.43	0.98	0.37	2.14	0.8	0.04	0.64
Electrical	Phy,Chim,Math	0.000	0.000	1.000	0.000	3.000	0.000	1.000	0.000

Mech	Phy,Chim,Math, Info	0.5	0.000	1.000	0.000	0.250	0.000	1.000	0.000
Mining	Chim,SVT,Math	1.3	0.71	0.90	0.5	-1.5	0.71	0.75	0.5
Petro&CheM	Chim,Phy,Svt,Math	2.000	0.000	1.000	0.000	0.4	0.6	0.85	0.9
	BAC ‘D’ Predictors								
Civil&ArcH	Chim,Math,Info	5.50	0.41	0.38	0.50	0.000	0.000	1.000	0.000
Comp	Chim,Math,Info	3.0	0.45	0.94	0.2	0.2	0.65	0.95	0.92
Mining	Chim,Math,Info	9.3	0.16	0.99	0.05	0.000	0.000	1.000	0.000
	BAC ‘IT’ Predictors								
Comp	Phy, Info	0.5	0.000	1.000	0.000	0.38	0.40	0.80	3.1

From the table above, GCE A/L results in sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering differently in terms of gender. The residuals for the prediction of students' academic performance in computer engineering and in electrical engineering are positive for female engineering students, which implies that the GCE A/L results in the sciences under predicted students' academic performance in these two engineering departments for female students. The residuals were positive for all the six engineering departments for the male engineering students, which implies that the GCE A/L results in sciences under predicted students' academic performance in all the six engineering departments in this study.

BAC 'C' results in the sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering, and in petroleum and chemical engineering differently in terms of gender, while BAC 'C' results in sciences do not significantly predict students' academic performance in electrical engineering, mechanical engineering, and in mining engineering differently in terms of gender. These results under predicted students' academic performance in civil engineering and architecture, computer engineering, mining engineering and in petroleum and chemical engineering for the female engineering students, while the high school results under predicted male engineering students' academic performance in computer engineering, and mining engineering.

BAC 'D' results in sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering and in mining engineering differently in terms of gender. These results under predicted female students' computer engineering and under predicted male students' academic performance civil engineering and architecture, computer engineering and mining engineering. BAC 'IT' results in the sciences significantly predict students' academic performance in computer engineering differently in terms of gender. These results under predicted female students' academic performance in computer engineering.

Decision Rule

The alternate hypothesis is retained for GCE A/L results and students' academic performance in all the six branches of engineering, while the null hypothesis is rejected. The alternate hypothesis is also retained for BAC 'C' results and students' academic performance in civil engineering and architecture, computer engineering and in petroleum and chemical engineering. The alternate hypothesis is retained BAC 'D' results in sciences and students' academic performance in engineering in civil engineering and architecture, computer engineering and mining engineering. The alternate hypothesis is also retained for BAC 'IT' results in sciences and students' academic performance in computer engineering.

Hypothesis Four

Ho4: High school results in sciences do not significantly predict students' academic performance in engineering differently in terms of their motivation for engineering studies

Ha4: High school results in sciences significantly predict students' academic performance in engineering differently in terms of their motivation for engineering studies.

This hypothesis was tested by carrying out multiple linear regression analysis using the four different degrees or levels of motivation for engineering studies for the prediction of students' academic performance in the various branches of engineering considered in this study from various high school results. From the output of the multiple linear regression analysis, the standard error of estimates (SEE) for the different levels of students' motivation for engineering studies for the various engineering departments were compared in order to test for differential prediction. That is different SEE values signify differential prediction for the students with the various levels of motivation for engineering studies. while the same value of SEE signify non differential prediction. But in the case where the SES values are similar further comparisons are made with the regression intercepts in order to determine if the predictors predict the criterion in the same way. The residuals indicate normal prediction, over prediction or under prediction. That is when the residual has a positive value, it signifies under prediction, when the residual has a negative value, it signifies over prediction and when it has a value of zero, it signifies normal prediction.

Table 114

Differential Prediction of students' Academic Performance in engineering by High School results with respect to their motivation for engineering studies

CATEGORIES

		Lowly Motivated				**Averagely Motivated**				**Fairly Motivated**				**Highly Motivated**			
Dept	Predictors GCE A/L	Bo	SEE	R^2	Residual	Bo	SEE	R^2	Residual	Bo	SEE	R^2	Residual	Bo	SEE	R^2	Residual
Civil&Arch	Phy,Chem,Math ,Fmath	No valid case				4.33	0.00	1.00	0.00	2.00	0.00	1.00	0.00	2.3	0.00	1.00	0.00
Comp	Phy,Chem,Math ,Fmath	1.50	0.00	1.00	0.00	2.22	0.00	1.00	0.00	0.22	0.47	0.90	2.23	-0.51	0.42	0.89	2.99
Elec	Phy,Chem,Math ,Fmath	-2.00	0.00	1.00	0.00	2.00	0.00	1.00	0.00	1.13	0.47	0.82	7.86	0.00	0.00	1.00	0.00
Mech	Phy,Chem,Math ,Fmath	No Valid Case				2.50	0.00	1.00	0.00	3.39	0.00	1.00	0.00	3.33	0.00	1.00	0.00
Mining	Chem&Gl	No Valid Case				0.32	0.22	0.96	0.75	Dv is Constant				-1.00	0.00	1.00	0.00
Petr&Chem	Phy,chem,Gl	1.20	0.00	1.00	0.00	2.10	0.00	1.00	0.00	0.20	0.41	0.90	2.2	-0.31	0.37	0.89	2.78
BAC 'C'Predictors																	
Civil&Arch	Phy,Chim,Math, Info	No Valid Case				2.67	0.00	1.00	0.00	2.93	0.3	0.86	0.8	DV is Constant			

Comp	Phy,chim,Math, Info,ChTP	2.00	0.00	1.00	0.00	2.00	0.00	1.00	0.00	-1.00	0.00	1.00	0.00	2.00	0.00	1.00	0.00
Elec	Phy,Chim,Math	2.45	0.00	1.00	0.00	3.00	0.00	1.00	0.00	4.50	0.00	1.00	0.00	DV is Constant			
Mech	Phy,Chim,Math, info	No Valid Case				-3.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00	-0.43	022	0.87	0.90
Mining	Chimie,SVT,Math	3.00	0.00	1.00	0.00	2.00	0.00	1.00	0.00	1.50	0.00	1.00	0.00	5.50	0.75	0.9	0.5
Petr&chem	Chim,SVT,Phy, Math	No Valid Case				-1.00	0.00	1.00	0.00	0.50	0.00	1.00	0.00	2.00	0.00	1.00	0.00
BAC’D’ Predictors																	
Civil&Arch	Chim,Math,Info	No Valid Case				No Valid Case				5.50	0.41	0.38	0.50	2.90	0.00	1.00	0.00
Comp	Chim,Math,Info	No valid case				2.33	0.00	1.00	0.00	1.00	0.00	1.00	0.00	No valid case			
Mining	Chim, Math, SVT	1.30	0.71	0.90	0.50	4.50	0.00	1.00	0.00	1.50	0.00	1.00	0.00	0.39	0.45	0.83	3.2
BAC ‘IT’ Predictors																	
Comp	Phy,Info	No valid Case				1.00	0.00	1.00	0.00	0.50	0.00	1.00	0.00	2.4	0.17	0.86	0.80

From the table above, GCE A/L results in sciences significantly predict students' academic performance differently in terms of students' motivation for engineering studies in Computer engineering, electrical engineering, mining engineering and in petroleum and chemical engineering. The GCE A/L results in sciences under predicted the academic performance of students who were averagely motivated in mining engineering, those who were fairly motivated in the departments of computer and electrical engineering, and those who were highly motivated in the departments of computer engineering and in petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture, electrical engineering, mechanical engineering and mining engineering. BAC 'C' results underpredicted the academic performance of students who were fairly motivated in the department of civil engineering and architecture and for students who were highly motivated in the departments of mechanical and mining engineering. BAC 'D' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture and mining engineering. BAC 'D' results under predicted the academic performance of students who were fairly motivated in the department of civil engineering and architecture and those who were highly motivated in the department of mining engineering. BAC 'IT' results significantly predicedt students' academic performance differently in terms of their motivation for engineering studies in the department of computer engineering. BAC 'IT' results underpredicted the academic performance of students who were highly motivated in the department of computer engineering.

Decision Rule

The alternate hypothesis is retained for the differential prediction of students' academic performance in computer engineering, electrical engineering, mining engineering and petroleum and chemical engineering by their GCE A/L results. The alternate hypothesis is also retained for the differential prediction of students' academic performance in terms of students' motivation for engineering studies for students' academic performance in civil engineering and architecture, electrical engineering, mechanical and mining engineering by the results they scored in BAC 'C'. The alternate hypothesis is also retained for the differential prediction of students' academic performance in civil engineering and in mining engineering by BAC 'D' results. The alternate hypothesis is also retained for the differential prediction of students' academic performance in computer engineering by BAC 'IT' results.

Hypothesis Five

H_{05}: High school results in sciences do not significantly predict students' academic performance differently in terms of the type of high school they attended

H_{a5}: High school results in sciences predict students' academic performance in engineering differently in terms of the type of high school they attended.

This hypothesis was tested by carrying out multiple linear regression analysis for the prediction of students' academic performance in the various branches of engineering considered in this study from various high school results in the study for students from public, mission and private high schools respectively. From the output of the multiple linear regression analysis, the standard error of estimates (SEE) for the engineering students from the various types of high schools in the various engineering departments were compared in order to test for differential prediction. That is different SEE values signify differential prediction for the students with respect to the type of high school they attended while the same value of SEE signify non differential prediction. But in the case where the SES values are similar further comparisons could be made with the regression intercepts in order to determine if the predictors predict the criterion in the same way. The residuals indicate normal prediction, over prediction and under prediction. That is when the residual has a positive value, it signifies under prediction, when the residual has a negative value, it signifies over prediction and when it has a value of zero, it signifies normal prediction.

Table 115

Differential Prediction of students' academic performance in Engineering by High school results with respect to type of high school attended.

CATEGORIES

		Public				**Mission**				**Private**			
Dept	**PredGCE A/L**	**Bo**	**SEE**	**R^2**	**Res**	**Bo**	**SEE**	**R^2**	**Res**	**Bo**	**SEE**	**R^2**	**Res**
Civil&arch	Phy,chem, Mat,Fmath	4.30	0.00	1.00	0.00	2.00	0.00	1.00	0.00	0.67	0.00	1.00	0.00
Comp	Phy,Chem, Math,Fmath,Comp	0.00	0.00	1.00	0.00	5.43	0.00	1.00	0.00	0.00	0.00	1.00	0.00
Elec	Phy,Chem, Math,Fmath	-0.04	0.24	0.96	2.71	2.00	0.00	1.00	0.00	-2.00	0.00	1.00	0.00
Mech	Phy,Chem, Math,Fmath	0.75	0.00	1.00	0.00	2.20	0.00	1.00	0.00	0.00	0.00	1.00	0.00
Mining	Chem&Geol	0.33	0.41	0.81	3.49	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00
Petr&Chem	Phy,Chem, Geol	-0.67	0.26	0.86	0.83	DV is Constant				-2.00	0.00	1.00	0.00
	BAC 'C' Predictors												
Civil&arch	Phy,Chim, Math,Info	2.67	0.00	1.00	0.00	0.45	0.00	1.00	0.00	DV is Constant			
Comp	Phy,Chim,	10.80	0.51	0.92	0.57	4.0	0.00	1.00	0.00	No valid Case			

	Math,Info, ChimTP					0							
Elec	Phy,Chim, Math	0.45	0.00	1.00	0.00	3.0	0.00	1.00	0.00	4.3	0.00	1.00	0.00
Mech	Phy,Chim, Math	0.50	0.00	1.00	0.00	0.00	0.00	1.00	0.00	2.75	0.72	0.9	0.6
Mining	Chim,SVT, Math	-4.00	0.20	0.84	0.82	No Valid Case				0.30	0.00	1.00	0.00
Petr&Chem	Phy,Chim,SVT,Math,	15.50	0.74	0.90	0.65	2.00	0.00	1.00	0.00	0,00	0.00	1.00	0.00
	BAC ‘D’Predictors												
Civil&arch	Chim,Math, Info	5.50	0.41	0.38	0.50	No Valid Case				0.30	0.00	1.00	0.00
Comp	Chim,Math, Info	0.50	0.00	1.00	0.00	0.00	0.00	1.00	0.00	7.00	0.00	1.00	0.00
Mining	Chim,Math, SVT	-0.95	0.16	0.99	0.05	No Valid Case				-1.00	0.00	1.00	0.00
	BAC ‘IT’ Predictors												
Comp	Phy,Info	2.67	0.43	0.83	3.54	2.0	0.00	1.00	0.00	0.67	0.00	1.00	0.00

From the table above, GCE A/L results in sciences significantly predicted students’ academic performance differently in terms of the type of high school they attended in electrical engineering, mining engineering and in petroleum and chemical engineering.

The GCE A/L results in sciences also under predicted the academic performance in electrical engineering, mining engineering and in petroleum and chemical engineering for students from public high schools. This therefore signifies that the academic performance of students from public high schools in engineering schools is more than depicts their GCE A/L results. BAC ‘C’ results significantly predicted students’ academic performance differently in terms of the type of high school they attended in the departments of computer engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering. BAC ‘C’ results underpredicted the academic performance of students from public high schools in the departments of computer enineering, the department of mining engineering and the department of petroleum and chemical engineering and also underpredicted students’ academic performance for students from private high schools in the department of mechanical engineering. BAC ‘D’ results significantly predict students’ academic performance differently in terms of the type of high school the engineering students attended in civil engineering and architecture, and in mining engineering. There was also under prediction of students’ academic performance in civil engineering and architecture and in mining engineering by their BAC ‘D’ results. BAC ‘IT’ results also significantly predicted students’ academic performance in computer engineering differently in terms of the type of high school attended by the computer engineering students. Furthermore, BAC ‘IT’ results underpredicted the academic performance of students from public high schools in the department of computer engineering.

Decision Rule

The alternate hypothesis is retained for the differential prediction of students’ academic performance in electrical engineering, mining engineering and in petroleum and chemical engineering by GCE A/L results. The alternate hypothesis was retained for the differential prediction of students’ academic performance in the departments of computer engineering, mechanical engineering, mining engineering and petroleum and chemical engineering in in terms of the type of high school attended by BAC ‘C’ results. Moreover, the alternate hypothesis was retained for the differential prediction of students’ academic performance in civil engineering and architecture and mining engineering by BAC ‘D’ results. Also, the alternate hypothesis was retained for the differential prediction students' academic performance in computer engineering by their BAC 'IT' results.

Table 116 a

Summary of Findings on predictions of students' academic performance in engineering from their high school results

Predictors (GCE A/L)	**Engineering Dept**	**Level of study**	**R^2**	**Adjusted R^2**	**Df**	**F-Stats**	**Significance**
Phy,Chem,Math,F.Math	Civil Eng & Arch	1	0.87	0.86	4,51	83.69	0.000
		2	0.87	0.86	4,51	83.69	0.000
		1&2	0.87	0.86	4,51	83.69	0.000
Phy,Chem,Math,F.Math	Comp.Eng	1	0.93	0.89	5,59	25.53	0.000
		2	0.87	0.79	5,59	11.61	0.001
		1&2	0.86	0.78	5,59	10.99	0.001
Phy,Chem,Math,Fmath	Elec.Eng	1	0.83	0.82	4,63	76.9	0.000
		2	0.95	0.89	4,63	137.29	0.000
		1&2	0.87	0.86	4,63	105,94	0.000
Phy,Chem,Math,F.Math	Mech.Eng	1	0.78	0.76	4,42	37.71	0.000
		2	0.65	0.62	4,42	19.66	0.000
		1&2	0.65	0.62	4,42	19.66	0.000
Chem and Geol	Mining	1	0.62	0.59	2,29	23.28	0.000
		2	0.84	0.83	2,29	74.48	0.000

		1&2	0.84	0.83	2,29	74.48	0.000
Phy,Chem,Geol	Petro&cheM	1	0.94	0.93	3,23	130.33	0.000
		2	0.78	0.75	3,23	27.27	0.000
		1&2	0.81	0.78	3,23	32.26	0.000
BAC 'C'							
Phy,Chim,Math,Info,	Civil&ArcH	1	0.99	0.99	4,19	143.63	0.000
		2	0.90	0.88	4,19	43.91	0.000
		1&2	0.90	0.88	4,19	43.91	0.000
Phy,Math,Info,ChimTP, Chim	Comp.Eng	1	0.99	0.95	5,2	27.26	0.036
		2	0.97	0.90	5,2	14.127	0.06
		1&2	0.98	0.92	5,2	16.25	0.05
Phy,Chim,Math	Elec.Eng	1	0.36	-0.61	3,2	0.37	0.79
		2	0.67	0.16	3,2	1.33	0.46
		1&2	0.36	-0.61	3,2	0.37	0.79
Phy,Math,Chim,Info	Mech	1	0.98	0.96	4,4	49.51	0.001
		2	0.93	0.86	4,4	13.65	0.01
		1&2	0.98	0.96	4,4	49.51	0.001
Chim,SVT,Math	Mining	1	1.00	1.00	3,2	0.00	0.000
		2	1.00	1.00	3,2	0.00	0.000

		1&2	1.00	1.00	3,2	0.00	0.000
Phy,Chim,SVT,Math	Petro&CheM	1	0.95	0.92	4,8	35.26	0.000
		2	0.97	0.90	4,8	29.40	0.000
		1&2	0.94	0.90	4,8	29.40	0.000
BAC 'D'							
Math, Info, Chim	Civil& Arch	1	0.96	0.94	3,6	46.84	0.000
		2	0.95	0.93	3,6	38.45	0.000
		1&2	0.94	0.91	3,6	32.72	0.000
Math, Chim Info	Comp.Eng	1	1.00	1.00	3,2	0.00	0.000
		2	0.64	0.09	3,2	1.10	0.50
		1&2	0.93	0.82	3,2	8.38	0.11
Math, Chim,SVT	Mining	1	0.99	0.98	3,2	123.78	0.08
		2	0.99	0.98	3,2	123.78	0.08
		1&2	0.99	0.98	3,2	123.78	0.008
BAC 'IT'							
Phy, Info	Comp.Eng	1	1.00	0.00	2,0	0.00	0.000
		2	1.00	0.00	2,0	0.00	0.000
		1&2	1.00	0.00	2,0	0.00	0.000

Table 116.b

Summary of findings on Differential Prediction of students' Academic Performance in Engineering

Predictors	Eng.Dept	DIFFERENTIAL PREDICTION		
GCE A/L		**Gender**	**Motivation for Eng. studies**	**Type of High School**
Phy,Chem,Math,F.Math	Civil&Arc	*	*	ns
Phy,Chem,Math,F.Math ,Comp	Comp.Eng	*	*	ns
Phy,Chem,Math,F.Math	Elec	*	*	*
Phy,Chem,Math,F.Math	Mech	*	ns	ns
Chem, Geol	Mining	*	*	*
Phy,Chem,Geol	Petro &Chem	*	*	*
BAC 'C				
Phy,Chim,Math,Info	Civil & Arc	*	*	ns
Phy,Chim,Math,Info, Chim TP	Comp.Eng	*	Ns	*
Phy,Chim,Math	Elec	Ns	*	ns
Phy,Chem, Math, Info	Mech	ns	*	*
Chim,SVT,Math	Mining	*	*	*
Phy,Chim,Math,SVT	Petro&Chem	*	Ns	*
BAC 'D'				
Chim,Math,Info	Civil &Arc	*	*	*
Chim,Math,Info	Comp.Eng	*	*	ns
Chim,Math,SVT	Mining	*	*	*
BAC 'IT'				
Phy, Info	Comp.Eng	*	*	*

significant = *, non significant = ns

From the summary tables above, the findings reveaed that;

1) GCE A/L results in sciences significantly predict students' academic performance in Civil engineering and Architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering

2) BAC 'C' results significantly predict students' academic performance in Civil engineering and Architecture, Computer engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering, but does not significantly predict students' academic performance in electrical engineering. BAC 'D' results significantly predict students' academic performance in civil engineering and

architecture, and in mining engineering, but did not significantly predict students' academic performance in computer engineering. BAC 'IT' results significantly predict students' academic performance in computer engineering.

3) GCE A/L results in sciences significantly predict students' academic performance in civil engineering and architecture, electrical engineering, Compute engineeringr mechanical engineering mining engineering and in petroleum and chemical engineering differently in terms of gender. BAC 'C' results in the sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering, and in petroleum and chemical engineering differently in terms of gender. BAC 'D' results in sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering and in mining engineering differently in terms of gender. BAC 'IT' results in the sciences significantly predict students' academic performance in computer engineering differently in terms of gender.

4) GCE A/L results in sciences significantly predict students' academic performance differently in terms of their motivation for engineering studies in Computer engineering, electrical engineering, mining engineering and in petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture, electrical engineering, mechanical engineering and mining engineering while BAC 'D' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture and mining engineering, and, BAC 'IT' results also significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the department of computer engineering.

5) GCE A/L results in sciences significantly predicted students' academic performance differently in terms of the type of high school they attended in electrical engineering, mining engineering and in petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance in computer engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering differently in terms of the type of high school they attended. BAC 'D' results significantly predict students' academic performance differently in terms of the type of high school the engineering students attended in civil engineering and architecture, and

in mining engineerin and BAC ‘IT’ results also significantly predicted students’ academic performance in computer engineering differently in terms of the type of high school attended by the computer engineering students.

6) From the multiple linear regressions carried out for the prediction of students’ academic performance in the various branches of engineering by their high school results, the regression models for the prediction of students’ academic performance in various branches of engineering were derived. The differential prediction analysis also done gives an insight on how each of the regression models could be used given that within any population there are different sub groups who might have have different characteristics and potentials.

The regression models are as follows

Regression models with GCE A/L Results

1)Civil Engineering and Architecture

Y = 0.17 + 0.84 (Physics Grade) + 0.21 (Chem Grade) + 0.33 (Maths grade) + 0.32 (F.Maths Grade)

2)Computer Engineering

Y = 0.82 + 0.25 (Physics Grade) + 0.3 (Chem Grade) + 0.84 (Maths Grade)+ 0.06 (Fmaths Grade) + 0.49 (Comp Sc. Grade)

3)Electrical Engineering

Y = 0.53 + 0.37 (Physics Grade) + 0.43 (Chem Grade) + 0.53 (Maths Grade) + 0.37 (Fmaths Grade)

4)Mechanical Engineering

Y = 2.13 + 0.087 (Physics Grade) + 0.234 (Chem Grade) + 0.154 (Maths Grade) + 0.24 (Fmaths Grade)

5)Mining Engineering

Y = 0.29 +0.27(Chem Grade) + 0.76(Geol Grade)

6)Petroleum and Chemical Engineering

Y = -1.75 + 0.028 (Physics Grade) + 0.056 (Chem Grade) + 1.36 (Geol Grade)

Regression models with BAC 'C' Results

1)Civil Engineering and Architecture

Y= 1.67 + 0.071(Physique Grade) + 0.30 (Chim Grade) + 2.97(Math Grade) + 0.59(Info Grade)

2)Computer Engineering

Y = 5.11+ 1.62 (Physique Grade) + 2.87(Math Grade) + 0.31(Info Grade) - 0.36(ChimTP grade) - 0.64 (Chim Grade**).**

3)Electrical Engineering

Y = 3.0 + 1.43 (Maths Grade) + 0.43 (Physics Grade) + 0.86 (Chim Grade)

4)Mechanical Engineering

Y = 0.64 + 0.096 (Maths Grade) + 0.25 (Physique Grade) + 0.44 (Chim Grade) + 0.37 (Info Grade)

5)Mining Engineering

Y = 0.15 + 0.15 (Chim Grade) + 0.54(SVT Grade) + 0.54 (Math Grade)

6)Petroleum and Chemical Engineering

Y = 0.62 + 0.28 (Chim Grade) + 0.11 (SVT Grade) + 1.20 (Physique Grade) + 0.13 (Math Grade)

Regression models with BAC 'D' Results

1) Civil Engineering and Architecture

Y = 0.27 + 0.59 (Math Grade) + 0.43 (Info Grade) + 1.01(Chim Grade)

2) Computer Engineering

Y = 2.45 + 0.32(Math Grade) + 0.87(Info Grade) + 1.77(Chim Grade)

3) Mining Grade

Y = -0.95 + 0.20 (Chim Grade) + 0.15(Math Grade) + 1.2 (SVT Grade)

Regression models with BAC 'IT' Results

1) Computer Engineering

Y = 0.5+ 0.5 (Physique Grade) + 0.5 (Info Grade)

The above regression models could be used for the placement of students into various engineering departments from the students' high school results. With due consideration of the gender of students, their motivation towards engineering studies and the type of high school attended, students could be placed into various strata following the level to which they belong in the above cited categories so that the placement could be appropriate or to ensure fairness in the case of selection.

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Introduction

This chapter focuses on the discussions of the findings from the data analysis done in chapter four using multiple linear regression analysis with SPSS version 26.0. It also embodies the conclusion of the findinds of the study, the implications of the findings, recommendations, suggestions for further studies, the limitations, and a summary of the study.

Discussion of the Findings

GCE A/L Results in Sciences and students' Academic Performance in Engineering

From the analysis carried out in the study using multiple regression analysis with SPSS version 26.0, the results revealed that GCE A/L results in the sciences significantly predict students' academic performance in civil engineering and architecture F (4, 51) = 83.69, P = 0.000, with a multiple correlation coefficient of $R^2 = 0.87$, that is 87% of the variation of students' academic performance in civil engineering and architecture could be accounted for by their GCE A/L results in Physics, Chemistry, Mathematics and Further Mathematics. Amongst these predictors, the grades students' score in Physics, Mathematics and Further Mathematics were the significant predictors of students' academic performance in civil engineering and architecture. Therefore, students who perform academically well in Physics, Mathematics and Further Mathematics will definitely perform well in civil engineering and architecture. This therefore means that these science subjects are good preparatory bases for civil engineering and architectural studies. Furthermore, this result signifies that to a great extent the examination content of these subjects in the GCE A/L examinations which are a reflection of the curriculum as well as the examination practices are of appropriate standards.

GCE A/L results in sciences also predict students' academic performance in compurter engineering, F (5,9) = 10.99, P = 0.001, which means it is significant at the 0.001 level of significance and with a multiple correlation coefficient of $R^2 = 0.78$. That is 78% of the variability of students' academic performance in engineering could be accounted for by their GCE A/L results in Physics, Chemistry, Mathematics, Further Mathematics and

Computer Science. Amongst, these subjects, the most significant predictors are the grades students score in Physics, Chemistry and Mathematics. This signifies that students who perform academically well in GCE A/L Physics, Chemistry and Mathematics will definitely perform well in computer engineering. It is thus surprising to see that though the grades scored in computer science predicts students' academic performance in computer engineering, it does not predict students' academic performance in computer engineering as much as the grades scored in GCE A/L Physics, Chemistry and Mathematics. Consequently, one cannot comfortably say students could be admitted into the computer engineering department of engineering schools from the grade they scored in computer engineering only. But if the grade scored in computer science greatly significantly predicted students' academic performance in computer engineering over and above the grades scored in the other science subjects, one could conveniently use it for the placement of students into the department of computer engineering. Thus students who do not offer computer science in high school or who did not have a pass in computer science in high school but who had pass grades in Physics, Mathematics and Further Mathematics, could still perform well in computer engineering. Therefore in order to make computer science to have its right place in the placement of students into the computer engineering department, emphases should be laid on looking into the curriculum to see if it actually tailor students for computer engineering in the university and also emphasis could be laid on the measurement and evaluation practices such as the setting and vetting of computer science examination at the GCE A/L.

Furthermore, GCE A/L results in sciences significantly predict students' academic performance in Electrical engineering, $F (4, 63) = 105.94$, $P = 0.000$, which means it is significant at the 0.001 level of significance or within the 99% confidence interval. It also has a multiple correlation coefficient of $R^2 = 0.87$ which indicates that 87% of the variability of students' academic performance in electrical engineering could be accounted for by the grades they scored in some science subjects. The science subjects whose grades predict students' academic performance in electrical engineering are; Physics, Chemistry, Mathematics and Further Mathematics. The grades scored in Physics and Mathematics in the GCE A/L were the most significant predictors of students' academic performance in electrical engineering. Therefore, to a great extent students going into electrical engineering studies should atleast have a a pass grade in Mathematics and Physics.

Also GCE A/L results in sciences significantly predict students' academic performance in mechanical engineering, F (4, 42) = 19.66, *P* = 0.000, which means it is significant at the 0.001 level of significance. The multiple correlation coefficient was $R^2 = 0.65$ which means that 65% of the variability of students' academic performance could be accounted for by the grades scored in some science subjects. The science subjects whose grades accounted for this variability of students' academic performance in mechanical engineering are; Physics, Chemistry, Mathematics and Further Mathematics. Amongst these subjects, it is the grade scored in Chemistry that stood out as the most significant predictor of students' academic performance in mechanical engineering. This implies students who perform academically well in Chemistry at the GCE A/L examination could definitely perform well in mechanical engineering at university. The multiple correlation coeficient being just 0.65, means the science subjects do not adequately predict students' academic performance in mechanical engineering or simply means when considering the GCE A/L results in sciences as predictors of students' academic performance in mechanical engineering, 35% of the variability of students' performance could be explained by other predictors. Or in order words, one could say that the probalility that a students' GCE A/L results will predict his or her academic performance in mechanical engineering is just 0.65. With regards to this, adequate modifications could also be done in the progran of the science subjects in order to make sure that they better prepare students for mechanical engineering studies.

GCE A/L results also significantly predict students' academic performance in Mining Engineering F (2, 29) = 74.48, *P* = 0.000. This means it is significant at the 0.001 level of significance. The multiple correlation coefficient for the regression was $R^2 = 0.84$, which means that 84% of the variability of students' academic performance in mining engineering could be explained by the grades they score in some science subjects. The grades scored in Chemistry and in Geology in the GCE A/L examination, with the grade scored in Geology being the most significant predictor of students' academic performance in mining engineering. This finding is quite in place since Geology is the GCE A/L subject which is closest to mining engineering. This therefore also furher implies that the Geology program to a great extent is tailored and geared towards preparing students for future academic adventures such as studying mining engineering, it also implies that the measurement and evaluation applied in Geology is to a great extent apt.

Moreover, GCE A/L results in sciences also significantly predict students' academic performance Petroleum and chemical engineering, F (3, 23) = 32.26, *P* = 0.000. This means the prediction of students' academic performance by GCE A/L results in sciences is significant at the 0.001 level of significance. The correlation coefficient of the regression was 0.81, which means that 81% of the students' academic performance could be predicted by students' academic performance in the GCE A/L Physics, Chemistry and Geology. Amongst these subjects, the grades scored Geology were the most significant predictor to students' academic performance in petroleum and chemical engineering. Though Chemistry being a predictor but not a significant predictor of students' academic performance in petroleum and chemical engineering is a call for concern. Thus Chemistry in the GCE A/L could be made more potent as a predictor of students' academic performance by inculcating into the chemistry program practical aspects which will relate more to real life than just doing practicals which are not linked to our daily lives.

From the above discussions, it shows that GCE A/L results in science subjects generally significantly predict students' academic performance in various branches of engineering, and this finding are concurrent with those of Darlington and Bowler (2016) who found out that engineering students find both A-level Mathematics and Further Marhematics are good preparation for undergraduate engineering studies. The findings of this study were also in line with those of De Winter and Doudou (2011) who did a study in the Netherlands with the aim of determining the extent to which students' academic performance in engineering could be predicted by their high school end of course examination scores, and found out that natural science and Mathematics factor which comprise of Physics, Chemistry and Mathematics as loading variables were the strongest predictor of students' academic performance in the various engineering departments.These results were also in accordance with those of Lee et al, (2008) who carried out research in order to determine the predictors of students' academic performance in an engineering program and found out that a number of statistical modules studied in A/L Mathematics and the Mathematics diagnostic test results significantly predicted students' academic performance in engineering.

The findings of this study were also in line with those of Rahman et al (2012) who found out that there was no significant difference between students' academic performance in secondary school results and their results in engineering in a polytechnic institute. That is, the results of their findings revealed that there was a positive correlation between the students' secondary school results and their academic performance in university. The findings were also in accordance with the findings of Geiser and Santelices who affirmed that high school grades are significantly the best predictors of students' performance in institutes of higher learning. Moreover, the findings of Huang and Fang (2013) that the various types of Mathematical models predicted students' academic performance in engineering also corroborated with those of this study as Mathematics was seen to predict students' academic performance in almost all the branches of engineering. Still in line with the importance of Mathematics in engineering studies, the study of Hans et al, (2015) found out that to engineering students and lecturers, Mathematics is quite important for engineering studies. This finding is in accordance with the finding in this study as Mathematics predicts students' academic performance in most engineering branches. Contrarily, the finding that Mathematics significantly predict students' academic performance in engineering was not in accordance with that of Cole (2014) who found out that A/L Mathematics grade did not significantly predict students' academic performance in engineering in the first year.

Furthermore, since findings in the study revealed that GCE A/L results significantly predicted students' academic performance in most of the engineering branches, with civil engineering and architecture being one of the branches, the results corroborated with the findings of Shrestha and Shields (2015) which stipulated that there was a positive correlation between the grade scored in Mathematics and students' GPA in their fundamental construction. The findings of this study also fall in line with those of Bingolbali et al (2007), who found out that mechanical engineering students see Mathematics as a tool for application in their subject, thus buttressing the importance of Mathematics in mechanical engineering. Moreover, the finding that GCE A/L results predict students' academic performance in mechanical engineering is in accordance with that of O'Dwyer (2012), who carried out a research on the effect of students' academic performance in electrical engineering and found out that these subjects had a positive correlation with performance in electrical engineering. Also, looking critically at the findings above, one observes that the grades scored in Mathematics generally predict students' academic performance in engineering better than the grades scored in Further Mathematics, though the Further Mathematics program was designed to prepare students for Mathematics related courses at University. This finding falls in line with that of Akoko (2010) who found out that students' grades scored in Mathematics at the GCE A/L predicted their academic performance better in Mathematics related courses in University than their grades scored in Further Mathematics at the GCE A/L.

BAC Results in sciences and students' Academic Performance in Engineering

From the analysis carried out with the use of multiple linear regression analysis in order with the aid of SPSS version 26.0, the findings revealed that BAC 'C' results significantly predict students' academic performance in civil engineering and architecture $F(4,19) = 43.91$ $P = 0.000$, and with a multiple correlation coefficient of $R^2 = 0.9$, which means that 90% of the variability of students' academic perfromance in civil engineering and architecture could be explained by the grades students from the BAC 'C' extraction score in some science subjects. The science subjects whose grades predict students' academic performance in civil engineering and architecture were; Physique, Chimie, Mathematiques and Informatique. Amongst these predictors, the most significant predictors were the grades scored in Chimie, Math and Info. This means that the grades scored in Math, Chimie and Info could to a great extent be used to place students into the civil engineering and architecture department. The grade scored in Physiqu does not predict significantly students' academic performance in engineering as the grades of the other s cience subjects and thus its a call for concern, thus necessary modifications should be made in the assessment of Physique in the BAC 'C' series. BAC 'D' results also significantly predict students' academic performance in civil engineering and architecture $F(3,6) = 32.73$, $P = 0.000$ with a multiple linear regression of $R^2 = 0.94$ which implies 94% of the variability of students' academic performance in civil engineering and architecture. The predictors in this case were the grades scored in Math, Info and Chimie, with the most significant predictor being the grade scored in Chimie. With the BAC 'D' results too, the grade scored in Physique does not also predict students' academic performance in civil engineering and architecture, and i this case, it is not even a predictor. Therefore, some necessary adjustments could be made with the Physique program in both the BAC 'C' and BAC 'D' programs in order for it to better suit students insertion into the department of civil engineering and architecture.

BAC 'C' results also significantly predict students' academic performance in computer engineering F (5,2) = 27.26, *P* = 0.000 and with R^2 = 0.98 which signifies that 98% of the variability of students' academic performance in computer engineering is accounted for by the grades they score in Physique, Math, Info, Chimie and Chimie TP, with the most significant predictor amongst all them being the grade scored in Physique. This therefore means that there is a high probability that Physiques program has aspects which better prepare students for computer engineering and consequently students who score top grades in Physique definitely are top academic achievers in computer engineering. On the contrary the grades scored in BAC 'D' do not significantly predict students' academic performance in computer engineering F (3,2) = 8.38, *P*= 0.11. With R^2 = 0.93 which means 93% of the variability in students' academic performance in computer engineering. The predictors were the grades scored in Math, Info and Chimie. The result being insignificant shows that the science subjects in BAC 'D' series does not adequately prepare students for computer engineering studies. Moreover, BAC 'IT' results significantly predict students' academic performance in computer engineering F (2,0) = 0.000, *P* = 0.000 and has R^2 = 1.00 which means that 100% of the variation of students' academic performance in computer engineering could be accounted for by the grades they scored in some science subjects in BAC 'IT'. The predictors were; the grades scored in Physique and the Grade scored in Informatique.

With regards to predicting students' academic performance in electrical engineerinng, BAC 'C' results did not significantly predict students' academic performance in electrical engineering F (3,2) = 0.37, P = 0.79 with R^2 = 0.36, which means that 36 % of the variability of students' academic performance in electrical engineering could be explained from the grades they score in some science subjects in the BAC 'C' examination. The predictors were the grades scored in Physique, Chimie and Math. Amongst these predictors, none was significant. From these results, one can see that the science subjects in BAC 'C' do not adequately prepare students for electrical engineering studies. That is, there is a probability that to an extent the programs in the sciences in the BAC 'C' series do not adequately suit electrical engineering studies

Moreover, BAC 'C' results in the sciences significantly predict students' academic performance in mechanical engineering F (4,4) = 49.51, *P* = 0.001, with a multiple linaer regression coefficient of R^2 = 0.93, which indicates that 93% of the variation in students' academic performance in mechanical engineering could be accounted for by the grades they score in the science subjects in the BAC 'C' examination. The predictors for the regression model were; the grades scored in Physique, Math, Chimie and Info, with the grades scored in chimie and Informatique being the most significant predictors. This therefore signifies that more elements pertaining to mechanical engineering especially practical aspects should be inculcated into the Physique program which would help to better prepare students from the BAC 'C' extraction for mechanical engineering studies

BAC 'C' results in the sciences also significantly predict students' academic performance in mining engineering F (3,2), *P* = 0.000 and having a multiple linear regression coefficient of R^2 = 1.00, which indicates that 100% of the variability of students' academic performance in mining engineering could be accounted for by the grades students score in science subjects. The predictors for the regression model were, the grades scored in Chimie, SVT and Mathematiques. BAC 'D' results in the sciences also significantly predict students' academic performance in mining engineering F (3,2) = 123.78, P = 0.008 and has a multiple linear correlation coefficient of R^2 = 0.99 which means that 99% of the variability of students' academic performance could be explained by the grades they score in some science subjects. The predictors in the regression model were the grades scored in Mathematiques, Chimie and SVT in the BAC 'D' examination. It is not surprising that the grades scored in Chimie and SVT are predictors of students' academic performance in mining engineering since mining engineering is highly anchored on these subjects and it also signifies that these subjects are well tailored to also prepare students for mining engineering studies.

Furthermore, BAC 'C' results in the sciences also significantly predict students' academic performance in petroleum and chemical engineering F (4,8) = 29.40, *P* = 0.000 and has a multiple correlation coefficient of 0.94 which means that 94% of the variability of students' academic performance in petroleum and chemical engineering could be explained by the grades they scored in science subjects. The predictors of students' academmic performance in engineering were; the grades scored in Physique, Chimie, Mathematiques and SVT, with the grades scored in Physique being the most significant predictor. Chimie not being a significant predictor is not a surprise given the nature of the chimie program which does not dwell so much in organic Chemistry and Inorganic Chemistry.

Therefore, BAC 'C' results in the sciences significantly predict students' academic performance in civil engineering and architecture, in computer engineering, in mechanical engineering, in mining engineering, and in petroleum and chemical engineering. BAC 'D' results in sciences significantly predict students' academic performance in civil engineering and Architecture and in mining engineering and BAC 'IT' results in sciences significantly predict students' academic performance in computer engineering. These findings are in accordance with those of Darlington and Bowler (2016) who found out that engineering students find both A-level Mathematics and Further Marhematics are good preparation for undergraduate engineering studies. The findings of this study were also in line with those of De Winter and Doudou (2011) who did a study in the Netherlands with the aim of determining the extent to which students' academic performance in engineering could be predicted by their high school end of course examination scores, and found out that natural science and Mathematics factor which comprise of Physics, Chemistry and Mathematics as loading variables were the strongest predictor of students' academic performance in the various engineering departments.These results were also in accordance with those of Lee et al, (2008) who carried out research in order to determine the predictors of students' academic performance in an engineering program and found out that a number of statistical modules studied in A/L Mathematics and the Mathematics diagnostic test results significantly predicted students' academic performance in engineering. The findings of this study were also in line with those of Rahman et al (2012) who found out that there was no significant difference between students' academic performance in secondary school results and their results in engineering in a polytechnic institute. That is, the results of their findings revealed that there was a positive correlation between the students' secondary school results and their academic performance in university. The findings were also in accordance with the findings of Geiser and Santelices who affirmed that high school grades are significantly the best predictors of students' performance in institutes of higher learning.

BAC 'C' results in sciences do not significantly predict students' academic performance electrical engineering, while BAC 'D' results in sciences did not significantly predict students' academic performance in computer engineering. These findings were also in accordance with those of Cole (2014) who found out that high school results did not significantly predict students' academic performance in engineering.

The findings discussed above on the prediction of students' academic performance in engineering by their high school results, that is by either their GCE A/L and BAC result could be anchored on the classical test theory. That is, the science subjects whose grades significantly predict students' academic performance are measured in the GCE A/L or BAC examinations in such a way that students' observed scores obtained which are the grades they score are not very different from the students' true scores. That is, the errors encountered in the measurement are not too much, thus they are highly minimised. Since the observed scores are not quite different from the true scores, there is a high probability for these scores to predict students' future academic performance, since the scores are almost true to the students. While the subjects whose grades do not predict students' academic performance have a high probability of haven been measured with errors.

Also, anchoring these findings of this study to the item response theory, the science subjects whose grades significantly predict students' academic performance in engineering has a high probability of having items of appropriate diffiuculty and discrimination indices, of appropriate discrimination indices and appropriate probalility of guesing for papers with multiple choice items. This is because when these psychometric properties are of adequate standard, they measurement errors are minimised. On the contrary, the subjects whose grades do not significantly predict students' academic performance in engineering have a high probability of having items of inappropriate difficuty and discrimination indices or whose probability of guessing is not appropriate. This is because when items have these inappropriate psychometric properties, they do liable to encounter measurement errors and consequently the measurements or grades earned could be far from the grades the student would have earned if the measurement was properly done and consequently might not predict students' academic performance in future examinations.

Furthermore, these findings could also be anchored on the generalizability theory. According to the generalizability theory, the inpredictability of the grades scored in some science subjects in high school to students' academic perfromance in engineering school could be as a result of measurement errors encountered in the course of test construction, administration or during the process of scoring. This could be in either ways, that is, if the errors are encountered in the GCE or BAC examinations, there might be no predictability with regards with the particular subject concerned and if the errors are intead done in the engineering school in the course of assessment, measurement or evaluation, then that might be the cause of the fact that some grades scored do not predict students' academic performance in some engineering departments.

Moreover, the theory of attribution also finds to place to explain the findings above. That is, students who attribute their success or failure in the GCE or BAC examinations to factors which are under their control, such as hard work, then they will definitely work hard in engineering school and thus their high school results will definitely predict their academic performance in engineering. But in the case where their success or failure is coming from sources which they cannot control such as gifts and encouragement from others, when those aspects are not there, their academic performance would probably not be at the same level and thus their previous academic performance in this case are their GCE results might not predict their academic performance in engineering.

Furthermore, Lev Vygotsky's theory of constructivism could also be used to underpin the findings of this study. Vygotsky's theory holds that mediators help the human to alter his or her environment. That is, mediators help students go across the zone of proximal development. That is, if there is an enabling environment which aids the learners to easily resolve their inner conflicts and develop new knowledge, then the learner will certainly learn faster and perform better than a learner in an inert learning environment. Therefore, the grades of students in some particular subjects might not predict their academic performance in some branches of engineering because there might be drastic contrast between their high school environment and their learning environment at engineering school.

Differential Prediction of High School Results in Sciences with respect to Gender

GCE A/L results in sciences significantly predict students' academic performance in civil engineering and architecture, electrical engineering, Computer engineeringr mechanical engineering mining engineering and in petroleum and chemical engineering differently in terms of gender. Therefore, the GCE A/L results in sciences affect male students' academic performance in engineering differently from their male counterparts. The GCE A/L results in sciences also underpredict male students' academic performance in civil engineering and architecture, in mining engineering and in petroleum and chemical engineering while it predicts the academic performance of female students of the same department normalll. It also underpredicts both male and female students' academic performance in computer engineering, as well as in electrical engineering, but the extent of underprediction for the male engineering students is more than than that for the females in these two engineering departments.

Also, BAC 'C' results in sciences predicted students' academic performance differently with respect to gender in the following departments; in civil engineering and architecture, in computer engineering, in mining engineering and in petroleum and chemical engineering. There was also underprediction for both male and female students in the mining engineering department, in the computer engineering department and in the petroleum and chemical engineering department. BAC 'D' results in sciences also predicted students' academic performance in civil engineering and architecture, in computer engineering and in mining engineering. There was underprediction for the male students in the department of civil engineering and architecture and in the department of mining engineering while there was underprediction for both the male and female engineering students in the department of computer engineering. BAC 'IT' results also significantly predict students' academic performance differently in terms of gender. There was also underprediction for female students while there was normal prediction for male students.

The above results which show significant differential prediction with respect to gender falls in line with the findings of Gamache and Novick (1985) who did a study to determine the differential prediction of a two- year cumulative GPA bu by sub sets of ACT scores and composite scores with respect to gender and found out that the GPA for women were underpredicted while those for the men were over predicted. These results were also in accordance with those of Jones and Vanyur (1985) who found out that the correlation coefficient between MCAT and GPA was higher for women than for men. This finding of this study is also in accordance with that of Crawfort et al, (1986) who found out that the GPA for male students were overpredicted by their ACT scores and HSGPA while that for their female counterparts were underpredicted. The findings of this study were also concurrent to that of Koeing et al (1998), who did a study on the predictive validity and differential predictive validity of MCAT across gender and ethnicity to students' academic performance in medical studies measured in terms of GPA. The coefficient of prediction revealed that the coefficient of prediction was almost the same for male and female students, also the performance of white students were slightly underpredicted while the performance of the Asians, the Blacks, and the Hispanics were over predicted with those of Asians and the Hispanics being more significantly overpredicted.

These findings were also in accordance with those of Kyei-Blankson (2005) whose results indicated that women had higher validity coefficients than men. There was underprediction of the academic performance in medical school by MCAT scores for white students while there was overprediction of the academic performance for Blacks and Hispanics. Moreover, the findings of Al-Hattami (2012) who did a study in order to determine the differential predictive validity of high school GPA to students' academic performance in GPA across gender as one of the factors he considered for differential prediction. His findings revealed that differential predictive validity was observed across gender.

Since there is significant differential prediction of students' academic performance in engineering by their high school results with respect to gender, it is therefore important for male and female students viling for places into engineering schools to be placed in different groups or strata, that is one group for the male students and the other group for the female especially if they are to be selected based on their high school results in sciences, so that the male students will compete amongst themselves while the female students will compete amongst them selves. This will thus go a long way to butress the fifth UNESCO sustainable development goal which pin points on gender equality.

Differential Prediction of Students' Academic performance with respect to students' motivation for engineering studies

GCE A/L results in sciences significantly predict students' academic performance differently in terms of their motivation for engineering studies in Computer engineering, electrical engineering, mining engineering and in petroleum and chemical engineering. There was underprediction for students who were fairly motivated and highly motivated in the department of computer engineering and in petroleum and chemical engineering. There was also underpridiction for students who were averagely motivated in the department of mining engineering and underprediction for students who were fairly motivated in electrical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture, electrical engineering, mechanical engineering and mining engineering. BAC 'C' results underpredicted the academic performance of students who were fairly motivated in the department of civil engineering and architecture and also underprediction for the students who were highly motivated in the departments of mechanical and mining engineering. BAC 'D' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture and mining engineering. BAC 'D' results under predicted the academic performance of students who were fairly motivated in the department of civil engineering and architecture and those who were highly motivated in the department of mining engineering. BAC 'IT' results also significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the department of computer engineering. Moreover, BAC 'IT' results underpredicted the academic performance of students who were highly motivated in the department of computer engineering.

From the findings above one can conclude that students' high school results in sciences to a great extent significantly predict students' academic performance in engineering differently in terms of the students' motivation for engineering studies. This therefore means that students' motivation for engineering studies should be considered as a mitigating factor for the placement of students into various branches of engineering from their high school results. From the results of the analysis one can also see that high school results predicted students' academic performance in engineering generally better for students who a lowly and averagely motivated than for those who were fairly and highly motivated. This therefore implies that some students might not perform relatively well in their high school end of course examinations, but because of their high intrinsic motivation for engineering studies, they could perform relatively better academically at engineering school. This also further implies that students' intrinsic motivation for engineering studies is directly proportional to their academic performance in engineering, that is, to a greater extent, intrinsic motivation for engineering studies affects students' academic performance in engineering.

The findings of this study were in accordance with that of Gero (2016), who did a study in Israel with the aim of identifying the factors which make students to chose to study engineering. His findings revealed that students are more motivated to study engineering by intrinsic factors. The findings were also in line with those of Shehab et al (2016) who found out that interest which is intrinsic was one of the most powerful factors that affected students' choice of a career goal. In accordance with this, Kolmos et al (2013) also found out in their study that motivational factors such as intrinsic motivation factors were one of the most pertinent with respect to influencing students' choice for particular engineering programs.

Moreover, the findings above were in line with those of Goold and Devitt (2012) who carried out a study to determine the role of Mathematics in engineering practice and to determine if there is a relationship between students' experience in school Mathematics and choice for an engineering. The findings of the study revealed that 75.9% of the students who took part in the survey attested that they chose engineering career because of the feeling in Mathematics. Furthermore, the findings of Liberty et al (2015) who found out that college physics affects students' readiness for engineering studies. Also these findings were concurrent to that of James and John (1995) who carried out a study to determine the predictors of persistence and success in an engineering program and whose findings revealed that students who performed academically well in Mathematics and science courses and who were interested in engineering genuinely were more likely to persist and succeed in engineering studies.

This finding can be linked to the social cognitive career theory. This theory which explains motivation or the choice of a career path through four aspects which are; self efficacy, interest, goal expectation and social support and barriers underpins this work to a great extent. That is, students who have a high self efficacy, that is students who are confident in their abilities definitely have high intrinsic motivation and with this motivation they were motivated to embark on engineering studies despite their high school results and with that motivation in place at engineering school, they definitely performed well. Also, those who were highly interested in engineering studies definitely also performed well academically at engineering school despite the results they scored at high school. On the contrary, student who were more affected by their expectancy value, which is more extrinsic, when they got into engineering school and their expectations are not met to an extent or when they started seeing the realities of the engineering profession while at school, their academic performance in engineering might have started thwarting because the motivation which they had could not be maintained and consequently they might have just performed academically as well as if there were not motivated. Also for the engineering students who were motivated into engineering studies by social support from parents, family members, peers and councilors, if per-say they got into engineering school and those facets of the social support were not present, they might have also lost the original steam which they had on entering engineering school and thus might just have performed academically as if there were no motivating factors.

Taking into cognizance the fact that students could greatly be motivated from their expectations, one could also therefore anchor this finding on the expectancy value theory. That is, some engineering students on getting into engineering school placed so much value on their expectations, which in turn motivated them a great deal and in engineering school they started seeing that their expectations would not surely come to reality, their motivation might have greatly reduced and they might have just been as if they were not motivated.

The theory of attribution also finds place in anchoring this research finding. That is, if what motivated some students to embark on engineering education were considered by them to be static, then no matter what happens at engineering school, their motivation still remained in place and they definitely performed well because of the motivation, but if they considered the factor of motivation as dynamic, that is, which could change at any time, then when there was a change in these motivating factors then their performances were surely affected. Also the students who were relatively highly motivated considered their motivation to be internal, that is, to have come from within, rather than coming from external sources, thus, adequately adjusted to challenges and difficult moments in order to maintain their motivation and thus their academic performances were not affected to a great extent by adverse conditions. Furthermore, factors that motivated some of the students were under their control and thus they could mainain thier motivation and remain on course and their academic performance to a great extent remained on same gear as initially oriented by their motivation. On the other hand, for studenyts whose motivating factors were not under their control, they could easily loose grip of their academic standing whenn their motivation is altered because they could not control it. This thus accounts for the differential prediction of students' academic performance by their high school results in sciences with respect to their motivation for engineering studies.

Differential Prediction of students' academic performance in engineering with respect to the type of high school attended

GCE A/L results in sciences significantly predicted students' academic performance differently in terms of the type of high school they attended in electrical engineering, mining engineering and in petroleum and chemical engineering. There was underprediction of the academic performance of students from public high schools from the departments of electrical engineering, mining engineering and in the department of petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of the type of high school they attended in computer engineering, mining engineering, mechanical engineering and in petroleum and chemical engineering. The BAC 'C'results underpredicted the academic performance of students from public high schools in the departments of computer engineering mining engineering and in petroleum and chemical engineering, and these results also underpredicted the academic performance of students from private high schools in the department of mechanical engineering. BAC 'D' results significantly predict students' academic performance differently in terms of the type of high school the engineering students attended in civil engineering and architecture, and in mining engineering and theese results underpredicted students' academic performance in civil engineering and architecture and in mining engineering. BAC

'IT' results also significantly predicted students' academic performance in computer engineering differently in terms of the type of high school attended by the computer engineering students, and these results underpredicted the academic performance of students from public high schools in the department of computer engineering.

The findings above reveal that the high school results in sciences for students from mission schools and lay private schools generally predicted students' academic performance in engineering better than the results of those from public high schools, rather in some cases, there was underprediction of the academic performance in engineering for students from public schools. This could be as a result of the fact that some of these public schools do not have learning facilities which match up with the student enrollment as students could easily be seen working in groups on a set of practical equipment in the laboratory and also a high student teacher ratio as compared to some mission and lay private schools. With all these, some students are thus placed in a state where they cannot have results which match their actual potential and thus when they find themselves in engineering schools, they could easily perform academically better relative to their high school results and thus the underprediction as the findings depicted in some engineering departments.

The results of significant differential prediction with respect to type of high school attended is in line with the findings of Thiele and Singleton (2016) who found out that high school results predict students' academic performance differntly with respect to the various high school types which were gymnasium, comprehensive and independent schools. The findings of the study were also in concord with those of Davis and Norman (1954) whose findings also revealed that the prediction of freshman grades by first term high school average and SAT-V results for students from public schools were different from those of students from private schools. This finding was also in accordance with those of Hahn et al, (2014), who findings also revealed that the academic performance of students from private schools was different from the academic performance of students from public schools. On the other hand, the findings of significant differential prediction were not in line with the findings of Beinai and Perin (2016) whose findings indicated that students from different high schools did not profit from certain individual characteristics. This was also in accordance with the finding of Sabitu et al, (2014) who found out that there was no significant difference in academic performance of students from public and private schools.

From the above finding which indicates that there is differential prediction of students' academic performance in some branches of engineering by their high school results, in terms of the type of high school attended, it is therefore very important for students who want to get admission into engineering schools to be stratified according to the various types of high schools where they come from, which could be public schools, private schools and lay private schools before the selection and placement is done in order to minimise the effect of the type of high school attended or to give students from the different types of high schools fair chances of being selected into engineering schools.

Conclusion

This research work was out to determine the predictive validity of GCE A/L and BAC results in sciences to students' academic performance in engineering. The study also sought to determine the differential predictive validity of these high school results in sciences to students' academic performance in engineering with respect to gender, motivation for engineering studies and type of high school attended. The findings of this study of this revealed that GCE A/L results in sciences significantly predict students' academic performance in civil engineering and architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering. BAC 'C' results in sciences significantly predict students' academic performance in all the above branches of engineering apart from electrical engineering. BAC 'D' results in sciences also significantly predict students' academic performance in civil engineering and architecture, computer engineering, and mining engineering. BAC 'IT' results in sciences significantly predict students' academic performance in computer engineering.

The findings of the study also revealed that GCE A/L results in sciences predict students' academic performance differently in terms of gender in all the six branches of engineering considered in this study. BAC 'C' results in sciences also predicted students' academic performance in civil engineering and architecture, computer engineering and in petroleum and chemical engineering differently in terms of gender, while BAC 'D' results in sciences also predidicted students' academic performance in civil engineering and architecture, computer engineering and mining engineering differently in terms of gender and BAC 'IT' results in sciences predict students' academic performance in computer engineering differently in terms of gender.

The findings further revealed that GCE A/L results in sciences significantly predict students' academic performance differently in terms of their motivation in Computer engineering, electrical engineering, mining engineering and in petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture, electrical engineering, mechanical engineering and mining engineering while BAC 'D' results significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the departments of civil engineering and architecture and mining engineering, and, BAC 'IT' results also significantly predicted students' academic performance differently in terms of their motivation for engineering studies in the department of computer engineering.

Moreover, with regards to differential prediction high school results in sciences with regards to the type of high school attended, the findings revealed that GCE A/L results in sciences significantly predicted students' academic performance differently in terms of the type of high school they attended in electrical engineering, mining engineering and in petroleum and chemical engineering. BAC 'C' results significantly predicted students' academic performance differently in terms of the type of high school they attended in the departments of computer engineering, mechanical engineering, mining engineering and in petroleum and chemical engineering. BAC 'D' results significantly predict students' academic performance differently in terms of the type of high school the engineering students attended in civil engineering and architecture, and in mining engineerin and BAC 'IT' results significantly predicted students' academic performance in computer engineering differently in terms of the type of high school attended by the computer engineering students.

Therefore, from the findings above, it could be concluded that the GCE A/L results in some science subjects and the BAC results in some science subjects have significant predictive validity to students' academic performance in engineering. It could also be concluded that to a great extent GCE A/L results in sciences and BAC results in sciences have differential predictive validity to students' academic performnace in engineering with respect to students' gender, their motivation for engnineering studies and the type of high school they attended.

Implications of the Findings

From the findings discussed above, the following implications are arrived at;

1) The assessment, measurement and evaluation practices carried out by the GCE and BAC examination boards in the sciences are to a greater extent commendable, since a greater proportion of their results have adequate predictive validity.

2) GCE A/L and BAC results in the general sciences could be used for the selection placement of students into the various branches of engineering

3)From the findings of this study, students could be well guided and orientated on what particular branch of engineering to embark on based on their GCE A/L or BAC results in the general sciences.

4) Students' intrinsic motivation for engineering studies greatly affects their academic peformance in engineering

5) From the findings of this study, more fairness in the selection of students into engineering schools based on their high school results could be ensured by selecting the students differently with respect to their gender, their motivation for engineering studies and the type of high school attended.

6) From the findings, BAC 'C' are better predictors of students' academic performance in most of the branches of engineering than BAC 'D' results.

7)GCE A/L Mathematics are seen to be a better predictor of students' academic performance in engineering than Further Mathematics, though the further Mathematics program is designed to initiate students into Mathematics and Mathematics related courses in the university

Recommendations

1) Engineering schools should implement mechanisms for determining students' motivation for engineering studies by introducing oral sessions or by putting in place motivation scales to be completed by the students in order to better guide and orientate them into the branches of engineering which would best suit their desires, aspiration and future prospects.

2) When the selection of students into engineering schools take into cognisanze the students' GCE A/L or BAC results, they should be placed into different strata with respect to their gender, motivation for engineering studies and the type of high school attended, from which quotas would be selected from each of the strata in order to have a balanced selection since these high school results to a great extent predict students' academic performance in engineering with respect to these strata differently.

3) The Ministry of Secondary Education should put in place appropriate strategies and mechanisms to make sure all secondary and high schools have well equipped science laboratories in order to ground students more in practicals so as to facilitate their aquisition of basic scientific psychomotor skills that will prepare them better for sciences and fields of applied sciences such as engineering at University.

4) Practicals should be inculcated fully into the syllabuses of the science subjects in high school in the French sub system of education, such that they will have a fixed percentage in the BAC examinations in each of the science subjects, so that its status will no longer be optional but mandatory

5) The engineering schools should endevour to have well equipped and up to date laboratories and practical equipment, in order to better nuture and mature the basic skills students gained in high school in order to adequately prepare them for the job market and more importantly to be job creators.

6) Also, more aspects of electricity, electronics and electrostatics shoud be incucated into both the theoretical and practical syllabuses of Physique in BAC general sciences in order to better prepare students for the electrical engineering and computer engineering programs at University.

7) The BAC board should introduce multiple choice type of items into the BAC examinations since it is the most objective type of testing and which limits measurement errors.

8) The synergy between the ministry of secondary education and engineering schools should be improved upon in order to prepare a good transition for students from high school to engineering schools.

9) The BAC and GCE boards should make their evaluations to be more criterion reference based than norm reference based in order to make their results more dependable and reliable with more predictive power, since norm referencing could easily lump up students' with different abilities into a particular grade while criterion referencing easily weavers to a great extent political influences and other non academic factors and vices.

10) The following regression models should be used for the selection and placement of students into various engineering departments

Regression models with GCE A/L Results

Civil Engineering and Architecture

Y = 0.17 + 0.84 (Physics Grade) + 0.21 (Chem Grade) - 0.33 (Maths grade) + 0.32 (F.Maths Grade)

Computer Engineering

Y = 0.82 + 0.25 (Physics Grade) - 0.3 (Chem Grade) + 0.84 (Maths Grade) -0.06 (F.maths Grade) + 0.49 (Comp Sc. Grade)

Electrical Engineering

Y = 0.53 + 0.37 (Physics Grade) - 0.43 (Chem Grade) + 0.53 (Maths Grade) + 0.37 (F.maths Grade)

Mechanical Engineering

Y = 2.13 + 0.087 (Physics Grade) + 0.234 (Chem Grade) + 0.154 (Maths Grade) + 0.24 (F.maths Grade)

Mining Engineering

Y = 0.29 + 0.27(Chem Grade) + 0.76(Geol Grade)

Petroleum and Chemical Engineering

Y = -1.75 + 0.028 (Physics Grade) + 0.056 (Chem Grade) + 1.36 (Geol Grade)

Regression models with BAC 'C' Results

Civil Engineering and Architecture

Y= 1.67 + 0.071(Physique Grade) + 0.30 (Chim Grade) +2.97(Math Grade) + 0.59(Info Grade)

Computer Engineering

Y = -5.11+ 1.62 (Physique Grade) + 2.87(Math Grade) + 0.31(Info Grade) - 0.36(ChimTP grade) - 0.64 (Chim Grade**).**

Electrical Engineering

Y = 3.0 + 1.43 (Maths Grade) + 0.43 (Physics Grade) + 0.86 (Chim Grade)

Mechanical Engineering

Y = 0.64 + 0.096 (Maths Grade) + 0.25 (Physique Grade) + 0.44 (Chim Grade) + 0.37 (Info Grade)

Mining Engineering

Y = 0.15 + 0.15 (Chim Grade) + 0.54(SVT Grade) + 0.54 (Math Grade)

Petroleum and Chemical Engineering

Y = 0.62 + 0.28(Chim Grade) + 0.11(SVT Grade) + 1.20(Physique Grade) + 0.13 (Math Grade)

Regression models with BAC 'D' Results

Civil Engineering and Architecture

Y = 0.27 + 0.59 (Math Grade) + 0.43 (Info Grade) + 1.01(Chim Grade)

Computer Engineering

Y = 2.45 + 0.32(Math Grade) - 0.87(Info Grade) + 1.77(Chim Grade)

Mining Grade

Y = -0.95 + 0.20 (Chim Grade) + 0.15(Math Grade) + 1.2 (SVT Grade)

Regression models with BAC 'IT' Results

Computer Engineering

Y = 0.5+ 0.5 (Physique Grade) + 0.5(Info Grade)

Suggestions for Further Studies

1) Research should be carried out on the relationship between high school results and students' academic performance in other fields of sciences such as veterinary medicine and agriculture

2) Further studies should be carried out on the effect of non cognitive factors such as motivation and self efficacy to students' academic performance in engineering.

3) Studies should be carried out to determine the predictive validity of students' high school results in the Arts series to their academic performance in fields of social and management sciences at the University

4) A comparative study should be carried out to assess the predictability of high school results in general sciences and high school results in the technical fields to students' academic performance in engineering

5) A study should also be carried out to develop a placement guide which will be used for the placement of students into the newly created vocational training centres in Cameroon based on their academic backgrounds, motivation and aspirations.

Limitations of the Study

1) It was quite challenging to get all the engineering students in the various engineering schools as some were absent on the when the survey was carried out

2) It was also difficult to get some pertinent information from the GCE board and the BAC board which would have added more spice to this research work

Summary of the Study

This research work was out to determine the extent to which high school results in sciences which are the GCE A/L and BAC results in general sciences predict students' academic performance in engineering and to also determine the extent to which these high school results predict students' academic performance in engineering differently in terms of gender, motivation for engineering studies and the type of high school attended. The study was guided by six research questions and six corresponding objectives were also used in the study in order to find answers to the research questions. Five hypotheses were also tested at the 0.05 level of significance in line with the first five research questions. The following engineering branches were involved in this study: civil engineering and architecture, computer engineering, electrical engineering, mechanical engineering, mining engineering as well as chemical and petroleum engineering. The study was anchored on the following theories; classical test theory, the item response theory, the generalizability theory, the theory of attribution by Weiner, the theory of Constructivism by Lev Vygotsky, the Social Cognitive Career theory and the expectancy value theory.

The study made use of the quantitative research paradigm and explored the correlation survey research design. The study was carried out in six different engineering schools spread over five regions of the Republic of Cameroon, which are; The National Advanced Polytechnique Institute (NAHPI) of the University of Bamenda in the North West Region, The Faculty of Engineering technology (FET) of the University of Buea in the South West Region, The National Advanced school of Public works(NASPW) found in Yaounde in the Centre Region, The engineering school of the Catholic University of Cameroon (CATUC) Baham found in the West Region of Cameroon., The engineering school of the Catholic University Institute Buea (CUIB) found in the South West Region and the engineering school of the Catholic University Institute Buea Douala campus (CUIB D'la) found in the Littoral Region of Cameroon. The target population of the study was made up of students in engineering schools which begin specialisation into the various engineering branches from the first year. The sample population which was selected using the judgemental sampling technique stood at 952 engineering students and from amongst these students, sample of 500 engineering students was drawn using the proportionate simple random sampling technique. The instrument used for data collection was a questionnaire for students. The validity of the questionnaire was ensured by taking into cognizance the content validity and face validity. The content validity index of the questionnaire was 0.91 and the face validity was ensured by peer review. The reliability of the instrument was ascertained using the split half reliability method and a reliability coefficient of 0.89 was arrived at.

The data collected was analyzed using the multiple linear regression analysis using SPSS version 26.0. The findings of the study revealed that the GCE A/L results significantly predicted students' academic performance in all the six engineering branches considered in the study. BAC 'C' results significantly predicted students' academic performance in all the branches of engineering except for electrical engineering where it did not predict students' academic performance significantly. BAC 'D' results also significantly predicted students' academic performance in civil engineering and architecture, computer engineering and in mining engineering while BAC 'IT' results significantly predict students' academic performance in computer engineering. GCE A/L, BAC 'C', BAC 'D' and BAC 'IT' results significantly predicted students' academic performance in most of branches of differently in terms of gender, motivation for engineering studies and type of high school attended. It was recommended that the synergy between the Ministry of secondary education and the engineering schools should be fostered so that the high school programs in sciences will fine tuned and better oriented to prepare students for engineering studies. It was also recommended that the GCE A/L and BAC results in the general sciences should be used for the selection and placement of students into the various branches of engineering taking into consideration the students' gender, their motivation for engineering studies and the type of high school they attended. Therefore, it was recommended that the regression models generated in this study for the prediction of students' academic performance in engineering by their high school results in sciences should be used for the selection and placement of students into various branches of engineering.

REFERENCES

Achankeng, R.A. (2011). *Curriculum Processes. Application in Cameroon schools*. Patron Publishers. ISBN NO: 9956-11-054

Adams. G.S. (1966). *Measurement and evaluation in education, psychology and guidance*. Holt, Rinehart and Winston.

Ahmed, A., Shaheen, S., Elmardi, A., Musa, A. (2018). Item difficulty and item discrimination as quality indicators of physiology MCQ examinations at the Faculty of medicine. Khartoum University. *Khartoum Medical Journal.* 11(02), 1477-1486

Akbarpoor Shirazi, M. (2005). Six Sigma with a re- engineering approach. *Third international Conference on Management, Anyana research group.* Retrieved from https:// www. Civilica.com/ Paper- IRIMC03-IRIMC03-119.

Akoko, M. (2010). Assessment of the Effects of Affective Student Characteristics and Educational Background on Mathematics Achievement at the level of Higher Education in Cameroon. Published Doctoral Thesis.

Alahmadi, N., Alrahaili, M., Alshraideh, D., (2019). The impact of the formative assessment in speaking test on Saudi Students' Performance. *Arab World English Journal (AWEJ),* 10(1), 259-270.

Alderson, J. C. and., Clapham, C. and Wall, D. (1995). *language test construction and Evaluation*. Cambridge University Press

Alderson, J.C., Clapham, C. & Wall, D. (1995). *Language test construction and evaluation.* Cambridge: Cambridge University Press.

Al-Hattami, A.A.D. (2012). Differential predictive validity of high school GPA and College Entrance Test Scores for University Students in Yemen. Published PhD Theses

Ali, A., & Ali, U. (2010). Predictability of engineering students' performance at the University of Engineering and Technology, Peshawar from admission test conducted by educational testing and evaluation agency (ETEA), NWFP, Pakistan. *Procedia Social and Behavioral Sciences* 2 (2010) 976–982

Allchin, D. (2001). Error Types, Perspectives on Science, 9(1), 38-58

Allen, M. J., & Yen, W. M. (1979). Introduction to Measurement Theory. Monterey, CA: Books/ Co Publishing company

American Institute of Physics. A.I.P. (1955). The role of Physics in Engineering education. *Journal of Physics today*. 8, (12), 12.

Amin, M. E (2005). *Social science research: Conception, Methodology and Analysis.* Uganda; Makerere University press.

Anastasi, A. (1988). *Psychological testing.* New York Macmillan.

Anderson, G., Benjamin, D., Fuss, M. (1994). The Determinants of success in university introductory economics courses. *Journal of Economic Education*, 25(2), 99-119

Anderson, J.R., Conrad, F.G., & Corbelt, A.T. (1989). Skill acquisition and the LISP tutor journal of cognitive science. 13(4), 467-505

Annastasi, A., & Urbina, A. (2002). *Psychological testing,* 7th ed. Education (Singapore) Pvt. Ltd. Indian Branch. P.84.

Annie, W., Howard, W., Stoker., & Mildred, M. (1996). *Achievement and ability tests, definition of the domain.* Educational measurement university press of America pp 2-5 ISBN 978-0-7618-0380-0.

Apelian, D. (2013). Innovations and opportunities in Engineering Education. *Bridge Linking Engineering and Society.* 43(2).

Archambault, I., Eccles, J.S., & Vida, M.N. (2010). Ability Self-concepts and subjective value in Literacy: joint trajectories from Grades 1-12. Journal of Educational Psychology, 102: 804-816

Atieno, O.P. (2012). Predictive validity of Internal Examination in secondary schools in Kenya. *Published Masters dissertation.* University of Nairobi, Psychology department, school of education

Atkin, J., Black, P., & Coffey, J. (Eds.) (2005). Classroom Assessment and the Natural Science Education Standards. Committee on classroom Assessment and the National Science Education standards, Center for Education, National Research Council. National Academy Press.

Azen, R., Bronner, S., & Gafni, N. (2002). Examination of gender bias in university admissions. Applied Measurement in Education, 15, 75-94

Bagherzadeh, Z., Keshtiaray, N., & Assareh, A., (2017). A brief view of the evolution of technology and Engineering Education. *EURASIA journal of Mathematics, Science and Technology Education.* 13(10), 6749-6760

Bandura, A. (1986). Social Foundations of thought and action: A social cognitive theory. (Englewood Cliffs, NJ: Prentice-Hall)

Barcelona Declaration (2004). Engineering education in sustainable Development Conference Barcelona

Baytiyeh, H., Naja, M. (2020). Students' Enrollment in Engineering: Motivational Factors. *International Journal of Engineering Education. 26*(5): 1192-1199.

Beauchamp, K.G. (1997). *Exhibiting Electricity.* IET. ISBN 9780852968956

Benson, L., Morkos, B. (2013). *CAREER: Student motivation and Learning in Engineering.* 120th ASEE Annual Conference & Exposition.

Beinai, B & Perin, V. (2016). Type of high school Predicts Academic Performance at University better than individual differences. *Plos one 11*(10). e0163996

Bichi, A.A. (2016). Classical test theory: An introduction to linear modelling Approach to test and Item analysis. *International Journal of Social Studies, 2*(9), 27-33

Bingolbali, E., Monaghan, J & Roper, T. (2007). Engineering students' conceptions of the derivative and some implications for their Mathematical education. *International journal of Mathematical education in science and technology.* 38(6), 763-777

Black, P, & William, D. (1998). Inside the Black Box: Raising standards through classroom Assessment. *Phi Delta Kappan.* 80(2).

Black, P., Harrison, C., Lee, C., Marshall, B., & William, D. (2003). *Assessment for Learning: Putting it into practice.* Berkshire England: Open University Press.

Bong, M., Cho, C., Ahn, H.S., & Kim, H.J. (2012). Comparison of self-beliefs for predicting student motivation and achievement. *Journal of Educational Research, 105*, 336-352

Borsboom, D., Mellenbergh, G. J., & Van Heerden, J. (2004). The concept of validity. *Psychological Review*, *111*, 1061-1071. doi: 10.1037/0033295X.111.4.1061

Bossaert, G.S., Doumen, E., Buyse, K & Verschueren (2011). Predicting students' achievement after the transition to first grade. A two-year longitudinal study. *Journal of applied developmental psychology.*

Bothaina, A.A., Hamouda, A.M., Galal, M.A. (2019). Modelling of student academic achievement in engineering education using cognitive and non-cognitive factors. *Journal of Applied Research in Higher Education, 11*(2), 178-198

Breland, H. M. (1979). Population Validity and College Entrance Measures (Research Monograph No. 8). New York: College Entrance Examination Boa

Bridgeman, B. & McHale, F. (1996). Gender and ethnic group differences on the GMAT Analytical Writing Assessment (ETS RR-96-2). Princeton, NJ: Educational Testing Service

Bridgeman, B., McCamley-Jenkins, L., & Ervin, N. (2000). Predictions of freshman grade point average from the revised and recentered SAT I: Reasoning Test (College Board Research Report No. 2000-1). New York, NY: The College Board.

Brown, H. D. (2004). Language assessment Principles and Classroom Practices U.S.A. White Plains, NY: Pearson Education.

Brown, R., Coughlin, (E.d.). (2007). *The predictive validity of selected Benchmark*

Assessment. Regional Educational Laboratory Mid- Atlantic. Cambridge: University of Cambridge school of Education.

Bunch, M.E. (1958). The Concept of Motivation. *The Journal of General Psychology.5*(8): 189-205

Burke, J. (1978). Connections. Macmillan. p. 75. ISBN 0-333-24827-9

Bylund, R. A., & Reeves, E. B. (2005). Are Rural Schools Inferior to Urban Schools? A Multilevel Analysis of School Accountability Trends in Kentucky. Rural Sociology, 70(3), 360-384

Calvo, M. (2003). *Minerales Y Minas de Espana*. Vol II. Sulfuros Y Sulfosales. Vitoria, Spain : Musero de Ciencias Naturales de Alava, 205-335. ISBN 84-7821-543-3

Cameroon (1963). Loi No. 63/13 du Juin, 1963, portant organization de l'ensegnement publique secondaire et technique. Yaounde. Ministry of National Education

Cameroon BACalaureate Board (OBC). (2018). Series and specialties 2018-2019. Yaounde.

Cameroon GCE board (2007). *Information booklet*

Cameroon. (1998). Law No 98/ 004 of 14 April 1998. To lay down guidelines for education in Cameroon. Yaounde: Presidency of the Republic of Cameroon.

Cameroon. (2001). Law No. 005 of 16th April 2001 to guide Higher Education in Cameroon. Yaounde: Presidency of the Republic of Cameroon.

Cameroon. (2013). Education and Training Sector Strategie Paper (2013-2020). Yaounde: Ministry of Economy Planning and Regional Development.

Cardella, M. (2007). What your Engineering students might be learning from their Mathematics pre-reqs (Beyond Integrals and Derivatives). ASEE/ IEEE Frontiers in Education Conference, Milwaukee, Wilconsin, pp. S4F1-S4F6

Centre Pilote d'O rientation Scolaire, Universitaire et Professionnelle (C.O.S.U.P.). (2019). The GCE A- level in Arts series and Science series that make up the subsystem are distributed into subjects. Retrieved from www.orientation.cm>english-speaker on the 5th of September 2019.

Chakrabartty, S. N. (2013). Best Split-Half and Maximum Reliability. IOSR Journal of Research & Method in Education, 3(1), 1-8.

Christiana, Amaechi, Ugodulunwa, Uzoamaka, Priscilla, Okolo (2015). Effect of Formative Assessment on Mathematics Test Anxiety and Performance of Senior Secondary School Students in Jos, Nigeria: Journal of Research & Method in Education. Vol. 5 Issue 2. Pg. 38-4

Clayton, B. (2019). What are the traits necessary to be an Engineer. *Hearst Newspaper, LLC.*

Cohen, L., Manion, L., Morison, K. (2007). *Research Methods in Education*. 6th Ed. Roudledge, Taylor and Francis group.

Cole, J.S. (2014). A- level Mathematics module choice and subsequent performance in first year of an engineering degree. *Journal of MSOR connections.* Doi 10.11120/ msor.2014.00019.

Corbett, N., Sibbald, R., Stockton, P., & Wilson, A. (2015). Gross Error Detection: Maximising the Use of Data with UBA on Global Producer III (Part 2). 33rd International North Sea Flow Measurement Workshop 20th – 23rd October 2015.

Cordova, D.I & Lepper, M.R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization and choice. *Journal of educational Psychology*. 88 (4): 715-730

Craig, S.W., & James, A.W. (2003). An instructors guide to understanding test reliability. Testing and Evaluation services, University of Wisconsin 1025 W. Johnson St. Madison, WI53706.

Crawford, P. L., Alferink, D. M., & Spencer, J. L. (1986). Postdictions of college GPAs from ACT composite scores and high school GPAs: Comparisons by race and gender. West Virginia State College (ERIC Document Reproduction Service No. ED 326 541).

Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory.* New York: Harcourt Brace Jovanovich College.

Cronbach, L. (1971). Test validation. R. Thorndike (Ed.), *Educational measurement* (2ndedition pp 403-507). Washington D.C: American Council on Education.

Cronbach, L.J., & Meehl, P.E. (1955). *Construct validity in psychological bulletin*. 52(4), 281-302.

Cuello, J.C. (2005). Engineering to Biology and Biology to engineering. The bidirectional connection between engineering and Biology in biological engineering design. *International journal of Engineering.* 21, 1-7

Cullen, J., Francis, T., John. B.C. Hayhow, V.L., Van, L., & Plouffe, J.T. (1975). The effects of the use of grades as an incentive. *The Journal of educational research*; 68 (7), 277-279.

Darlington, E., & Bowler, J. (2017). Engineering undergraduate's views of A-level Mathematics and Further Mathematics as preparations for their degree. *Teaching Mathematics and its Applications: An international journal of the IMA.* 36(4), 200-216

Davis, J.A. (1954). Academic Performance of Public and Private school graduates at Princetan. *Research Bulletin.* https/www.online library. wiley.com

De Winter, J.C.F., & Dodou, D. (2011). Predicting academic performance in engineering using High School exam scores. *International journal of*

Engineering Education. 27(6), 1343-1351

DeVellis, R.F. (2011). *Scale development: Theory and application.* Sage Publications, Inc

Devillis, R. E. (2006). Scale Development: Theory and Application. Applied Social Science. Research Method Series. Vol. 26 Newbury Park: SAGE Publishers Inc

Diener, E & Crandall, R. (1978). *Ethics in Social and Behavioral Research.* University of Chicago Press.

Downing, S. M. (2004). Reliability: On the Reproducibility of Assessment Data. Med Education, 38, 1006-1012.

Ebel, R.L., & Fresbie, D.A. (1991). *Essentials of educational measurement* (5th ed.) Englewood Cliffs, NJ: Prentice Hall.

Eccles J. S., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), Achievement and achievement motivation (pp. 75–146). San Francisco, CA: W. H. Freema

Eccles, J.S., Wigfield, A., & Schiefele, U. (1998), Motivation to succeed, in Damon, W. (Series, Ed.) and Eisenberg (Vol. Ed.), *Handbook of child Psychology.* 5th.ed. Vol III, 1017-1095.

Emovon, E. U. (1985): Sciencing. The Nigerian Experience. The Practice of science in Nigeria.Keynote Address.*Proceedings of the 26th Annual Conference of Science Teachers' Association of Nigeria*. pp. 7-12

Engellant, K.A., Holland, D.D., Piper, R.T. (2016). Assessing Convergent and Discriminant Validity of the motivation construct for the Technology Integration Education (TIE) Model. *Journal of Higher Education Theory and Practice, 16*(1), 37-50

Faleye, B.A., & Afolabi, E.R.I. (2006). The predictive validity of Osun state junior secondary certificate examination. *Electronic journal of Research in Educational Psychology*. 53(1), 131-144. (9)

Federico, F. (2009). The making of the first microprocessor, *IEE solid state circuits Magazine IEEEXPLORE*

Fleming, J., & Garcia, N. (1998). Are standardized tests fair to African Americans? Predictive validity of the SAT in Black and White institutions. Journal of Higher Education, 69(5), 471-495.

Frankfort-Nachmias and Nachmias (1992). *Research Methods in the Social Sciences*. Edward Arnold

Fulcher.G & Davidson, F. (2007). Language Testing and Assessment. London: Routledge.

Fung, Y.C. (2004). Jacob schools. Ucsd.edu. Retrieved on 29 May 2019.

Gafoor, K.A. (2013). Types and Phases of Evaluation in Educational Practice. https// www.research gate. Net/Publication/ 27223705. Assessed on 20 April 2020.

Gagne, R.M. (2005). Principles of Instructional Design. 5th Ed. Thomson Wadsworth.

Gamache, L. M., & Novick, M. R. (1985). Choice of variables and gender differentiated prediction within selected academic programs. Journal of Educational Measurement, 22, 53–70

Ganesh, R. (2012). *Applied biological engineering principles and practice.* Rijeka: In Tech.

Ganesh, T. (2009). Reliability and Validity Issues in Research. Integration and Dissemination. Research Bulletin, 4, 35-40.

Gay, L.R., (1996). *Educational research: Competencies for analysis and application: Upper Saddle River,* New Jersey: Merrill, Prentice-Hall Inc., pp 249-305

Geiser, S., Santelices, V., M. (2007). Validity of high school grades in predicting student success beyond the fresh man year: High School Record vs Standardized tests as indicators of Four-year College outcomes. *Research and Occasional Paper Series:* CSHE.6.07. https:// www.coursehero.com. Assessed 30 April 2020.

Gero, A., Abraham, G. (2016). Motivational factors for studying science and engineering in beginning students: The case of academic preparatory programmes. *Global Journal of Engineering Education. 18*(2)

Geske, A., Grinfelds, A., Dedze, I., & Zhang, Y. (2006). Family background, school quality and rural-urban disparities in student learning achievement in Latvia. Prospects. 36(4), 419431

Givner, N., Hynes, K. (1979). Achievement test validity: correction for restriction effects. *College and University, 54,* 119-123.

Gluch, P. (2000). Costs of Environmental Errors (CEE): A Managerial Environmental

Good, C.V. (1973). *Dictionary of Education.* McGraw Hill Book Company Inc. New York, pp. 5,30, 100-104, 318-320

Goold, E., & Devitt, F. (2012). The role of Mathematics in Engineering practice and in the formation of engineers. *SEFI, 40th annual Conference, 23-26, September 2012*. Thessalonika, Greece.

Goswami, U. (1991). Put to the test: the effects of external testing on teachers. *Educational researcher* 20,8-11.

Guarniere, M. (2014). Electricity in the age of Enlightenment. *IEEE Magazine.* 8(3):60-63

Gravetter, F.J., Forzano., & Lori-Ann, B. (2012). *Research methods for the behavioural sciences. (*4th edition). Belmont Calif.: Wadsworth.p.78. ISBN 978-1-111-34225-8

Grimson, J. (2002). Re-engineering the curriculum for the 21st Century. *European journal of Engineering Education,* 27(1), 31-37

Gronlund, N.E. & Linn, R.L. (1990). Measurement and Evaluation in Teaching (6th Edition), New York: Macmillan.

Gronlund, N.E. (1985). Measurement and Evaluation in teaching, New York: Macmillan Publishing Company

Gulliksen, H., & Wilks, S. S. (1950). Regression tests for several samples. Psychometrika, 15, 91-114.

Gwet, K. L. (2012). Handball of inter-rater reliability. 3rd ed. USA. Advanced Analytics, LLC; 2012.

Hackett, G & Lent, R.W. (1992). Theoretical Advances and current enquiry in career psychology in S.D Brown and R.W. Lent (Eds). *Handbook of Counselling Psychology.* 2nd ed. 419-451.

Hackett, G., & Betz, N.E. (1981). A self-efficacy approach to the career development of women. *Journal of Vocational Behaviour, 18,* 326-336

Hahn, S., Kini, T.H, Seo, B. (2014). Effects of Public and Private schools on Academic Achievement. *Seoul Journal of Economics 27* (2), 137-147

Hambleton, R.K., Swaminathon, H., & Rogers, H.J. (1991). *Fundamentals of Item Response Theory*. Newbury Park, CA: Sage Press

Hampshire Technology education (2012). New Hampshire state of New Hampshire Development of Education. *Association technology/ Engineering Education Curriculum Guide.* GCPSEA- Signature- education. Nh.gov.

Haradhsan, K.M. (2017). Two criteria for good measurements in research: validity and reliability. *Annals of spiru Haret University.* 17(3); 58-82

Haris, D., Black, L., Hernandez-Martinez, P., Pepin, B., & William, J. (2015). Mathematics and its value for engineering students; What are the implications for teaching? *International journal of Mathematical education in science and technology.* 46(3), 321-336.

Harlen, W. (2005). Trusting teachers' judgement; research evidence of the reliability and validity of teachers; assessment used for summative purposes

Hartman, H.L. (1992). Minning and Engineering Hand book, society for minning, metallurgy and Exploration, Inc, P3.

Hathcoat, J. (2013). Validity semantics in educational and psychological assessment. *Practical Assessment, Research & Evaluation, 18*(9), 1-1

Heiss, A., Oeggl, K. (2008). Analysis of the fuel wood used in late Bronze Age and Early Iron Age copper minning sites of the Schwaz and Brixlegg area (Tyrol, Austria). *Vegetation History and Archaeobotany*. 17(2): 211-21

Hejazi, J., Davami, P., Towhidi, N., Ardakani, A.H., Taheri, A.K., & Mahmodi, R. (2011). Technology and knowhow. *Iranian journal of Engineering Education.* 12(48), 65-88.

Hood, S. B. (2009). Validity in psychological testing and scientific realism. *Theory & Psychology, 19,* 451-473. doi:0.1177/0959354309336320

Hopkins, K.D. & Stanley, J.C. (1981). *Educational and Psychological Measurement and Evaluation.* N.J. Prentice-Hall.

Huang, S & Fang, N. (2013). Predicting students' academic performance in an engineering dynamic course. A comparison of four types of predictive mathematical models. *Journal of computers and engineering.* 61, pp 133-145*in College.* ISBN (e book). 9783668283558

Hughes, A. (2003). *Testing for Language Teachers*. Cambridge University Pres

Huws, N., Reddy, P., Talcott, J. (2006). Predicting university success in psychology: Are subject-specific skills important? *Psychology Learning & Teaching,* 5(2), 133-140

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender difference in mathematics performance*: A meta-analysis. Psychological Bulletin*, 107, 139-155.

Jacob, S.M and Isaac, B. (2005). Formative assessment and its E-learning implementation. *Proceedings for the international Conference for education.*

James, L., & John, H. (1995). Predictors of persistence and success in an engineering program. *NACADA journal* 15: 15-51

Jensen, A. R. (1980). *Bias in mental testing*. Free Press

Jimenez, E & Cox, D. (1990). The relative effectiveness of private and public schools. Evidence from two developing countries. *Journal of Development Economuics, 34*(2), 99-121

Johnson, D.G., Lloyd, S.M., Jones, R.F. (1986). Predicting performance at a predominantly black medical school. *Academic medicine, 61,* 629-639

Jones, R.F., & Vanyur, S. (1985). *Gender related test bias for the Medical College Admission Test*. Paper presented at the annual meeting of the National council on Measurement in Education in Chicago

Kane, M. (2001). Current concerns in validity theory. *Journal of Educational Measurement, 38*, 319-424.

Kane, M. (2012). All validity is construct validity. Or is it? *Measurement, 10*, 66-70.

doi:10.1080/15366367.2012.681977

Karakaya, I., & Tavúancil, E. (2008) The Predictive Validity of the University Student Selection Examination. Educational Sciences: Theory and Practice, vol.8 No.3 pp1011-1019.http://www.eric.ed.gov/ERICDocs/pdf dated 17-7-2009

Karimi, M.N. (2014). Iranian EFL, Teachers' perceptions of Dynamic Assessment: Exploring --the role of education and length of service. *Australian Journal of Teacher Education*, *39* (8),143-162.

Kathy, D. (2013). 22 Essay Assessment Technique for Measuring in Teaching Learning. Grow. The Education blog, www. Nwea.org 1-22 Essay formative Assessment. Assessed on 02/01/2020

Kaukab & Mehrunnisa (2016). History and Evolution of standardized testing. A literature review. *International Journal of Research-Granthaalayah 4*(5), 126-132

Kennedy, E. (2003). *Raising test scores for all students.* Thous and Oaks, CA: Corwin Press, Inc.

Kerlinger, F.N. (1995). Foundations of behavioral research (3rd ed.). Prism Books Private Limited.

Kibble, J.D. (2017). Best Practices in Summative Assessment. *Adv physiol Educ*, 41, 110-119.

Kim, A.N. (2014). *The Influences of Engineering students' motivation on short term tasks and long-term goals.* A published PhD Dissertation presented to the graduate School of Clemson University.

Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and Reliability of Measurement Instruments Used in Research. *American Journal of Health-System Pharmacists*, 65(1), 2276- 2284

Kizlik, B. (2014). Measurement, Assessment and Evaluation in Education. https// www.cloud.edu. Assessed 09 April 2020.

Kirby, R.S. (1990). *Engineering in History*. Courier Dover Publication, pp.331- 333.

Kolmos, A., Mejlgaard, N., Haase, S.S., Holgaard, J.E. (2013). Motivational factors, gender and Engineering Education. *European Journal of Engineering Education. European Journal of Engineering Education. 38*(3), 340-358.

Kulkarni, K.V. (1962). Construction of standardized achievement test in arithmetic. Aurangabad: Marathwada University.

Kuncel, N., & Hezlett, S. (2007). Standardized tests predict graduate students' success. *Science* 3 (15), 1080-1081

Kuncel, N.R., Campbell, J.P., & Ones, D.S. (1998). Validity of the Graduate Record Examination. Estimated or tactically known. *American Psychologist*, *53*, 567-568.

Kupermintz, H. (2003). Lee, C.J Cronbach's contributions to educational Psychology. In Zimmerman, B.J and Schunk, D.H. (Eds.). *Educational Psychology: A century of contributions,* 289-302.

Kyei-Blankson, S.L. (2005). Predictive validity, differential validity and differential prediction of the subtests of the medical college admission test. Published Ph. D theses.

Lavin (1965). *The prediction of academic performance of academic performance: A theoretical analysis and review of research.* Sage foundation, New york 1965. pp182.

Lawal, N., Badu, J.B., & Chukwuemaka, E.J. (2015). Predictive validity of first year GPA and final degree classification among management and social science students. *The International journal of Science and Technology.* 3(7), 210-215.

Lee, R., Miller, K.J., Gravam, W.K. (1982). Correction for restriction of range and attenuation, *in criterion related validation studies. Journal of Applied Psychology, 67, 637-638.*

Lee, S., Harrison, M.C & Robinson, C.L. (2006). Engineering students' knowledge of mechanics upon arrival. Expectations and reality. *Journal of Engineering Education.* 1(1), 32-38

Lee, S., Harrison, M.C., Pell. G., Robinson, C.L. (2008). Predicting performance of first year engineering students and the importance of assessment tools therein. *Journal of Engineering Education.* 3(1), 44-51.

Lemay, M. (2017). Personnel evaluation: What are the right metrics? https:// Cangarooh.Ca. Assessed on. 29 April 2020

Lent, R. W., & Brown, S. D. (2000). The role of contextual supports and Barriers in the choice of Math/ Science Educational options: A test of social cognitive hypothesis. *Journal of Counselling Psychology, 48* (4), 474-483

Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance [Monograph]. Journal of Vocational Behavior, 45, 79-122

Lent, R. W., Brown, S. D., & Hackett, G. (2000). Contextual supports and Barriers to Career Choice: *A social cognitive Analysis. Journal of Counselling Psychology*, 47, 36-49

Liberty, G.M., Aida, B.B., Dulog, A. (2015). *Readiness level of Engineering freshmen student*

Linn, R. L. (1978). Single-group validity, differential validity, and differential prediction. *Journal of Applied Psychology*, 63, 507–512

Linn, R. L. (1982). Ability testing: Individual differences, prediction, and differential prediction. In A. Wigor & W. Garner (Eds.), Ability testing: Uses, consequences, and controversies (pp. 335-338). Washington, DC: National Academy Press

Linn, R. L. (1982a). Admissions testing on trial. *American Psychologist*, 37, 279–291

Linn, R. L. (1982b). Ability testing: Individual differences, prediction and differential prediction. In R. L. Linn (Ed.), Ability testing: Uses, consequences, and controversies. Washington, DC: National Academy Press.

Lock, E.A & Latham, G.P. (1990). *A theory of goal setting and task performance.* Prentice Hall

Lojek, B. (2007). History of semiconductor Engineering Springer. Science & Business media, pp 321-323. ISBN 9783540342588.

Lovegreen, A.T. (2003) "Predicting the Academic Success of Female Engineering Students during the First Year of College Using the SAT and Non-Cognitive Variables" Virginia Polytechnic Institute and State University

Maccoby, E. E. & Jacklin, C. N. (1974). The psychology of sex differences. Stanford University

Madan, C. R., & Kensinger, E. A. (2017). Test–Retest Reliability of Brain Morphology. Estimates Brain Informatics. 4, 107-121.

Madaus, G.F. (1970). Placement, formative and summative evaluation. Paper presented to annual meeting; *AERA*. https://files.eric.ed.gov. Accessed on 21 April 2020.

Maheshwari. (2016). The concept of measurement in education.www.ukmaheshwari.com. accessed on 23/01/2020

Malhotra, N. K. (2004). Marketing Research: An Applied Orientation (4th Ed.). New Jersey: Pearson Education, Inc.

Marsh, C.J. (2007). A critical analysis of the use of formative assessment in schools. *Educational Research for Policy and Practice,* 6(1), 25-29.

Martin, P.J & Simmons, R.D. & Yu, L.S. (2013). The role of social capital in the experiences of Hispanic Women Engineering Majors. *Journal of Engineering Education, 102* (2), 227-243

Mattern, K., Patterson, B., Shaw, E., Kobrin, J., & Barbuti, S. (2008). Differential validity and prediction of the SAT (College Board Rep. No. 08-4). New York, NY: College Entrance Examination Board.

Maxey, J., & Sawyer, R. (1981, July). Predictive validity of the ACT Assessment for Afro American/Black, Mexican-American/Chicano, and Caucasian-American/White students (ACT Research Bulletin 81-1). Iowa City, IA: American College Testing.

Mbua, F. N. (2003). *Educational administration: Theory and practice*. Design House.

Mburu, D.N.P. (2013). Effects of the type of school attended on students' academic performnance in Kericho and Kipkelion District, Kenya. *International Journal of Humanities and Social Science 3*(4), 79-90

Mc Alpine, M.A. (2002). A summary of method of item analysis. CAA Centre. Lutton.

Meade, A., & Fetzer, M. (2008). A new approach to assessing test bias. Paper presented at the 23rd Annual Conference of the Society for Industrial and Organizational Psychology, San Francisco, CA.

Meade, A., & Fetzer, M. (2009). Test bias, differential prediction, and a revised approach for determining the suitability of a predictor in a selection context. Organizational Research Methods, 000(00), 1-24. https://doi:10.1177/1094428109331487

Meagan, N.T. (2019). Assessing students' success: Predictive validity of the ACT science subscore. A published PhD dissertation submitted to the College of Education, Eastern Michigan University, *Digitalcommons@EMU.*

Messick, S. (2000). Consequences of test interpretation and use: The fusion of validity and values in Psychological assessment. In R.D. Goffin & E. Helmes (Eds.), *Problems and solutions in human assessment* (pp.3 -20). Norwell, M.A: Kluwer Academic

Metler, C.A., & Vannatta, R. A. (2002). Advanced multivariate statistical methods: Practical application and interpretation. (2nd ed.). Los Angeles: Pyrczak.

Michael, A.L. (2016). Characteristics of a good test. Department of Library and Information science. Delta state university, Abraka.

Micheels, W.J. and Ray Karnes, M. (1950). Measuring educational achievement. New York: Mc Graw - Hill Book Company Inclusive

Miller, C. (2013). Atlas of US and Canadian Environmental History, P.64

Mohanty, G., Gretes, J., Flowers, C., Algozzine, B., & Spooner, F. (2005). Multi-method evaluation of instruction in engineering classes. *Journal of Personnel Evaluation in Education,* 18(2), 139-151.

Monk, D. H., & Haller, E. J. (1986). Organizational alternatives for small rural schools. Cornell: New York State College of Agriculture and Life Sciences at Cornell University, 1986.

Moskowhz, S.L. (2016). Advanced Materials innovation: Managing Global Technology in the 21st Century. John Wiley & Sons, p. 168, ISBN 9780470508923

Motahhari, N., Hossein, Y.M., & Davami, P. (2011). Engineering Education Necessities Considering industrial needs in Iran. *Iranian Engineering Education Quaterly*, 13th year, No.52, Winter 2011, pp 39. Retrieved from http://ijee.ias.uc.ir.

Motoachari, N., Hossein, Y.M., & Davami, P. (2011). Engineering education necessities, considering individual needs in Iran. *Iranian Engineering Quarterly*. 13(52), 39

Murphy, K. R., & Davidshofer, C. O. (2005). Psychological Testing: Principles and Applications (6th Ed.). Upper Saddle River, N.J.: Pearson/Prentice Hall

Nenty, H. J. (2015). Conjugal relationship between Assessment and Research. *African journal of Theory and Practice of Educational Research (AJTPER).* Vol 1. pp 1-23.

Nettles, A. L., & Nettles, M. T. (Eds.) (1999). Measuring up: Challenges minorities face in educational assessment. Norwell, MA: Kluwer Academic

Newton, P. E. 2007. Clarifying the Purposes of Educational Assessment. Assessment in Education: Principles, Policy & Practice, 14 (2): 149-170

Nick, S., Roy, B., Eleni, N. (2011). Motivation of Engineering students' in higher education, *Engineering Education, 6*:2, 39-46

Noble, J., Crouse, J., & Schulz, M. (1996). *Differential prediction/ impact in course placement for ethnic and gender groups.* ACT Research Report Series 96-8. Iowa city, IA: American College Testing

Noll, V.H. (1965). *Introduction to educational measurement.* Houghton Mifflin Company.

Nworgu, B.G. (2015). *Educational measurement and evaluation*; theory and practice. (2nd.ed). university trust printers.

Nworgu, B.G. (2015). Educational Research: Basic issues and Methodology. (3rd.ed). university trust printers.

O'Dwer, A. (2012). Comparison of Examination performance in Mathematics, Physics and Electricity of first year level 7 student cohorts in electrical engineering. SMEC: Proceedings of science and Mathematics Education Conference, Dublin City University, pp 85-88

O'Rourke, B., Martin, M.O., & Hurley, J.F (1989). The scholastic aptitude test as a predictor of third-level academic performance. *The Irish journal of education*, 23(1), 22-35

Oakes, W.C., Leone, L.L., Grun, C.J. (2001). Engineering your future. Great Lakes Press. ISBN 978-1-881018-57-5

Okumu, I.M., Nakajjo, A., Isoke, D. (2008). Socioeconomic determinants of primary school dropout: the logistic model analysis. *African journal of Economic review,2016- ajol. Info.*

Olagunju, A.M. (2015). The effect of formative assessment on students' achievement in secondary school Mathematics. *International journal of Education and Research,* 3(10), 481-490.

Omrin, M.S., & Ale, R.M. (2008). Predictive validity of English and Mathematics Mock Examination Results of Senior Secondary School Students' in WASCE in Ekiti- State Nigeria. *Pakistan journal of social sciences* 5(2), 139-141.

Omrod, J.E. (2003). *Educational Psychology: Developing learners*. (47th ed.) Merill Prentice Hall

Ornek, F., Robinson, W.R., Haugan, M.R. (2007). What makes Physics difficult? *Science Education International.* 18(3), 165-172

Ornstein, A.C, Hunkins, F. P. (2009). *Curriculum Foundations, Principles, and Issues* (5th ed.). Pearson printers.

Osborne, J.W., & Waters, E. (2002). For Assumptions of multiple regression that researchers should always test. *Practical Assessment, Research and Evaluation*, 8(2), 1-5.

Othuon, L.A. (1994). Hierarchical linear modelling of predictive validity. The case of Kenya Certificate of primary education examination. *Studies in educational evaluation.* 20 ;181-190.

Pablo-Lerchundi, I., Nunez-del-Rio, M., Gonzalez-Tirados, R. (2015). Career Choice in engineering students: Its relationship with motivation, Satisfaction and the Development of Professional plans. *Anales de Psicologia 3* (1), 268-279

Paipetis, S.A., Ceccarelli & Marco. (2010). *The Genius of Archimedes- 23 centuries of influence of Mathematics, Science and Engineering: Proceedings of an international Conference held at Syracuse, Italy, June 8-10, 2010*. Springer Science & Business Media. P. 416. ISBN 9789048190911

Patel, C.M., Chauhan, D.M. (2017). Motivation based Engineering Education. A case study of RK University. *Journal of Engineering Education Transformations*, special issue, e ISSN, 2394-1707.

Peers, I, S., & Johnston, M. (1994). Influence of learning context on the relationship between A-level attainment and final degree performance: A meta analytic review. *British Journal of Educational Psychology*, 64: 1-15

Pennington, D. (2003). *Essential* personality. Arnold. ISBN O340-76118-0

Potts, D.T. (2012). *A companion to the Archaelogy of the Ancient near East.* P. 285

Powell, J.C. (2010). Testing as feedback to inform teaching, in: learning and instruction in the digital age: making a difference through cognitive approaches. New York: Springer.

Pricilla, G.M., Baxter, D.H. (2020). Petroleun Engineering Encyclopaedia Britannica, Inc. https://www.britannica.com. Assessed on 02 March 2020

Rahman, A., Hasan, M., Mamun, A. (2012). Study of student performances between secondary school results with that of diploma engineering results: A case for the Polytechnic students of Bangladesh. *Journal of Asian Research Consortium*, 2(9): 245-253

Reynolds, C.R. (1982). Method of detecting construct and predictive bias. In R.A. Berk (Ed.), *Handbook of method of detecting test bias* (pp 199-227). John Hopkins University

Reynolds, C.R., & Kamphaus, R. W (Eds.). (2003). *Handbook of Psychological and Educational Assessment of Children: Intelligence, Aptitude and Achievement (2nd ed.).* New York: Guilford.

Robbins, T.W. & Everitt B.J. (1996). Neurobehavioural mechanisms of reward and motivation. *Neurobiology* 6(2), 228-236

Rowan, R. W. (1978). The predictive value of the ACT at Murray State University over a four-year college program. Measurement and Evaluation in Guidance, 11, 143–14

Rudner, L. (1994). Questions to ask when evaluating tests. Practical Assessment, Research & Evaluation, 4(2). Available online: http://PAREonline.net/getvn.asp?v=4&n=2

Sabitu, A.O., Babatunde, E.G., Oluwole, A.F. (2012). School types, Facilities and Academic performance of students in senior secondary schools in Ondo state Nigeria. *International Education studies 5*(3), 44-48

S.K. (ed). *Handbook of Research in Science Education.* Routledge pp. 82-103

Sackett, P. R., & Wilk, S. L. (1994). Within-group norming and other forms of score adjustment in preemployment testing. American Psychologist. 49 (11), 929-954

Saghafi, F., Ameli, M.S.J & Mohammadsa desghi, A.M. (2004). Risk management and value engineering. *International Conference on Industrial Engineeering.* Retrieved from https:// www.civilica.com

Salandanan., & Gloria, G. (2001). *Strategies for effective teaching.* Katha Publishing. Co. Inc.

Sanders, J.R. & Davidson, E.J. (2003). A model for school evaluation. *An International Handbook for Educational Evaluation.* Vol. 9. Pp 807-826. ISBN 978-1-4020-0849-8

Sarmah, H.K. (2012). Determination of Reliability and Validity measures of a questionnaire. *Indian Journal of Education and Information Management.* 1(11), 508-517.

Schiro, M.S. (2008). *Curriculum Theory: Conflicting Visions and Enduring Concerns.* Sage Publications.

Schumacker, R.E. (2010). Classical testAnalysis.https:// applied measurement associates. Com/ama/assets/File/Classical test analysis.pdf. Assessed on 02

March, 2020.

Segalas, J. (2009). Engineering education for sustainable future. PhD Dissertation. Barcelona.

Shannon, T. (2007). Deconstructing Paper based test scoring and test analysis using the university of Maryland Baltimore Test Scoring service. University of Maryland school of Pharmacy.

Shavelson, R.J. (2003). Lee, J. Cronbach. *The American Phylosophical society. 147*(4), 380-385

Shaw, I. (2000*). The Oxford History of Ancient Egypt*. Oxford University Press, p.108.

Shaw, S. & Bailey, C. (2011). An American university case study approach to predictive validity: Exploring the issues. *Research matters.* 12, 18-26

Shehab, R.L., Walden, S.E., Wellborn, E.E. (2015). Motivating factors for choosing Engineering as reported by Racial and Ethnic Minority students. 122nd ASEE Annual Conference & Exposition Scattle

Sheperd, L.A. (2006). *Classroom Assessment in Educational Measurement,* 4th. ed., ed. R.L.

Shete, A., Kausar, A., Lakhkar, K., Khan, S. (2015). Item analysis: An evaluation of multiple choice questions in psychology examination. *Journal of contdemporary Medical Education.* 3, 106- 9.

Shrestha, P.P & Shields, D.R. (2015). Correlating student performance in Fundamental of construction science course with Mathematics and Physics Grade Point Average. https://www.research *gate.net/ publication/237570143.* (Accessed on 18/06/2019).

Shreyas, V.K. (2013). Chapter 6- Reliability and Validity of the test. Shodhganga. https://Shodhganga. Inflibnet. ac. Ind > accessed on 16/01/2020 at 11.24 a.m.

Snowman, J., & Biehler, R. (2000). Psychology applied to teaching (9th.ed). Boston Houghton Miffin.

Stanley, J.C. and Hopkins, K.D. (1978). Educational and psychological mesurement and evaluation. New Delhi: Prentice - Hall of India Private Limited.

Suen, H.K., Lei, P. (2007). Classical Versus Generalizability Theory of Measurement. *Educational Measurement.*

Tabachnick, B.G., Fidell, L.S. (1996). *Using Multivariate Statistics (3rd ed.).* Harper Collins College Publishers 4.

Taher, A. (2012). The Predictive validity of Final English Exams as a measure of success in Iranian National University Entrance English Exam. *Journal of*

Language, Teaching and Research. 3(1). 224-228.

Tambo, L. I. (2003). *Cameroon National Education Policy Since the 1995 Forum.* Limbe: Design House.

Tambo, L. I. (2012). *Principles and methods of teaching application in Cameroon schools*. Buea; Anucam publishers. 131-133.

Tanyi, M. E. (2016). *Major Theories of Learning: The Process of Why, How and When We Learn* (2nd ed.). African Publications.

Tavakol, M., & Derrick, R. (2011). Post examination analysis of objective tests. *Med Teach*,33 447-58.

Taylor, J. R. (1999). *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurement*s. University Science Books.

Tchombe, T.M.S. (2014). *Gender in secondary school classroom practices in Cameroon*. Research report. The Common Wealth

Tchombe, T.M.S. (2019). *Psychological Paramaters in Teaching:* An Africentric Perspective to Learning as Process of Cognitive Enrichment. Design House.

Thiele, T., Singleton, A. (2016). Predicting students' academic performance based on school and socio demographic characteristics. *Studies in higher education 4*(18), 1424-1446.

Thissen, D & Orlando, M. (2001). Item response theory for items scored in two categories. In D. Thissen & Wainer, H (Eds). *Test scoring* (pp 73-140). Mahwah, N.J: Lawrence Erlbaum Associates, Inc.

Thissen, D., & Wainer, H. (2011). *Test scoring.* Mahwah, NJ. Eribaum.p1

Thomas, C. L. (1972). The relative effectiveness of high school grades and standardized test scores for predicting college grades for black students. Paper presented at the annual meeting of the National Council on Measurement in Education, Chicago.

Thorndike, R.L. (1949). *Personel selection: Test and Measurement techniques.* New York: Wiley.

Titler, R. (2014). Attitudes, identity and aspirations towards science. In Lederman, N.G., Abell,

Traub, R.E. (1997). The Classical Test Theory in Historical Perspective. *Educational Measurement: Issues and Practice*, 12, 8-14

Treadway, M. N. (2019). Assessing student success: Predictive validity of the ACT science subscore. Master's Theses and Doctoral Dissertations. 957.

Tukam, H.P. (1975). Teacher effectiveness and student performance. *The Journal of Economic Education*. 7(1), 34-39

Twycross, A., & Shields, L. (2004). Validity and Reliability-What's it All About? Part 2: reliability in Quantitative Studies. Paediatric Nursing, 16 (10), 36.

Vidal Rodeiro, C., & Zanini, N. (2015). The role of the A grade at A-level as a predictor of university performance in the United Kingdom. *Oxford Rev. Edu.* 4(1), 647-670

Vulperhorst, J., Lutz, C., Kleijn, R & Tartwijk, J. V. (2018). Disentangling the predictive validity of high school grades for academic success in university. *Assessment and Evaluation in Higher Education.* 43(3), 399-414.

Vygotsky, L.S. (1978). Mind and Society: The development of higher mental processes. (Cambridge, MA: Harvard University Press).

Weiner, B. (1974). *Achievement motivation and attribution theory*. General Learning Press

Widiastuti, S. (2017). Formative Assessment in EFL classroom practices. Bahasa Danseni 45(1), 50-65

Wigfield, A., & Gladstone, J.R. (2019). What does expectancy Value theory have to say about motivation and Achievement in times of change and uncertainty? *Motivation in Education at a time of Global change*: *Advances in motivation and Achievement*, Vol 20, 15-32

Wilder, G. Z., & Powell, K. (1989). Sex differences in test performance: A survey of the literature (College Board Report No. 89-3). Princeton, NJ: Educational Testing Service

William, J.B. (2017). The Electronic Revolution. Inventing the future. Springer. P 75. ISBN 9783319490885

Williams, M.N., Grajales, C.A.G., Kurkiewics, D. (2013). Assumptions of Multiple Regression: Correcting Two Misconceptions. *Practical Assessment, Research and Evaluation.* 18(11), 1-14.

Willingham, W. W. (1985). Success in college: The role of personal qualities and academic ability. New York: The College Boar

Willingham, W. W., & Cole, N. S. (1997). Gender and fair assessment. Mahwah: NJ: Erlbaum. (ED 416 293)

Wilson, J. (2010). Essentials of Business Research: A Guide to Doing Your Research Project. SAGE Publications

Wilson, K.M. (1983). A review of research on the prediction of academic performance after the freshman year (College Board Rep. No. 83-2). New York: College Entrance Examination Board

Winkelman, P. (2009). Perceptions of Mathematics in Engineering, European Journal of Engineering Education. 34(4), 305-316

Wrightstone, J.W., Justman, J. and Robbins, I. (1964). Evaluation in modern education. New Delhi: Eurasia Publishing House Private Limited.

Young, D. J. (1998). Rural and Urban Differences in Student Achievement in Science and Mathematics: A Multilevel Analysis. School Effectiveness and School Improvement, 9(4), 386-412

Young, J. W. (2001). Differential validity, differential prediction, and college admission testing: A comprehensive review and analysis (College Board Rep. No. 01-6). New York: College Entrance Examination Board

Zaida, H., & Dailiala, R. (2007). *Predicting students' academic performance, Comparing artificial neural network. Decision tree and Linear regression.* 21st annual SAS Malaysia Forum, Shangri-La. Hotel, Kuala Lumpura.

Ziedner, M. (1998). *Test anxiety: the state of the art.* New York plenum press.p. 259.ISBN 9780306471452.

Zujovic, A.M. (2018).'' Predictive validity of Florida's Post-secondary education readiness test''. Graduate theses and Disertations. http// scholarcommons. Usflexd/ 7253

APPENDICES

APPENDIX I: INFORMED CONSENT

INFORMED CONSENT

Introduction

I am ADE CYRIL MANCHO, a Ph. D research student in the Department of Curriculum and evaluation of the Faculty of Education of the University of Yaounde I. I am carrying out research on the topic ‘’ ***The Predictive Validity and Differential Predictive Validity of High School results in Sciences to Students’ Academic Performance in Engineering in Cameroon’’.*** I am going to furnish you with adequate information and later ask you to participate in this research. You are not obliged to decide instantly or today whether to participate in the research or not. Before you decide, you can talk to anyone you feel comfortable with about the research. In case of any aspect you don’t understand as I explain some important facets of the research, you are free to halt me and ask questions in order to get clarifications

Purpose of the research.

The study is aimed at finding out the extent to which GCE A/L and BAC results in general sciences predict students’ academic performance in engineering and how effectively these results could predict students’ performance differently in terms of gender, type of high school attended and the degree of students’ motivation for engineering studies. With the findings from this study, placement guides could be designed which will be used in placing students into various branches of engineering with respect to their high school results. These placements with respect to high school results will also take into cognisanze students’ gender, the type of high school they attended and their motivation for engineering studies.

Participant selection

All the engineering students in the school of engineering of the University of Bamenda who did general sciences in high school are invited to take part in the study.

Voluntary participation

Your participation in this research work is entirely voluntary. It is your choice to participate not. Whether you participate or not, your status as an engineering student will not change. If you decide to part take in the research, you may decide to terminate your participation at any time you deem it necessary during the research process.

Procedure

Data will be collected from you with the use of a questionnaire and data will also be collected from the school archives on you're A/L and BAC results and also on your academic performance at engineering school. At the end of the exercise, the data collected will be analysed and interpreted and the findings will be made public.

Risk

Participating in this research will expose you to more risk than if you were not participating in the research. We will try to reduce the chances of these occurring, but if it does happen you will be provided with justifications and backings.

Benefits

The study will quite beneficial to you because it will give you a moment to reflect on the engineering course you are offering vis a vis your drives and motives and your high school results.

Confidentiality

The information which will be collected from you will be kept confidentially and used only for research purposes. The information collected from you will be kept away and will only be at the disposal of the researcher and the academic supervisor. Any information you provide will have a number instead of your name and this number will be known only by the researcher and it shall be locked up with a lock and key. This shall not be given to anyone except my supervisor and the academic department.

Sharing the findings of the study

The findings of this study will be made available to your school administration once theresearch work has been completed. The findings will also be made public through public defence and by academic publications amongst others.

2 - CERTIFICATE OF CONSENT

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Name of participant ____

Signature of participant ____

Date ____

Name of witness ____

Signature of witness ____

Date ____

APPENDIX II: QUESTIONNAIRE

PREDICTIVE VALIDITY AND DIFFERENTIAL PREDICTIVE VALIDITY OF HIGH SCHOOL RESULTS QUESTIONNAIRE (PVDPVHRQ)

Dear respondents,

I am a PhD student of the Faculty of Education of the University of Yaounde I, carrying out research on the topic ***''The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to students' Academic Performance in Engineering in Cameroon''***

I will be most grateful if you assist me in giving answers to the set of questions below. The exercise is strictly for academic purposes. Your sincerity will be appreciated, and your response will be treated confidentially.

SECTION A: DEMOGRAPHIC INFORMATION

Instructions: place a tick in the box of the chosen response.

1) Name of Engineering school____

2)Gender: Male ( ) Female ( )

3) Age in years: Below 18 ( ) 18-21 ( ) 22-25 ( ) 26-29 ( ) Above 29 ( )

4) Age of entry into engineering school- Below 18 ( ) 18-21 ( ) 22-25 ( ) 26-29 ( ) Above 29 ( )

5) Type of High School Qualification: GCE A/L ( ) BAC C( ) BAC D ( ) BAC E( ) BAC IT( )

6) Engineering Department: Civil and Architecture ( ) Comp ( ) Elec ( ) Mech ( ) Mining( ) Petroleum ( )

7) Level of study: 3 ( ) 4 ( )

8) Type of High school attended: Public ( ) Mission ( ) Lay Private ( )

9) Location of High school: City ( ) Town ( ) Village ( )

10) Number of years spent in secondary and high school: Below 7 ( ) 7 ( ) 8 ( ) Above 8 ( )

11) Number of years spent out after high school before getting admission into Engineering school: 0 ( ) 1 ( ) 2 ( ) 3 and above ( )

12)Were you enrolled in another engineering school before coming to this engineering school? Yes ( ) No ( )

13) Highest academic qualification obtained before getting admission into this engineering school: GCE A/L/ BAC general ( ) Grade 1 ( ) HND( ) DIPES I( ) First Degree ( ) Above First Degree( )

14) Your high school had a well-equipped science lab: Yes ( ) No ( )

15) How many students were allocated to a set of equipment during practical sessions: 1( ) 2 ( ) 3( ) above ( )

16) You were well groomed in science practical's in high school: Yes ( ) No ( )

17) Overall grade point or grade scored in the GCE A/L or BAC examinations:

a) For students with GCE A/L: Less than or equal to 5 ( ) 6-10( ) 11-15( ) 16-20( ) 21-25( )
b) For students with BAC 'C', 'D' 'E' or 'IT': Passable ( ) Assez Bien ( ) Bien ( ) Tres Bien( ) Excellent ( )
18) Family structure: single parenthood ( ) Nuclear family ( ) Polygamous family( ) Other types ( )
19) How many children are in your household: 1 ( ) 2-4( ) 5 and above( )
20) Parent(s) occupation: Engineer ( ) other science related professions( ) Private sector or business( ) Civil servant but not engineer ( ) Others ( )

SECTION B: STUDENTS' MOTIVATION FOR ENGINEERING STUDIES
Instruction: Place a tick in the cell that describes how you feel about each statement on a ten-point Likert scale.

Strongly Disagree(SD)		***Somewhat Disagree (SWD)***			***Somewhat Agree (SWA)***			***Strongly Agree (SA)***	
1	2	3	4	5	6	7	8	9	10

S/N	**ITEM**	**SD**		**SWD**			**SWA**				**SA**
1.	I had always dreamt of becoming an engineer	1	2	3	4	5	6	7	8	9	10
2.	I had always wished to offer the branch of engineering I am offering	1	2	3	4	5	6	7	8	9	10
3.	My love for the sciences at high school made me to embrace engineering studies	1	2	3	4	5	6	7	8	9	10
4.	Even if I had passed the entrance examination into other professional schools, I would have still preferred the engineering school	1	2	3	4	5	6	7	8	9	10
5.	I chose this particular branch of engineering because I had developed interest in aspects related to it long time ago	1	2	3	4	5	6	7	8	9	10
6.	I chose this particular branch of engineering because I enjoy doing the activities pertaining to it	1	2	3	4	5	6	7	8	9	10
7.	I decided to study engineering because I was confident in my ability in Mathematics and in other science disciplines	1	2	3	4	5	6	7	8	9	10
8.	I am studying engineering because I	1	2	3	4	5	6	7	8	9	10

	know I can easily design and build things										
9.	I chose to do engineering because I like the challenge of solving problems	1	2	3	4	5	6	7	8	9	10
10.	I decided to do engineering because of my GCE A/L / BAC results	1	2	3	4	5	6	7	8	9	10
11.	I am into this particular branch of engineering because I perceived I would be competent in it	1	2	3	4	5	6	7	8	9	10
12.	I am doing this particular branch of engineering because it is more related to my best subject in high school	1	2	3	4	5	6	7	8	9	10
13.	I went into engineering studies because engineers are rich	1	2	3	4	5	6	7	8	9	10
14.	I chose to study engineering because it is a prestigious field of study	1	2	3	4	5	6	7	8	9	10
15.	I am studying engineering because I am sure of getting a lofty job upon graduation	1	2	3	4	5	6	7	8	9	10
16	I am studying this particular branch of engineering because it will set me up more for professional success	1	2	3	4	5	6	7	8	9	10
17	I am studying this particular branch of engineering because I noticed the society is facing problems which are related to this branch of engineering	1	2	3	4	5	6	7	8	9	10
18	I am studying this branch of engineering because it has more job prospects than the other branches of engineering	1	2	3	4	5	6	7	8	9	10
19	I am studying engineering because my parents want me to be an engineer	1	2	3	4	5	6	7	8	9	10
20	I decided to study engineering because a teacher or Guidance counsellor in high school advised me to pursue engineering studies	1	2	3	4	5	6	7	8	9	10
21	I am studying engineering because someone promised to sponsor me in university if I do engineering	1	2	3	4	5	6	7	8	9	10

22	I went into engineering studies because even as an engineering student I could start fetching money for my self	1	2	3	4	5	6	7	8	9	10
23	I chose this particular branch of engineering because I knew through it, I could easily get scholarships	1	2	3	4	5	6	7	8	9	10
24	I am studying this branch of engineering because I already had enough books and other materials to be used in this engineering program	1	2	3	4	5	6	7	8	9	10

SECTION C: GCE A/L or BAC Results in Sciences

Instruction: Place a tick in the box of the chosen response

I)For Students with GCE A/L

1 Grade scored in Physics: A ( ) B( ) C ( ) D( ) E( ) O( ) F( )
2 Grade scored in Chemistry: A ( ) B( ) C ( ) D( ) E( ) O( ) F( )
3 Grade scored in Mathematics: A ( ) B( ) C ( ) D( ) E( ) O( ) F ( )
4 Grade scored in Further Mathematics: A ( ) B( ) C( ) D( ) E ( ) O( ) F ( )
5 Grade scored in Computer Science: A ( ) B ( ) C ( ) D( ) E ( ) O( ) F ( )
6 Grade scored in Geology: A ( ) B( ) C ( ) D( ) E ( ) O( ) F ( )
7 Grade scored in ICT: A ( ) B( ) C ( ) D( ) E ( ) O( ) F ( )
8 Grade scored in Biology: A ( ) B( ) C ( ) D( ) E ( ) O( ) F ( )

II)For Students with BAC 'C'

Excellent (E), Tres Bien (TB) Bien(B), Assez Bien(AB), Passable (P), Echec (F)

1) Grade scored in Physique: E( ) TB( ) B( ) AB( ) P ( ) F ( )
2) Grade scored in Chimie: E( ) TB( ) B( ) AB( ) P ( ) F ( )
3) Grade scored in Mathematique: E( ) TB( ) B( ) AB( ) P ( ) F ( )
4) Grade scored in Informatique: E( ) TB( ) B( ) AB( ) P ( ) F ( )
5) Grade scored in SVT: E( ) TB( ) B( ) AB( ) P ( ) F ( )

OPTIONAL SUBJECTS

1) Grade scored in Chimie TP : E( ) TB( ) B( ) AB( ) P ( ) F ( )
2) Grade scored in InformatiqueTP: E( ) TB( ) B( ) AB( ) P ( ) F ( )
3) Grade scored in SVT TP: : E( ) TB( ) B( ) AB( ) P ( ) F ( )

II)For Students with BAC 'D'

Excellent (E), Tres Bien (TB) Bien(B), Assez Bien(AB), Passable (P), Echec (F)

1) Grade scored in Physique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

2) Grade scored in Chimie: E( ) TB( ) B( ) AB( ) P ( ) F ( )
1) Grade scored in Mathematique: E( ) TB( ) B( ) AB( ) P ( ) F ( )
2) Grade scored in Informatique: E( ) TB( ) B( ) AB( ) P ( ) F ( )
3) Grade scored in SVT: E( ) TB( ) B( ) AB( ) P ( ) F ( )

OPTIONAL SUBJECTS

1) Grade scored in Chimie TP : E( ) TB( ) B( ) AB( ) P ( ) F ( )

2) Grade scored in Informatique TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

3) Grade scored in SVT TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

III)For Students with BAC 'E'

Excellent (E), Tres Bien (TB) Bien(B), Assez Bien(AB), Passable (P), Echec (F)

3) Grade scored in Physique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

4) Grade scored in Chimie: E( ) TB( ) B( ) AB( ) P ( ) F ( )

5) Grade scored in Mathematique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

6) Grade scored in Informatique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

4) Grade scored in SVT: E( ) TB( ) B( ) AB( ) P ( ) F ( )

OPTIONAL SUBJECTS

1) Grade scored in Chimie TP : E( ) TB( ) B( ) AB( ) P ( ) F ( )

2) Grade scored in Informatique TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

3) Grade scored in SVT TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

IV)For Students with BAC 'IT'

Excellent (E), Tres Bien (TB) Bien(B), Assez Bien(AB), Passable (P), Echec (F)

1) Grade scored in Physique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

2) Grade scored in Chimie: E( ) TB( ) B( ) AB( ) P ( ) F ( )

3) Grade scored in Mathematique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

4) Grade scored in Informatique: E( ) TB( ) B( ) AB( ) P ( ) F ( )

OPTIONAL SUBJECTS

1) Grade scored in Chimie TP : E( ) TB( ) B( ) AB( ) P ( ) F ( )

2) Grade scored in Informatique TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

3) Grade scored in SVT TP: E( ) TB( ) B( ) AB( ) P ( ) F ( )

SECTION D: ACADEMIC PERFORMANCE IN ENGINEERING Instruction: Place a tick in the cell of the chosen response

YEAR OF STUDY	**GPA SCORED**					
	<2.00	2.00-2.19	2.20-2.49	2.50-2.99	3.00-3.59	≥3.60
1. FIRST						
2. SECOND						

3. How do you grade your performance in the first two years in the engineering school? Poor ( ) Average ( ) Fair ( ) Good ( ) Very Good ( ) Excellent ( )

APPENDIX III: RESEARCH AUTHORISATION

REPUBLIQUE DU CAMEROUN
Paix-Travail-Patrie
****
UNIVERSITE DE YAOUNDE I
****
FACULTE DES SCIENCES DE L'EDUCATION
****
DEPARTEMENT DE CURRICULA ET EVALUATION
....
Option : CURRICULA ET EVALUATION

REPUBLIC OF CAMEROON
Peace-Work-Fatherland
****
UNIVERSITY OF YAOUNDE I
****
FACULTY OF EDUCATION
****
DEPARTEMENT OF CURRILUM AND EVALUATION
....
Option: CURRICULUM AND EVALUATION

N° 174/20 UY1/FSE/VDSSE/

RESEARCH AUTHORISATION

I the undersigned, **Professor MOUPOU Moïse**, Dean of the Faculty of Education, University of Yaoundé I, hereby certify that **ADE CYRIL MANCHO,** matriculation N° **18W6608,** is a PhD research student in the Faculty of Education, Department: **Curriculum and Evaluation**, option: **Curriculum and Evaluation**

He is carrying out a research work in view of obtaining a PhD, precisely in the field of **Psychometrics**. His work titled: **"The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to Students' Academic Performance in Engineering in Cameroon"**, is under the supervision of Professor **EINSTEIN MOSES EGEBE ANYI**, of the University of Bamenda.

I would be grateful if you provide him with every information that can be helpful in the realization of his research work.

This Authorisation is to serve the concerned for whatever purpose it is intended to.

Done in Yaoundé on 12 AOUT 2020

For the Dean, by order

Le Vice-Doyen
DONGO Etienne
Professeur

j

THE PROVOST
CATHOLIC UNIVERSITY
INSTITUTE BUEA
(CUIB).

ADE CYRIL MANCHO
matricule: 18W6608
Faculty of Education
University of Yaounde I
13/11/2020

Permitted: Cf. Presidt. 17/11/2020

CATHOLIC UNIVERSITY INSTITUTE OF BUEA — THE PROVOST (CHIEF ACADEMIC OFFICER) — ...nti et scholari

Dr. Asobo Nkpolan Tonangy
DEF. BAHONSI Y DE. MPA
PED ANNZABIA

Sir,

AN APPLICATION TO CARRY OUT RESEARCH AT YOUR INSTITUTION.

I have the honour most respectful to apply to carry out research in your institution. I am a final year PhD student of the Faculty of Education in the University of Yaounde I, carrying out research on the topic «The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to students' Academic Performance in Engineering in Cameroun».

Sir, Your Institution is one of the target institutions for this research work. The information that will be given will be used only for the academic exercise and nothing else. While waiting for your kind consideration

I remain
Yours faithfully
Afem

k

THE VICE PROVOST
CATHOLIC UNIVERSITY
INSTITUTE BUEA
DOUALA-CAMPUS

ADE CYRIL MANCHO
matricule: 18W6608
Faculty of Education
University of Yaounde I
10/12/2020.

Sir, Perm... Dr. ... Mofon ... Vice Provost

CATHOLIC UNIVERSITY INSTITUTE OF BUEA — SCHOOL OF INFORMATION TECHNOLOGY — SANCTITATE ET SCHOLARI

AN APPLICATION TO CARRY OUT RESEARCH AT YOUR INSTITUTION.

I have the honour most respectful to apply to carry out research in your institution. I am a final year PhD student of the Faculty of Education in the university of Yaounde I, carrying out research on the topic «The predictive validity and Differential predictive validity of High school results in sciences to students' Academic performance in Engineering in Cameroon»

Sir, your Institution is one of the target institutions for this research work. The information that will be given will be used only for the academic exercise and nothing else.

While waiting for your kind consideration

I remain
Yours faithfully

Afon

THE PROVOST
CATHOLIC UNIVERSITY
OF CAMEROON
(CATUC).
BAHAM.

ADE CYRIL MANCHO
matricule : 18W6608
Faculty of Education
University of
Yaounde I

03/12/2020

Sir

AN APPLICATION TO CARRY OUT RESEARCH AT YOUR INSTITUTION.

I have the honour most respectful to carry out research in your institution. I am a final year PhD student of the Faculty of Education in the University of Yaounde I, carrying out research on the topic «The Predictive Validity and Differential Predictive Validity of High School Results in Sciences to Students' Academic Performance in Engineering in Cameroon».

Sir, your institution is one of the target institutions for this research work. The information that will be given will be used only for the academic exercise and nothing else. While waiting for your kind consideration

I remain
Yours faithfully

[signature]

Permission granted

sign: [signature] 03/12/2020

Paul T. Chongwain PhD
Provost SENG · Baham

SCHOOL OF ENGINEERING
FIDES ET RATIO
CATUC BAMBENDA

m

THE DIRECTOR GENERAL
OFFICE DU BACCALAUREAT DU CAMEROUN

ADE CYRIL MANCHE
matricule: 18W6608
Department of curriculum and Evaluation
Faculty of Education
University of Yaounde
09/10/2020

Sir,

AN APPLICATION TO GET THE STATISTICS OF BACCALAUREAT RESULTS IN the SCIENCE FROM 2010 to 2020.

I have the honour most respectful to to get some pertinent statistics from your prestigious Institution.

I am a PhD student of the Faculty of Education of the University of Yaounde I, carrying research on the topic « The predictive validity and differential predictive validity of High school results in sciences to students' academic performance in engineering in Cameroon »

Sir, the statistics of Baccalaureat results in the sciences from the year 2010 to the year 2020 will be of great value and importance to this research work.

I will be most grateful if my humble request is granted.

Attached to this application are;
- A copy of research Authorisation
- A copy of National Identity Card

I remain,
Yours faithfully

[signature]

n

ADE CYRIL MANCHO
matricule: 18W6608
Department of Curriculum
and Evaluation
Faculty of Education
University of Yaounde I
09/07/2020.

THE DIRECTOR
NATIONAL HIGHER
POLYTECHNIC INSTITUTE
(NAHPI)
UNIVERSITY OF BAMENDA

Sir,

AN APPLICATION TO CARRYOUT RESEARCH

I have the honour most respectful to apply to carryout research in your institution.

I am a PhD student of the Faculty of Education of the University of Yaounde I, carrying out research on the topic «The predictive validity and differential predictive validity of high school results in science to students' Academic performance in Engineering».

Sir your Institution is one of the target institutions for this study.

I will most grateful if my humble request is granted.

Attached to this application are,
- A copy of research Authorisation
- A copy of National Identity Card.

I remain,
yours faithfully

ADE CYRIL MANCHO
[signature]

Approved
Pls see relevant
structures
[signature]
10/07/20

o

THE DEAN
OF THE FACULTY
OF ENGINEERING
AND TECHNOLOGY (FET)
UNIVERSITY OF BUEA

O.K.
See the Vice-Dean
12/11/20

ADE CYRIL MANCHO
matricule: 18W6608
Faculty of Education
University of
Yaounde I
12/11/2020.

Sir,

AN APPLICATION TO CARRY OUT RESEARCH AT YOUR INSTITUTION.

I have the honour most respectful to apply to carry out research at your institution. I am a final year PhD student from the Faculty of Education in the University of Yaounde I, carrying out research on the topic "The predictive validity and Differential predictive validity of High school results in Sciences to students' academic performance in Engineering in Cameroon."

Sir, your Institution is one of the target institutions for this research work. The research work will involve the administering of a questionnaire to some students of your Faculty.

Thanks sir for your keen comprehension.

I remain
yours faithfully

Attached to this application are,
- A copy of Research Authorisation
- A copy of the Questionnaire.

Afm

p

ADE CYRIL MANCHO
matricule: 18W6608
Dept of Curriculum and Evaluation
Faculty of Education
University of Yaounde
19/06/2020.

THE DIRECTOR
GENERAL.
OFFICE DU BACCALAUREAT
YAOUNDE.
CAMEROON

Sir,

AN APPLICATION TO GET CERTAIN INFORMATION FROM YOUR INSTITUTION

I am a PhD student in the Department of Curriculum and Evaluation of the Faculty of Education of the university of Yaounde I

Currently, I am carrying out my research work and it greatly concerns the Baccalaureat examinations organised by the OBC. Consequently, I will be most grateful if I am furnished with the following information

- The History of the Creation of the BACC board.
- The administrative organisation of the BACC board
- The role of the BACC board in preparing (Item setting and item design) and administering examinations
- The scoring and grading of Examinations
- The process of evaluation and publication of results.
- The syllabuses for all the Science subjects used for the Baccalaureat examinations

Sir, I will be most grateful if my humble request is granted.

Attached to this application are;
A Copy of National Identity Card
A copy of Research Authorisation

Yours faithfully
ADE CYRIL MANCHO
[signature]

q

THE REGISTRAR
CAMEROON GCE
BOARD.

ADE CYRIL MANCHO
matricule: 18W6608
Department of
Curriculum and Evaluation
Faculty of Education
University of
Yaounde I
Tel: 675827297
13/11/2020

Sir,

AN APPLICATION TO GET THE STATISTICS OF GCE ADVANCED LEVEL RESULTS IN THE SCIENCES FROM 2010 to 2020.

I have the honour most respectful to apply for the provision of some pertinent information from your prestigious institution.

I am a PhD student of the Faculty of Education of the university of Yaounde I, carrying out research on the topic «the predictive validity and Differential predictive validity of High School results in Sciences to students' academic performance in Engineering in Cameroon».

Sir, the statistics of the GCE A/L results in Sciences from the year 2010 to the year 2020 will be of great value and importance to this research work.

I will be most grateful if my humble request is granted

Attached to this application are;
- A copy of Research Authorisation
- A copy of National Identity Card.

I remain
Yours faithfully
[signature]

r

THE DIRECTOR
GENERAL
OFFICE DU BACCALAUREAT
DU CAMEROUN

ADE CYRIL MANCHE
matricule: 18W6608
Department of curriculum
and Evaluation
Faculty of Education
University of Yaounde
09/10/2020

OFFICE DU BACCALAUREAT DU CAMEROUN
DIRECTION
COURRIER ARRIVEE
Arrivée 09 OCT 2020 N° 6678

Sir,

AN APPLICATION TO GET THE STATISTICS OF BACCALAUREAT RESULTS IN the SCIENCE FROM 2010 to 2020

I have the honour most respectful to to get some pertinent statistics from your prestigious Institution.

I am a PhD student of the Faculty of Education of the university of Yaounde I, carrying research on the topic « The predictive validity and differential predictive validity of High school results in sciences to students' academic performance in engineering in Cameroon »

Sir, the statistics of Baccalaureat results in the sciences from the year 2010 to the year 2020 will be of great value and importance to this research work.

I will be most grateful if my humble request is granted.

Attached to this application are;
- A copy of research Authorisation
- A copy of National Identity card

I remain,
Yours faithfully

[signature]