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Research Article

Modelling achievment in mathematics: The predictive role of affective variables among students

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The purpose of this study was to model a pathway using affective variables to predict academic achievement in mathematics among students. Causal–comparative research design with a total of 739 students were used for the study. Multivariate statistical techniques- multiple regression and path analysis procedures were used for data analysis. The result showed that all the variables combined had a strong effect in predicting achievement in mathematics. The result indicated that the most meaningful causal model had thirteen significant pathways and that 68.22% of the total effect of the affective variables in predicting achievement in mathematics were direct while 31.69% were indirect. It was also revealed that all the six affective variables directly impacted students 'achievement in mathematics. Learners' sociability and academic optimism were found to contribute most significantly to the prediction of students' achievement in mathematics. The implications of the study were discussed, and policy suggestions made.

Keywords: Verbal and non-verbal prompts, student engagement, biology, classroom discourse

1. Introduction

Educational consumption has received great emphasis all over the world as a result of the enormous role it plays in the socio-economic, political and technological development of the society. In Nigeria, Ministry of Education (2014) has expressly stated the relevance of education as an instrument for excellence. Education is conceived as a fulcrum upon which societal advancement revolves. Education is the oxygen for development and the manure that stirs societal growth. It is aimed at producing productive and creative citizens with identifiable characteristics that can make them functional members of the society. Functionality, according to Asuquo et al. (2003) is the ability of the individual to contribute to himself and the society at large. This contribution is tied to the Latin adage, "nemodat qua nonhabet" which translated means "one cannot give what he /she does not have". This implies that for the learner to be contributive in all ramifications, the individual must possess a measurable level of knowledge, skills, abilities, and techniques acquired over time in a particular area. In recognition of this fact, the secondary school curriculum is programed to provide a middle manpower that can function well in the society. Therefore the learner forms the very purpose of educational activities. The curriculum process: selection of objectives, planning, implementation, and evaluation of the curriculum is to ensure that various content and learning experiences are selected to equip the learner with needed skills and knowledge to facilitate their contribution to societal growth and development. Learners are therefore, expected to perform adequately in their academic endeavors which is not only tied to their cognitive aspect but on the affective and psychomotor aspects as well (Ofem et al., 2024). One of such areas that the learners have not demonstrated high achievement in our own schools is in mathematics.

Mathematics is a subject that has direct relationship with other subjects particularly science related subjects. It is a subject that is offered virtually at all levels of education and considered as the bedrock for all scientific and technological development of any nation that must attain any

envisaged technological height. There is nothing in the world that mathematical thinking is of no relevance. mathematics fosters creative thinking, enhances abstract thinking, and improves individual's numeric and analytic skills. Irrespective of how rudimentary it might be, every man needs mathematics to survive. There is ''no doubt about the fact that an individual can get on sometimes without knowing how to read and write, but can never push on smoothly without knowing how to count, measure, add and subtract''(Anaduaka & Okafor, 2013). Mathematics equips an individual with knowledge and skills to handle daily life challenges with rationality, solve wide range of difficult tasks, and organize difficult problems into logical and simple forms. The importance of mathematics has made almost all human endeavors to incorporate it into their different curricula. The multifaceted use of mathematics in businesses, industries, at home, in schools, offices and other innumerable dimensions make mathematics an important subject for students to learn and acquire the skills not just for admission purposes but also for daily living. It is unfortunate to see students fail in an important subject as Mathematics. What has continued to perplex the hearts of all those interested in the education of the child is the question of what would have been the cause of these failure? Factors identified for this failure are enormous ranging from personality, political, economic, home and pyscho-social factors (Adeyemi & Adeyemi, 2014; Habibollah et al., 2009; Moyosola, 2013; Umoinyang, 1999; Undorbuoye, 2015).

However, these studies only examined affective variables and perhaps, a combination of some of the variables in explaining the variance in students' academic performance. Affective traits include a wide range of variables that tends to describe individual behavior at a particular time and this ranges from individual's interest, preferences, attitude, motivation, locus of control, causal attributions, achievement motivation among others. Many scholars have attached great magnitude to cognitive domain of learning. Sjoberg et al. (2004) noted that the affective components are as important as the cognitive domain which have been emphasized over the years. That in fact, it is the affective component that delivers the capacity of the cognitive variable. Where the individual has no interest nor display a negative attitude to a particular phenomenon, intelligence and perceptual abilities will have no value. Therefore, the individual's affect is important in the learning process as well. Little effort has been made to extensively investigate the affective areas of the learner to ascertain the extent of its influence on the learning outcome of the students. Much of the works that are carried out are mostly on certain areas of the learner which include self-concept, motivation, attitude, interest, locus of control and a lot more. The researcher shall isolate this work on some of the variables such as, sociability. Adaptability, creativity, academic optimism, causal attribution, and achievement motivation be studied together to determine their predictive ability in influencing students' academic achievement in mathematics using a path analytical approach. The researchers therefor selects this models to examine them individually and collectively to examine their effect on academic performance.

The crux of the problem was the long-standing poor performance of students in mathematics given the relevance of subject in the students' academic progression and acquisition of scientific skills needed to move the nation. All efforts to ensure that students perform maximally well has proved abortive. Approaches initially used to solve this problem has been univariate in nature. The study thus, seeks to apply a multivariate method to proffer solution to this problem. See Appendix 1 for the table showing the progression rate of performance for 6yrs. Thus, the following questions were raised:

RQ 1) How do the students' affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability and learners' creativity) individually and collectively predict student's achievement in Economics?

RQ 2) What is the most meaningful causal model for explaining secondary school student's achievement in economics using the affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability and academic stress)?

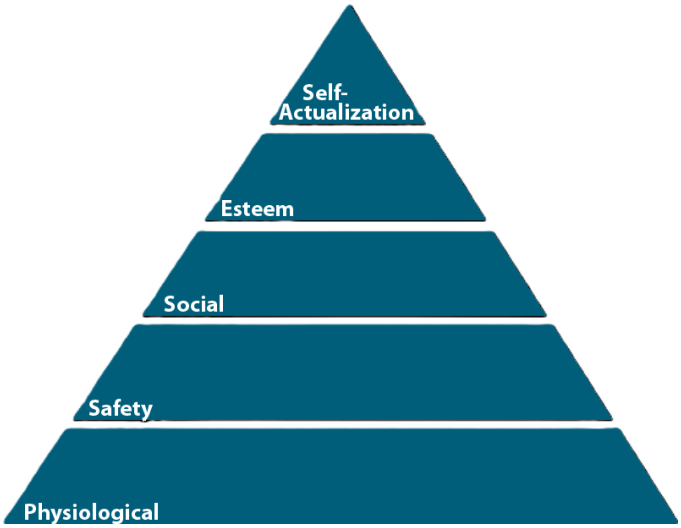
RQ 3) What proportion of the effect of the student's affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability and academic stress) (i) direct and (ii) indirect?

2. Background

2.1. Abraham Maslow Hierarchical Needs Theory

Abraham Maslow (1908-1970) theory of hierarchical needs theory postulates that every human being has needs and that the satisfaction of these needs which are progressive in nature tends to facilitate the desire for the satisfaction of more needs That is, he consistently noted that those human needs are in hierarchy. That as one need is satisfied, there is the tendency for the emergence of a higher order needs and these operative in life. He conceptualized his system of needs into two namely, deficit needs and growth needs. In the deficit needs, he saw that humans strive for food, shelter, and clothing to quench thirst. That once these needs are satisfied, the individual seeks to satisfy safety needs; love, social acceptance, and desire to be highly valued emerge as well. Under the second category, there is only one general need called self-actualization. He critically criticized those psychologists who believed that man is selfish, evil, and anti-social. Different from other needs theorist, Maslow (1954) structured human needs into five categories from physiological to self-actualization needs. These are represented in Figure 1.

Figure 1
Maslow theory of hierarchical needs



According to Maslow, the most basic needs of man are the physiological needs yet the least significant for self-actualization. That when these basic needs are deprived for a relatively longer period, it affects the satisfaction of other needs. For example, to motivate a student to do his assignment and pass examination, certain things like pocket money, snacks, and control from excessive play could be applied from him/her until he/she passes.

By implication of this theory to the study, the safety needs which according to Joshua and Joshua (2011) is born out of the desire for everyone to be protected from brutality, harassment and intimidation is important in school environment. Where the child feels that they could be punished unnecessary by teachers and students, they develop fear of various kinds about their inabilities and in capabilities to cope with various school subject, peers, teachers, school task and responsibilities and even the society- parents and community members.

2.2. Conceptual Framework

2.2.1. Path model

Path analysis is a multivariate statistical technique that is used in modelling the relationship between observed variables. It is a technique that is concerned with examining the direct and indirect effect of identified independent variable on dependent variable. Unlike univariate statistics where a single variable is used to explain the variance in another variable which is

difficult to be accepted in the behavioral sciences because of the nature of variable we are dealing with, multivariate statistics which path model is a class type help us in combining a few variables to model their relationship, thereby validating an existing theory or help in building theories that will facilitate decision making. Path analysis is not used in discovering causes. It relies heavily on multiple correlation and multiple regression statistics. Path analysis make use of endogenous and exogenous variables to explain the kind of relationship existing in the model or system. This study was, therefore, a predictive study concerned with modelling a pathway among affective variables and students' academic in mathematics among secondary school students.

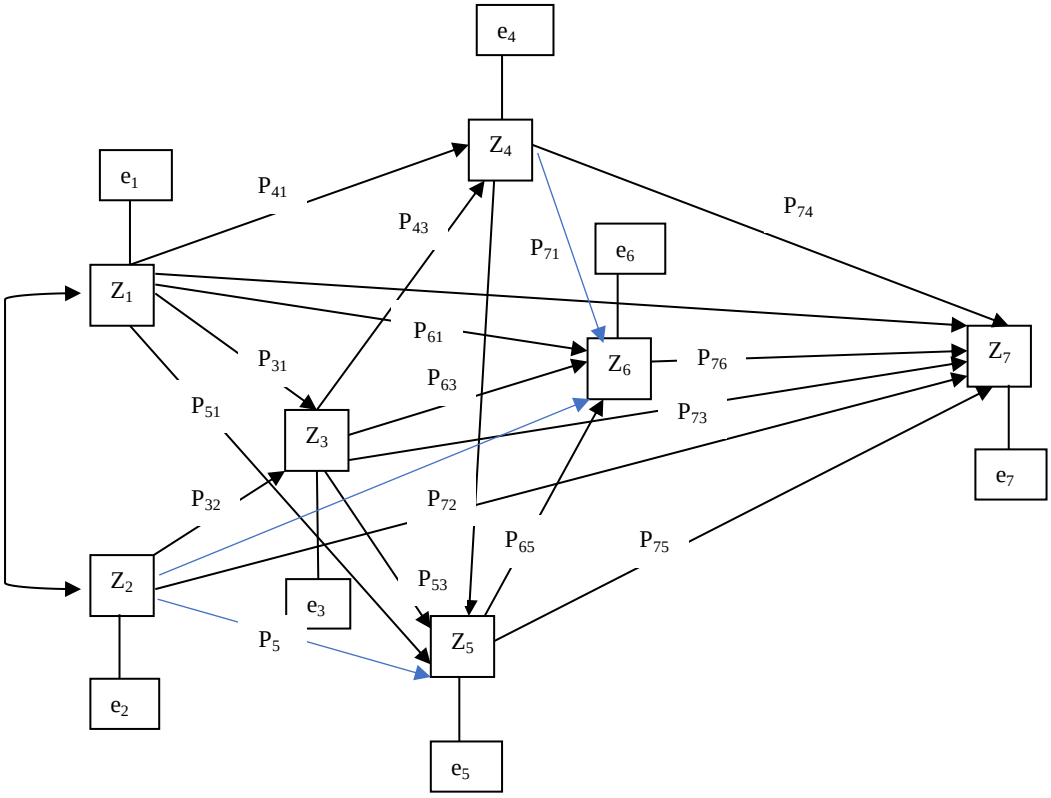
In paths analysis, the researcher hypothetically formulates a theory which he intends to substantiate on the quantitative estimates derived from the analysis. This was governed by rules which are; direct arrows represents paths; straight line arrows are used to originate from the source of the effect to the dependent variables.

The following is the variables description as used in the paths.Z_1= Academic optimism; Z_2= Causal attribution; Z_3= Academic stress;Z_4= Learner's adaptability;Z_5= Achievement motivation; Z_6= Learner's sociability; Z_7= Academic achievement. The general form of the regression equation that was employed is shown below:

$$Y= a + \beta_1X_1+ \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6$$

Where Y= Predicted value (dependent variable)
X_1,X_6 = independent variables
β_1,β_6 = standard regression coefficients (beta weights). The causal model is specified in Figure 2.

Figure 2
Hypothesized model of affective variables and academic achievement in mathematics



To determine the significant paths in the hypothesized path model, the structural equations of the paths are generated as follows:

$Z_1= e_1$- - - - - equ 1
$Z_2= e_2$- - - - - - equ 2
$Z_3=P_{31}Z_1 +P_{32}Z_2$- - - - equ 3

$Z_4=P_{41}Z_1 +P_{43}Z_3$- - - - equ 4
$Z_5=P_{51}Z_1 +P_{52}Z_2 + P_{53}Z_3 + P_{54}Z_4$- - - equ 5
$Z_6=P_{61}Z_1 +P_{62}Z_2 + P_{63}Z_{3+} P_{64}Z_4 +P_{65}Z_5$- - equ 6
$Z_7= P_{71}Z_1+P_{72}Z_2 +P_{73}Z_3 +P_{74}Z_4 +P_{75}Z_5 +P_{76}Z_6$- equ 7

3. Literature Review

Hoy et al. (2006) introduced academic optimism feeling in school level. They noted that academic optimism is made up of "cumulative self-efficiency of teachers, academic cadre trust in students and their parents and scientific stress or academic pressure for achieving academic expectation".

Scheier and Cawer (1985) defined academic optimism as the tendency or feelings that success in academic work as approved to failure will generally occur when confronted with difficult challenges. It is the belief that irrespective of academic pressure, difficulties and task, there is every likelihood that one can still achieve maximally in his/her academic endeavor. Generally, optimism used to define an individual's positive attitude to personal or environmental situations/factors. Optimism can be temperamental or learned optimism is the development of a specific tendency to achieve a set goal. Isaacowitz and Seligman (2001) noted that optimistic people must be realistic because been over-optimistic may reduce an individual chance of performing very well as the individual may overlook the negative outcomes.

It is obvious that in every circumstance around the learners, the 'why' word must always arise. It is the responses to the 'why' questions that provides causal explanations and gives us an idea about reasons to events or actions (Forsterling, 2001; Wong & Weiner, 2001). Thus, attributions are human explanations to justify these abilities or inabilities to certain event. This is why Wilson et al. (2012) suggested that in order to break the cycle of self-blame and avoid poor performances, attempt should be made to change students' attributions to internal factors.

Most importantly, Weiner (2005) noted that in students' attributional tendency, it is the outcome that determines their causal explanations, where the outcome is positive the learners is extended, develops sense of pride and esteem but where the outcome is negative, then frustrations and deep sense of sadness leads him to causal ascriptions. Various methods according to Farid and Iqbal (2012) have been employed by researchers to examine students' attributions. Proudfood et al. (2001) divided these method under four categories. The first category contains scales where learners choose from a list of given attributions like effort, luck and ability. In the seasons category, learners provide explanation of possible causes of specific outcomes. The third category is content analytical procedures while the fourth category ask respondents to rate their personal or hypothetical attributions. There is a connection between what wee describe as causes of failure or success to failure behaviour. Luck is an external factor that is not stable and is subject to change over time. Learners who must be successful must make use of their ability and effort and they attribute this commonly to internal factors.

Stress is intricately found in human as no man can an unavoidable run away from it. At different times in man's life, every individual faces stress irrespective of age, occupation, social status, race, cultural background, etc. (Oyerinde, 2004). Lazarus and Folkman (1984) defined stress as a psychological state of arousal that occurs when external demands , task exceed a person's adaptive abilities . Stress requires that an organism should be able to adapt, to cope, or to adjust (Rathus, 2000). Most stress analyst believes some stress is necessary for our health. For example, stress researcher Selye (1975) referred to such healthful stress as eustress, whereas stress that leads to negative consequences is known as distress. She further posits that over stress can over labour our capacity to adjust, dampen our moods, impair our ability to experience pleasure, and harm the body.

Academic stress is the product of a combination of academic related task and activities that exceed the adaptive abilities and resources available to an individual. If a student is unable to cope effectively with academic stress, thenserious psycho-social-emotional health consequences may result (MacGeorge et al., 2005). Academic stress is mental distress with respect to some anticipated frustration associated with academic failure or even unawareness to the possibility of such failure.

Students must face many academic demands, for example, school examination, answering questions in the class, showing progress in school subjects. Understanding what the teacher is teaching, competing with other classmates, fulfilling teachers and parent's academic expectations. Bisht in

Accordingly, work related stress has become an important subject for studies in academic circles especially in the field of behavioural science (Agolla & Ongori, 2009), its harmful effects on wellbeing (Ariëns, 2001; Hoogendoorn, 2000; Kivimäki, 2002). Research on stressors and its influence on academic performance have also received wider attention among scholars. Kaplan and Sadock (2000) suggested that an optimal level of stress can enhance learning ability. However, stress can affect learning negatively and memory. Stress can cause physical and mental health problems; diminish students' self-confidence and impact students' academic accomplishment negatively.

Gang-Chang (2005) believes that "adaptation can be not only a process, but also a status". Every organism obtains balance in the environment by assimilation and conformity to the demands of the environment and then a balance can be maintained. Academic adaptability according to Lin et al. (2014) is the tendency to achieve better learning outcome by overcoming all academic difficulties, adjusting to the needs of the classroom environment, accommodating innovations in the school setting. It is the ability of the learner to develop new behavioral tendencies to get use to the demands of the learning environment. Adaptability to the academic environment is necessary because they are reoccurring innovations in the school environment. Therefore, the learning organism must ensure that he/she fits in by adjusting academically to the new demands and learning task. In accordance with the above statement, Tingyoung and Hong (2006) explained that academic adaptability is a behavioural process of adjusting to the demands and needs of the learning environment to maintain a balance.

Motivation is a strong determinant in students' achievement. Its absence is a strong problem in learners' engagement in classroom activities. Muola (2010) observed that motivation is one of the factors that can enhance students' academic success or failure. Foldman (2005), Wood (2002) and Slavin (2006) sees motivation as factors that instigates human behaviour, gets them going and determines where one goes. That is motivation, can direct and sustain human behaviour to satisfy their needs. Martins (2009, 2010), Jones (2008), and Green et al. (2007) posit that motivation and learners' engagement in academic have been the focal point of many researchers to improve student's classroom performance. Individuals differ in their motivation drives. This difference is what defines achievement motivation. Akpan and Umobong (2013) explained that achievement motivation is the extent to which individuals differs in their needs to strive to attain rewards, such as get promoted to new class, praises from teachers and parents and cultivate a sense of personal mastery. To an extent, individual with high sense of academic motivation acts in a way that will facilitate their high achievement in school than others, as well as doing the unusual. They are seen working very hard to achieve their goals (Zenzen, 2002). Most importantly achievement motivation is self determination to be outstanding in one's engagement either in school or out school. Therefore Muola (2010) stipulates that achievement motivation is strongly related to academic success and sees it as the need to succeed in academic work as people who are motivated are likely to perform well in their examinations.

Denhardt (2008) argued that although motivation is not directly observed but, its drives can be observed in the behavioral tenderness of the learner. Motivation is not similar with satisfaction. Motivation, like any other psychological construct is made up of different aspects and one of such aspects is motivational orientation. Steward et al. (2010), motivational orientation is a driving force that compels an individual to get committed or engaged in a particular activity. It is an embodiment of so many constructs which include intrinsic and extrinsic motivation, assessment anxiety, self-efficacy, self-determination, and personal relevance.

Intrinsic motivation constitutes internal factors that propels a student into learning without external rewards instigating the behaviour. It is the true human ability at work especially in search for and to face new challenges. Individuals who are often internally motivated are often focused to

their set goals, engaged in mental and physical activities, self-critical and appraised. They can learn easily from their mistakes. Get involved in independent or autonomous learning, tend to explore the environment, ask mind provoking questions to get broaden understanding and knowledge of the phenomenon under studying, explore learning avenue outside the classroom situation and express positive attitude to learning task. They show better understanding of learning content and are willing to learn new concepts. In contrast to the intrinsically motivated student, the extrinsically motivated student gets the drive to be involved in any learning activity due to external factors such as reward, praise and promotion that is attached to it. Therefore, positive reinforcers are the reason for getting involved in any learning task (Benabole & Tiwle, 2003). The disadvantage of it is that, when these positive reinforcers are removed from the environment, the individual gets demotivated. In the whole, several research studies have indicated that academic motivation relates with academic achievement (Busato et al., 2000).

3.1. Empirical Literature

Singh and Jha (2013) carried out a study on anxiety, optimism, and academic achievement among student of private medical and engineering colleges. A comparative study in Sikkim Municipal University with casual comparative design was conducted with a total of 346 students selected from few faculties. Scores of the latest two semesters were used to measure academic achievement of students while Shinha's comprehensive anxiety test (Ofem et al, 2024) and learned optimism scale (Busato et al., 2000) were used to measured anxiety and optimism respectively. The result showed that anxiety had a negative significant relationship with performance, but optimism was found to be positively related with academic performance.

Wayne et al. (2015) carried out a similar study on academic optimism, of schools: A force for students' achievement. A survey research design was adopted with stratified random sampling techniques used to collect a diverse sample of 96 high schools. A random sample of teachers from each school provided data on the school's academic optimism, students' academic performance measures and personal data were obtained from the state education department. A confirmatory factor analysis and hypothesis tests were conducted simultaneously via structural equation modeling [SEAT]. After controlling for student demographic variables such as socio-economic status previous achievement and location, the findings showed that academic optimism made significant contribution to students' achievement.

In another study on the effect of academic optimism on academic achievement in Alabama by Raymona (2010), the research design was a correlational design using school scores on Academic Optimism Scale [AOS] and Reading and Mathematics Test [ARMT] scores. Purposive sampling technique was used to collect a sample of 29 schools. The widespread variables of the study were categorized as collective efficacy, academic emphasis and faculty trust of clients while the dependent variable was student academic achievement measured by fifty grade reading score on the ARMT for each school. Two hierarchical multiple regressions was used to test the hypothesis. The findings of the study revealed that academic optimism has a positive significant correlation with academic achievement on reading and mathematics test. The relative contribution of each of the variable (academic emphasis, faculty trust and collective efficacy) was analyzed and it was found that there was a positive triadic relationship of all the variables on students academic achievement. Collectively, all variables were strong predictors of academic achievement in mathematics.

In another study on investigating causal attributions of success and failure on mathematics among students in Turkish high schools by Savas and IIyas (2010), a causal comparative design was adopted for the study, purposive sampling techniques was adopted to select a total sample size of 96 final year student within the age range of 17 – 18 years. A five-point Likert modified scale was used for data collection. Data collected were evaluated using a software for quantitative analysis and the result of each item were interpreted. The reliability of the instrument was carried out using Cronbach alpha method and the coefficient was .85. The result showed that student attributes certain factors such as difficulty in mathematics subjects, inadequate materials to meet

the students' needs and teachers' negative attitude to students in the classrooms to their feature in mathematics.

Farid and Iqbal (2012) carried out a study on causal attributions belief among school students in Pakistan. Descriptive design was adopted with random sampling techniques to collect a sample of 396 students from government secondary school of both urban and rural locale. Questionnaire base on taxonomy of 8 types of belief, ability, effort, task difficulty, luck, strategy, interest family influence and teacher influence were used. Cronbach alpha was used to determine the reliability and its coefficient was 0.823. Data were collected from respective sampled schools. Descriptive statistics (means and standard deviations) were used for data analysis. The result showed that student confirmed all causes of potential causes of their faces and failures. It was also found that parents and teachers were responsible their success in school than failure.

Chuanping (2009) carried out a study on the causal attribution and academic achievement in college students in Shandong, China. A total of 1,400 subjects were drawn from 2 universities for the study. The first was administered to students during self-study time. Questionnaire for international external factors were also administered. SPSS software version 10.0 for windows was used for data analysis. The result showed that students differ in their attributions to success and failure. It was also found that higher education student had higher expectations when they fail and are willing to put in more effort and their best to make progress. It was shown that when students obtain higher score and good grades, they feel satisfied, gratified, and proud of their success. However, they feel compunctious and sad after fail. It is, therefore, the type of attribution that determines their academic motivation, emotional state that will inversely influence their achievement.

Gbettor et al. (2015) carried out a study on stress and academic achievement: Empirical Evidence of Business Students in a Ghanaian Polytechnic. A cross sectional research design was adopted in conducting the study. A total population of 275 students were sampled using multistage sampling procedure. Burge's (2009) modified five-point Likert stress scale was used to collect data for the study. Descriptive statistics such as mean scores and standard deviations were used to determine the most dominant sources of stress. Non-parametric inferential statistics was used to assess the significance differences in stress level by demographic variables. Finally, Spearman's correlation coefficient was used to determine the effects of stress on students' academic performance. The study among other things showed that stress was not significantly related with academic performance

Emmanuel et al. (2014) similarly carried out a study on perceived stress and academic performance of senior high school students in Western Region, Ghana. The study sought to finds out the profile and the relationship between Senior High School Students' perceived stress and academic performance. A total sample of 120 Senior High School Students randomly selected from four Senior High Schools in the Western Region of Ghana participated in the study. The instruments used for the research were the students-Life Stress Inventory [SSI] by Gadzella (1991) and Mathematics Achievement Test adopted from the West African Examination Council [WAEC]. Data gathered from these instruments were analyzed using Percentages and Pearson Product Moment Correlation Coefficient. Results showed that, majority of the students experienced moderate stress levels and that, none of the students experienced high stress levels. The study also indicated that, there is no significant correlation between the level of perceived stress and academic performance of the students. The results further showed that, schools in the urban areas performed better on the achievement test compared to schools in the rural areas. The research has provided insights for stakeholders in education to provide the necessary structures to help students manage stress to improve their academic performance.

In another research on relationship between stress and academic achievement of senior secondary school students by Rajni and Gartia (2012), a total of sample of 120 senior secondary school students randomly selected from six senior secondary schools of North-western Delhi participated in the study. Three null hypotheses were tested using data gathered from research instruments. The instrument included Stress Inventory designed and standardized was used for

data collection. Academic achievement was taken from the students' previous examinations. Data generated from these instruments were correlated using Pearson product moment correlation method. Results showed a positive correlation between stress and academic achievement. Significant difference exists in the academic achievement of students having high, moderate and less stress. Students with high and moderate stress performed better than the students having less stress. Further it was also found that stress and academic achievement are not mediated by gender.

Devi (2015) carried out a study on academic adaptability and academic achievement among tribal adolescents in Manipur. Expost facto research design was adopted for the study and a total of 629 students in Manipur were used for the study. A standardized academic adaptability inventory instrument with 30 items was adapted. Descriptive Statistics (means and standard deviations) and inferential statistical (t-test and coefficient of correlation) were used. The result shows that there exists a low positive correlation between academic adaptability and academic achievement in the area. It was also found that academic achievers had better adaptability status in schools than low achievers.

Abtalic and Nadri (2012) carried out a study on examining the relationship between creativity, academic adaptability, and academic achievement of high school students in Zanjan city by). The study adopted the expost facto research design with purposive sampling technique to collect a total of 2002 students. Standardized instrument of adaptability and Abedi's creativity questionnaire were utilized for data collection. The students score in mathematics and physics were used to measure their academic performance. Pearson product moment and independent t-test were used for data analysis. The result showed that there was a significant positive correlation between creativity, its dimension, academic adaptability was positively related with academic performance.

Akpan and Umobong (2013) carried out a study on analysis of achievement motivation and academic engagement of student in the Nigerian classroom by Expost facto research design was adopted for the study with a multi-stage sampling technique and stratified sampling to select 10 schools and 540 student in the three senatorial district of Akwa Ibom State, Nigeria; questionnaire named achievement motivation and academic engagement [AMAEQ] was used with reliability coefficient of .37 and .81. Data were collected by visiting the sample schools. Data collected were analyzed using inferential statistics of analysis of variance and t-test at .05 level of significance. The result showed that achievement motivation is significantly influence academic engagement with high motivated students been more academically engaged than the moderately and lowly motivated students.

Tella (2007) carried out a study on impact of motivation on students' academic achievement and learning outcomes in mathematics among secondary school students in Nigeria. Expost facto was the research design with random sampling technique adopted to collect a sample of 600 students. Data were collected using a questionnaire and achievement test in mathematics. The data were analysed using analysis of variance and independent t-test, the result showed that achievement motivation significantly influence student academic performance in mathematics. It was also discovered that there were gender differences when influence of achievement motivation on academic achievement was compared.

Irsa et al. (2012) carried out a study on impact of achievement goals, scalability and gender on academic achievement of university students in Sargodha, Pakistan. Survey research design was adopted for the study with purposive sampling technique to collect a sample of 300 undergraduates' students from different departments in the university of Sargodha. Standardized instruments were used such as the achievement goal, questionnaire, and sociability subscale of California psychological inventory to measure achievement goals and sociability respectively. Regression statistical tools was used for analysis and the result showed that learner's sociability enhances academic performance, but it was shown that boys were more sociable than girls.

Kumar (2012) carried out another study an academic achievement of high school students in relation to certain personality tracts variables such as learners' sociability self-confidence, and ambition of high show students were used. Descriptive survey method of research was adopted

for the study. Simple random technique was used to select a sample 320 high school students. Questionnaire developed to cover the selected variables was used for data collection. Pearson product moment correlation was used to determine the correlation of each variable with academic achievement. The result showed that there was a significant positive relationship between sociability, self-confidence and ambitious behaviour of learner and their academic performance.

Kris et al. (2014) carried out another study on impact of sociability on academic performance and retention of nature of Americans. A descriptive survey research design was adopted for the study. Stratified and purposive sampling technique was used to collect a sample of 480 students in the area. Sociability inventory scale and achievement test in English language were used for data collection. Pearson product moment correlations was used for data analysis and the result shows that sociability significantly relate positively with academic performance but does not show significance on retention ability.

4. Methodology

4.1. Research Design

The study adopted a causal comparative research design. The design was found appropriate since the variables have already occurred, and the researchers cannot manipulate them. The researchers only studied them in retrospect to observe their effect on the dependent variable.

4.2. Research Setting

The study was carried out in Ikom Education Zone in Cross River State, Nigeria. Ikom Education Zone is one of the politically created senatorial district in the area with six Local Government Area. The Area is purely agrarian with farming as he main occupation in the area. The area has mostly public secondary schools with few private schools in the area.

4.3. Population and Sample

The population of the study consist of 7386 SS2 students in public secondary school in Ikom Education Zone who are offering mathematics in 2020/2021 session. The population distribution is shown in Table 1.

Table 1
Population distribution of students in the study area

S/N	*Names of LGA*	*No of schools*	*No of students*
1	Abi	12	881
2	Boki	28	1390
3	Etung	11	506
4	Ikom	17	2017
5	Obubra	16	1287
6	Yakurr	16	1305
	Total	100	7386

Note. Source: Ministry of Education, Cross River State (2021).

The multistage sampling technique was adopted for the study. First, the study population was divided into strata according to the local governments. Each local government therefor becomes a stratum. In each local government, the names of the schools were listed for selection. The researcher selected 20% of the schools in each of the stratum to form the schools that was used in the study. Thus, a total of 20 schools were selected for the study. In each of the schools selected, sampling frame was created to enable all the students have equal chance of been selected for the study. Simple random sampling technique was further employed to ensure that all members of the population has equal opportunity of been selected for the study. A total of 739 students selected from a population of consisting of 7386 SS2 students in public secondary school in Ikom Education Zone who are offering mathematics in 2015/2016 session.

4.4. Instrumentation: Construction, Validity and Reliability

Two instruments such as a questionnaire titled "Students Affective Variables Scale " [SAVS] and mathematics achievement test [MAT] were used for data collection. The instruments were validated by Test Experts from University of Calabar, Calabar and were pilot tested using Cronbach alpha reliability technique. The coefficient of correlation ranged from .78-.81 for the all the variables considered high for the instrument to be considered dependable for data collection. Data were collected appropriately by the researchers. The prediction of students' academic achievement using the selected affective variables was carried out using Statistical Package for Social Sciences version 20 programme for multiple regression statistics while simple percentages were used to determine the direct and indirect effect of the variables. The result is presented in the following section.

5. Results

5.1. Results related to the First Research Question

First research question of the study was "How do the students' affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability, and learners' creativity) individually and collectively predict student's achievement in Mathematics?". To answer this research question, it was converted to a hypothesis stated as: there is no significant relative or individual contribution of students' affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability, and learners' creativity) on student's achievement in mathematics. The hypothesis was tested using simple correlation and multiple linear regression. The result is presented in Table 2 and Table 3.

Table 2
Inter-correlation matrix of affective variables and students' mathematics achievement

	ACO	CAT	ACAS	LEA	ACM	LES	MAT
ACO	1						
CAT	.179	1					
ACAS	.010	.390*	1				
LEA	−.028	.089	.136	1			
ACM	.275*	.017	−.002	.058	1		
LES	.177	.280*	.025	.033	.149	1	
MAT	.273	−.027	.083	.112	.234*	.572*	1

Note. *: Correlation is significant at .05; ACO: Academic optimism; CAT: Causal attribution; ACAS: Academic stress; LEA: Leaners' adaptability; ACM: Achievement motivation; LES: Learners' sociability; MAT: Mathematics Achievement Test.

The result presented in Table 2 is the inter-correlation matrix of the six affective variables and students' achievement in mathematics taken by the respondents. The table shows that the least correlation coefficient is -.002 and that is the correlation between achievement motivation and academic stress. The highest correlation is coefficient of .576 was obtained for the relationship between learners' sociability and academic achievement in mathematics among SS 2 students. Using regression analysis, Table 3 reveals the individual and collective contribution of the six affective variables in predicting SS2 students' achievement in mathematics which yielded a coefficient of multiple regression of $R^2 = .451$ and an adjusted $R^2 = .449$. From this result, it can be inferred that 44.9 % of the total variance of students' academic achievement in mathematics is explained by the 6 affective variables. Although, the percentage effect of the joint contribution of the affective variable to variance in mathematics is low, the analysis of variance result for the prediction produced an F-value of 101. 159 which is significant at .05 levels. This significant value of F-ratio when interpreted could mean that the six (6) affective variables used in the study when combined have a significant effect and can be used to predict or explain students' achievement in

Table 3
Summary of multiple regression analysis of the relative and collective effect of the predictors on academic achievement in mathematics

Source of variation	*Sum of squares*	*df*	*MS*	*F*	*p*
Regression	1539.37	6	256.56	101.158*	.000
Residual	1856.53	732	2.536		
Total	3395.90	738			
Variables		*standardized coefficient (β)*		*t*	*p*
Constant		10.973		18.292	.000
Academic optimism		0.198		6.804	.000
Causal attribution		−0.310		−9.837	.000
Academic stress		0.174		5.802	.002
Learners' adaptability		0.097		3.484	.001
Achievement motivation		0.090		3.126	.002
Learners' sociability		0.602		20.731	.001

Note. R=.672; R^2= .451; Adj R^2 =.449; MAT = …… + .198Z_1 +(−0.310) Z_2 + 0.174 Z_3 +0.097 Z_4 + 0.090 Z_5 + 0.602 Z_6

mathematics. Hence, the hypothesis was rejected. Further result reveals the strength of the individual affective variables (academic optimism, causal attribution, academic stress, leaners' adaptability, achievement motivation and leaners' sociability) in predicting students' achievement in mathematics as still shown in Table 3. The result shows that the standard beta weights (β) ranged from. −0.310 for causal attribution to 0.602 for learners' sociability and the t-values ranges from −9.837 for causal attribution to 20.731 for learners' sociability. Beta weights generally indicates the strength of each prediction. The analysis of these beta weights shows that all the six affective variables; academic optimism (β= .198), causal attribution (β= −.310); academic stress (β= .174); leaners' adaptability (β= .097); achievement motivation (β= .090) and leaners' sociability (β= .602) were all significant predictors of students' achievement in mathematics. A deep inspection of these beta weight values shows that learners' sociability is the strongest predictor, followed closely by academic optimism, academic stress, learners' adaptability, achievement motivation and causal attribution.

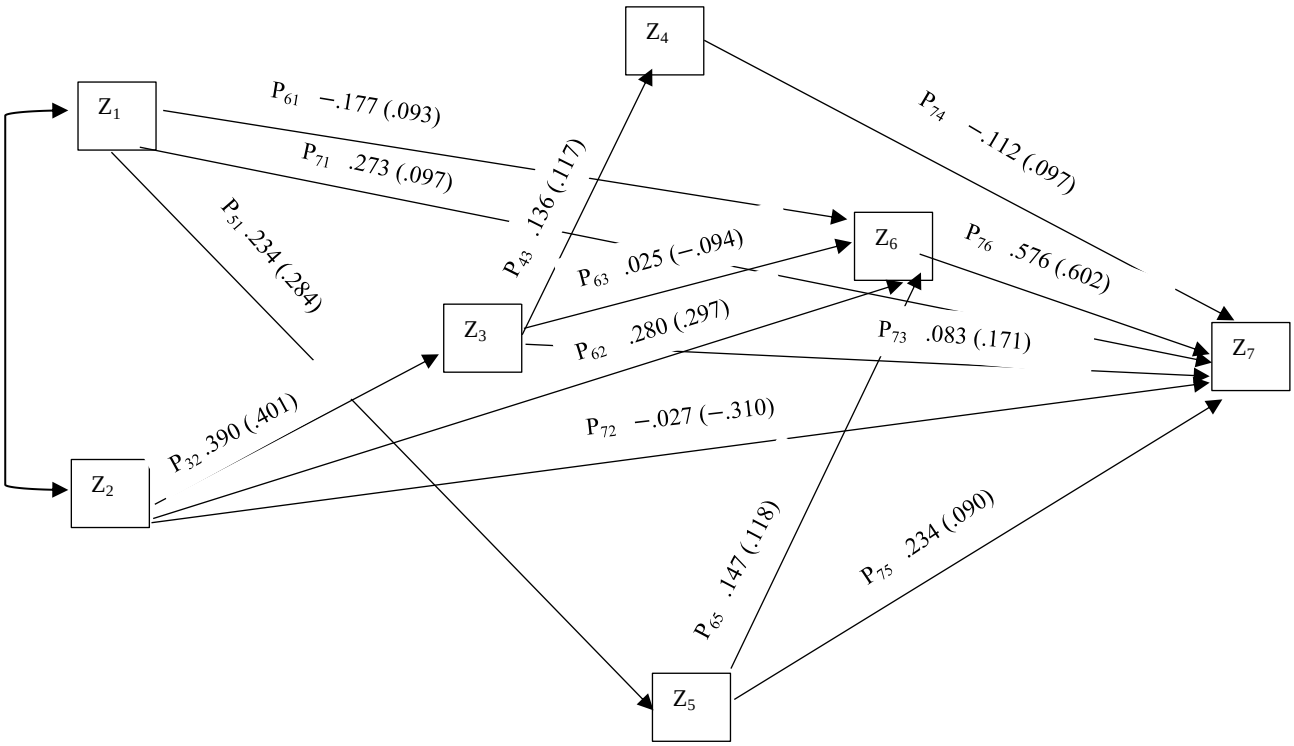
5.2. Results related to the Second Research Question

Second research question of the study was "What is the most meaningful causal model for explaining secondary school student's achievement in economics using the affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability, and academic stress)?". To answer this question, series of multiple regressions were conducted using structural modelling equation and the result is presented in Table 4.

Table 4
Significant paths through which the independent variables determined mathematics achievement of students

Paths	*Path coefficient*	*Significiant level*	*Paths*	*Path coefficient*	*Significiant level*
P_{31}	−.062	.072	P_{62}	.297*	.000
P_{32}	.401*	.000	P_{63}	−.094*	.014
P_{41}	.038	.310	P_{64}	.015	.673
P_{42}	.051	.211	P_{65}	.118*	.001
P_{43}	.117*	.003	P_{71}	.198*	.000
P_{51}	.284*	.000	P_{72}	−.310*	.000
P_{52}	−.040	.303	P_{73}	.174*	.000
P_{53}	.051	.960	P_{74}	.097*	.001
P_{54}	.069	.057	P_{75}	.090*	.002
P_{61}	.093*	.012	P_{76}	.602*	.000

Figure 2
Parsimonious causal model of six affective variables on students' academic achievement in mathematics (Z_7)



P_{31}- P_{76} = are obtained by regressing variable 3, 4, 5, 6, taken as the dependent variables on their predictor variables using the Structural Equation Models [SEM] earlier developed.

Figure 2 shows that after trimming using significance and meaningfulness as criterion, thirteen (13) out of twenty (20) hypothesized paths were retained. The value in the paths indicates the original correlation coefficients and beta weight (β) in the brackets. The direction of the causal paths of the variables in the model is the paths ways which are significant and meaningful as well as possess a link with the dependent variable (achievement in mathematics). An inspection of the model in Fig. 2 revealed that out of the 13 significant pathways, 6 pathways are direct while 7 are indirect. From the new model, a new set of structural equations are obtained and are presented below:

$Z_1= e_1$, $Z_2= e_2$, $Z_3= P_{31}\ Z_2 + e_3$, $Z_4= P_{43}\ Z_4 + e_4$, $Z_5= P_{51}\ Z_1 + e_5$, $Z_6= P_{61}\ Z_1 + e_5 + P_{62}\ Z_2 + P_{63}\ Z_3 + P_{65}\ Z_5 + e_6$, $Z_7= P_{71}\ Z_1 + e_5 + P_{72}\ Z_2 + P_{73}\ Z_3 + P_{74}\ Z + P_{75}\ Z_5 + P_{76}\ Z_6 + e_6$

To validate the parsimonious model drawn from Figure 2, the original correlation matrix of the six affective variables were reproduced. Table 5 shows the original correlation coefficients are presented in the upper half of the matrix and the reproduced ones are indicated at the lower half of the matrix. The discrepancies between the original and reproduced correlation matrix are shown in Table 5 and Table 6 shows the discrepancies between the original and reproduced. The discrepancies between the original and reproduced correlation shown in Table 5 are negligible except for causal attribution and mathematics achievement. These discrepancies could be due to error arising from the sampling technique and error from the instrument because of its inability to accommodate all the items that are supposed to be covered. Despite these, the values are small enough to justify the acceptance of the model as good, consistent and reliable for explaining the causal influence of the six variables and achievement in mathematics.

Table 5
The original and reproduced correlation matrix of affective variables and mathematics achievement

Variable	ACO	CAT	ACAS	LEA	ACM	LES	MAT
ACO	1						
CAT	.179**	1					
ACAS	.010	.390**	1				
LEA	−.028	.089**	.136**	1			
ACM	.275**	.017	−.002	.058	1		
LES	.177**	.280**	.025	.033	.149**	1	
MAT	.273**	−.027	.083**	.112**	.234**	.572**	1

Discrepancies between the original and reproduced correlation of affective variables and mathematics achievement

Variable	ACO	CAT	ACAS	LEA	ACM	LES	MAT
ACO	.000						
CAT	.000	.000					
ACAS	.009	.000	.000				
LEA	.019	.000	.000	.000			
ACM	.004	.020	.006	.004	.000		
LES	.004	.038	.099	.015	.003	.000	
MAT	.016	.068	.025	.025	.058	.005	.000

Note. ACO: Academic optimism; CAT: Causal attribution; ACAS: Academic stress; LEA: Leaners' adaptability; ACM: Achievement motivation; LES: Learners' sociability; MAT: Mathematics Achievement Test.

Hence, it can be concluded here that Figure 2 can be used to explain the causal linkages among the criterion variables and the predictor variable. It can be concluded that the modelling involving affective variables and academic achievement in mathematics is meaningful and parsimonious.

5.3. Results related to the Third Research Question

Finally, third question of the study was "What proportion of the effect of the student's affective variables (academic optimism, causal attribution, achievement motivation, learners' sociability, learners' adaptability, and academic stress) (i) direct and (ii) indirect?". Tables 6 and 7 were first used in ascertaining the significant direct and indirect effect of the variables of the study.

Table 6
Paths, their coefficient and their nature (direct or indirect) on students' achievement in mathematics

Paths	*Path coefficient*	*Nature of paths*	*Remarks*
P_{31}	−.062	Indirect	NS
P_{32}	.401*	Indirect	S
P_{41}	.038	Indirect	NS
P_{42}	.051	Indirect	NS
P_{43}	.117*	Indirect	S
P_{51}	.284*	Indirect	S
P_{52}	−.040	-	NS
P_{53}	.051	-	NS
P_{54}	.069	-	NS
P_{61}	.093*	-	S
P_{62}	.297*	Indirect	S
P_{63}	−.094*	Indirect	S
P_{64}	.015	-	NS
P_{65}	.118*	-	S
P_{71}	.198*	Direct	S
P_{72}	−.310*	Direct	S
P_{73}	.174	Direct	S
P_{74}	.097*	-	S
P_{75}	.090*	-	S
P_{76}	.602*	-	S

Table 7
Variables with direct effects in mathematics achievement

S/N	Variables	Beta weights	Significance	Remarks
1	Academic optimism	.198	.000	S
2	Casual attribution	−.310	.000	S
3	Academic stress	.174	.000	S
4	Learners' adaptability	.097	.001	S
5	Achievement motivation	.090	.002	S
6	Learners' sociability	.602	.000	S

Table 7 showed that all the six direct paths had a significant direct effect on academic performance in mathematics among senior secondary school students. The variables are academic optimism, causal attribution, academic stress, leaners' adaptability, achievement motivation and learners' sociability. It is important to note that learners' sociability has the most effective direct causal effect on student's achievement in mathematics. From the result in Table 13 and 14, the null hypothesis which states that there are no significant direct and indirect effects of affective variables is rejected. From the analysis, it was found that there are significant direct and indirect effects of the affective variables as outlined in achievement in mathematics. Variables whose indirect effect are found very prominent are causal attribution and academic stress (P_{32}= .401); achievement motivation has an indirect link with academic optimism (P_{51}= .287); and learners' sociability and causal attribution (P_{62}= .297).

Table 8
Decomposition of the total effects on mathematics achievement of SS2 students into proportion of direct and indirect effect

Predictor variable	Total effect	Direct effect	Indirect effect
ACO (Z_1)	.237	.198	.078
CAT (Z_2)	−.027	−.310	.028
ACAS(Z_3)	.083	.174	−.091
LEA (Z_4)	.112	.097	.015
ACM (Z_5)	.234	.090	.144
LES (Z_6)	.572	.602	−.030

Note. Proportion of total direct effect = 68.22; Proportion of indirect effect = 31.69.

Table 8 showed that the total effect (direct and indirect) of the six variables predictors as well as the proportion of their direct and indirect effect relative to the overall relative effect on Mathematics achievement test. The proportion of the total direct effect to total indirect effect is approximately 68.22 and 31.69, respectively. The result shows that three out of the six affective variables (learners' sociability, academic optimism, and academic stress) exert direct effect as shown in their ratios 16: 14: 48 learners' sociability, academic optimism, and academic stress respectively. Achievement motivation and learners' adaptability, though has a low significant direct effect on students' achievement in mathematics, their proportion of the effect is as low as 7.21% and 7.77% respectively when compared to the overall total effect. In all, the six predictors' variables showed that the proportion of direct effect in relation to the overall total effect was found higher than the indirect effect as they influence students' academic achievement in mathematics.

6. Discussion

The results derived from research question one revealed that the six affective variables (academic optimism, causal attribution, academic stress, leaners' adaptability, achievement motivation, and leaners' sociability) when taken together are effective predictors of students achievement in mathematics (see Table 1). A further study of the table revealed that learners' sociability is the highest predictor followed by academic optimism, academic stress, learners' adaptability, achievement motivation and causal attribution. The findings were in line with that of Sjoberg et al.

(2004) that asserted that affective variables are strong factors that can enhance learners 'improvement in academics. He noted that where individual's emotions are feelings about a particular stimulus is taken into consideration, the individual is likely to do concentrate on that object to achieve what he or she wants. This implies that it is not only intelligence of the child that determines the child's chances of success in school but factors such as the child's ability to associate with others in school, belief in oneself to succeed despite all odd, get along with the changes in the environment as well as identify causes of failure if any and then decides on what to do to get on.

The direct effect could be as a result of the fact that students obtained more knowledge, are able to break complex problems when they interact, sit together to discuss and share knowledge on a particular topic or subject. The findings were in line with that of Irsa et al. (2012), Kris et al. (2014), and Bhajet (2013).

Parsimonious causal model showed that learners' sociability influence academic achievement directly and indirectly with a beta coefficient (β=.602) for direct effect and (β=They posited that learners who are sociable are able to get along with others and can easily benefit from the knowledge and skills of the friends. For example, mathematics involves to an extent complex task that may be very beneficiary where learners come together to share on a particular problem. There is the probability that it will induce higher knowledge and understanding to certain task which inversely will aid in the improvement of academic achievement. The findings also agree with McGuigan and Hoy (2006) that noted that students with sociable attributes either with friends or teachers can benefit from getting more explanation on difficult issues in their academic engagements. This could be as result of the fact that most classroom explanation and discussion may not provide the learner with the needed information to enhance certain clarifications. Learners who are able to approach teachers and friends may get explanation better than how they may have understood in the class and this will aid their improvement in performance. The indirect effect of learners' sociability although ,low, indicates that this type of opportunity can only come depending on the type of relationship that is existing between the teachers and students.

Eric and Forkuoh (2014) that asserted that achievement motivated learners are always in the class, consistent in doing classwork, participatory in classroom discussion , seek for help when confronted with difficult task. The indirect effect is strong and could be as a result of the fact that so many factor interplay with motivation that enhances performance. For example, learners' interest to mathematics, necessity of mathematics in admission could all have contributed in propelling the motivation of the learner. Therefore, when these are taken into cognizance which could be the variance unexplained can enhance achievement in mathematics. The evidence of the indirect effects of achievement motivation could be seen in the original correlation of achievement motivation Z_5 (r=.234); learners' sociability Z_6 (r=.149) ; academic optimism Z_1 (r=.275) as shown in the correlation matrix (Table 7). These values shows that achievement motivation is positively correlated with the two variables and so could enhance learners' achievement through them. When students are mindful of the goals, they have set for themselves, cost of achieving such goals, they will ensure that they do everything within their reach to achieve those set goals.

Causal attribution of students (Z_2) influenced the student's achievement (Z_7) with a negative direct effect of (β= -.310) and an indirect effect of (β= .028). the indirect effect of causal attribution is strong because learners are bound to always attribute their success or failure to factors which could be external or internal. Learners are liable to always assume that their success in academic cold be achievement motivation Z_5 (r=.234) and learners' sociability Z_6 (r=.149) which have positive correlation with academic achievement. Other than these variables, most students could attribute their success in academics to factor such as effort and ability. These could cause happiness and the motivation to work harder in order to achieve better result in future. The findings were in line with Farid and Iqbal (2012), Proudfood et al. (2001) and Goldstein and Brooks (2007) that asserted that student's identification of the rationale for their success or failure could mar or improve their academic performance.

Summarily, it appears that the entire six affective predictor variables had a direct effect on students' achievement in mathematics. From the decomposition table (Table 8), it seems that the highest direct effect on students' achievement in mathematics were through learners' sociability (48.27 %), academic optimism (15.87%) and academic stress (13.95%). These three variables jointly contributed about 78.09% to the total direct effect. Hence, they should be regarded as strong predictors of students' performance in mathematics. Finally, causal attribution contributed 22.69% followed by achievement motivation (11.54%) had the highest indirect effect and collective contribution of 34.23% to the total indirect effect in the dependent variable (Z_7), students' achievement in mathematics.

7. Limitations

The study like any other survey study has some limitations. First, the study involved the use of a questionnaire where respondents were asked to make a self-report of the variables under study. It is possible that response bias may have set in which has the tendency to affect the outcome of the study. Longitudinal studies can be very adequate to have a deeper understanding of the variable's interaction in future studies. More so, the study did not partial in the effect of demographic differences like gender and age in the study. Further studies can involve multigroup analysis to ascertain the level of differences among students in their performance trajectories. This is not however, to say that the findings of the work are useless s it has contributed to literature in mathematics education and insight for policy makes in curriculum planning.

8. Conclusion

Based on the findings of the study, it was concluded that student's affective variables such as academic optimism, academic adaptability, causal attribution, achievement motivation and academic stress influence academic achievement among students. It therefore means that these variables when taken individual predict students' performance in mathematics. Based on the findings it is imperative that teachers and administrators should ensure that a healthy social climate is maintained in school. This will help learners interact freely and obtain help when needed from teachers and peers. Similarly, motivational strategies that can sustain the hopes of the learners should be put in place to obtain better academic success and guidance counsellors must ensure that students with various educational and personal social problems are helped to overcome any academic obstacle.

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Appendix 1

Distribution of West African Secondary School Certificate Examination WASSCE grades in Mathematics: 2016-2021

Year	Total No. of candidate	% pass (A1-C6)	% pass (D7-E8)	% fail (F9)
2016	1306538	560974(42.93%)	363900(27.85%)	355382(27.20%)
2017	1540250	587630(38.15%)	412358(26.77%)	540262(35.07%)
2018	1672224	649156(38.81%)	586321(35.06%)	436747(26.11%)
2019	1689188	639760 (38.30%)	498521(29.51%)	550904(32.61%)
2020	1605613	529425 (30.32%)	502315(31.28%)	573873(35.74%)
2021	1605248	616370 (38.68%)	407123(25.36%)	581755(36.24%)

(Source: Statistics Office, WASSCE Calabar, 2021)