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PATH ANALYTICAL MODELING OF THE INFLUENCE OF STUDENT-RELATED VARIABLES AND TEST-TAKING SKILL ON ACADEMIC ACHIEVEMENT IN MATHEMATICS IN UPPER BASIC EDUCATION IN ABIA STATE OF NIGERIA

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ABSTRACT

The study focused on path analytical modeling of the influence of student-related variables and test-talking skill on academic achievement in mathematics in upper basic education in Abia state. Model testing correlation research design was adopted for the study. The study was conducted in Abia state of Nigeria. The population of the study consisted 31,809 upper basic education level two students for 2023/2024 academic session.Upperbasic two students were selected for the study. Data were collected using the following standardized instruments; Student Attitude toward Mathematics Inventory (MAI) for junior secondary school students, Study Habits Inventory (SHI), Academic Self-efficacy Scale (ASS), Peer pressure Inventory (PPI) and Test-Taking Skill Inventory (TSI). Academic achievement scores in mathematics were collected from the students' cumulative examination folder in their respective schools using Proforma. The instruments were revalidated for suitability. Cronbach Alpha was used to determine the internal consistency of the instruments which yielded coefficient values of .93, .94, .94, 95 and .81 for MAI, SHI, ASS, PPI and TSI respectively. After collecting the data from all sources, the data were checked for missing values and restriction of range. Thereafter, assumptions of absence of outliers, nonlinearity, and non-normality of path analysis were checked and met. After assessing the suitability of the data, a path analysis study were conducted using Mplus 7.4 version software. The researchers also found among others that study habit, attitude towards mathematics and self-efficacy have medium positive direct effect size on students' academic achievement in mathematics at Upper Basic Education in Abia state respectively , while, test-taking skill has large positive direct effect size on students' academic achievement in mathematics. However, peer pressure has a small direct effect size on students' academic achievement in mathematics at upper basic education level in Abia state. Based on the findings, the researchers recommended among others, that schools should implement programmes that enhance students' academic self-efficacy, test-taking skill, study habit and positive attitude towards mathematics through mentorship, goal-setting workshops, and positive reinforcement strategies.

Keywords: Mathematics, Academic Achievement, Attitude, Peer pressure, Test-taking skill, Self-efficacy, Study habit and Path Analysis.

Introduction

Mathematics is one of the core subjects in both basic and senior secondary schools; and also it is needed for admission into tertiary institutions in Nigeria. According to Federal Republic of Nigeria (FRN, 2014) in the National Policy on Education, the main objective of teaching mathematics in basic education level is to enable students acquire basic scientific knowledge and skills that will enable them meet societal needs of creating employment and wealth. The contribution of mathematics to the national development has been seen in all facets of human life in various degrees (Anekwe, 2021). Possession of minimum of credits/passes in five subjects including English Language and Mathematics qualifies a graduate of 9-year basic education who sat for the Basic Education Certificate Examination (BECE) for admission into the 3-year Senior Secondary School programme.

Despite the importance of mathematics in various field of human endeavours, the students' performance in BECE in the subject has seriously been the issue of concern to mathematicians, psychometricians, test developers, parents, researchers and other stakeholders in education as it worsen day by day. The poor performance by students in the mathematics has been cited in some studies (Anekwe, 2021; Ajike, 2019; Ngussa and Mbuti, 2017; Mabula, 2015). In Abia state, it was recorded that from 2018-2022 the percentage pass with credit and above in mathematics in Basic Education Certificate Examination were 52.0%, 54.0%, 53.94%, 40% and 47.29% respectively (Abia State Ministry of Education, Examination Development Centre, 2024).The poor achievement have great consequences and implications on the students, teachers, parents, education stakeholders and the nation at large. The poor achievement affects the nation now, in areas like economy, educational advancement, science and technology, politics, welfare, culture, and even religious value because it is a sound mind that maintains values. Besides, most residents in Abia state are business people as such the knowledge of mathematics by their children will also help them in business transactions.

The poor achievement in mathematics at the upper basic education level in Abia state have been attributed to many factors such as; student factors, family factors, school factors, peer factors as well as teacher factors (Vintere and Zeidmane, 2014). Some authors such as Sivapakiam and Nalinilatha (2017); Elizabeth and Enose (2016)); Hajilan (2016) ; have emphasized that, the student variables influencing their academic achievement emanates from the attitude, gender, interest, attendance to classes, motivation, age among others. Academic achievement is the sum total of a student's performance after the content of a curriculum has been taught or delivered by the teacher. Attitude is a predisposition of an individual to react favourably or unfavourably towards a designed class of stimuli such as objects, places and persons. Attitude could be learnt or formed and acquired from members of the family, teacher and peer group. Self –efficacy can be defined as people's beliefs about their capabilities to produce the designated level of performance that exercises influence over events that affect their lives. Regarding school mathematics, self-efficacy is found to be one of the most critical variables for explaining difference in mathematics performance of students (Pajares, 2016). Schunk and Mullen (2012) also reported that self-efficacy is positively related to peer pressure. These variables explain difference in mathematics performance of students that explains some variations while predicting their performance in mathematics.

Peer pressure is another student related variable that may affect their mathematics achievement. Peers are people who are part of the same social group, so peer pressure or influence is when one does something because one wants to feel accepted and valued by their friends (Adeyemi*et al*, 2019). Peer groups influence each other in several ways; some are good while some are bad. Many peer groups can exert a positive influence on their friends, for instance, intelligent ones do help their peers to improve their academic performance. Study habits are the behaviours students use to complete academic work on a regular basis. It is an action such as reading, taking notes, holding study groups which the students perform regularly and habitually in order to accomplish the task of learning. It can be described as effective or ineffective depending upon whether or not they serve the students well. Husain (2020) stated that the concept of study habit is broad, as it combines nearly all other sub-concepts such as study attitude, study methods and study skills. Study habit has influence on test-taking skill of students.

Test-taking skill is a cognitive skill that allow students to undertake any testtaking situation in an appropriate manner, and to know what to do before, during, and after the test (Dodeen, 2009). These skills help students to translate their knowledge from classroom learning to answering and responding to questions when taking tests. Test-taking skill positively affect students' test-taking competency and hence impact upon their academic achievement. Test-taking skill is transferable skills (Sefcik, Bice and Prerost, 2013), where once acquired, students may be able to use these skills across a variety of subjects and within different settings and conditions. The influence of the aforementioned variables on students' academic achievement in mathematics can be studied through path analysis. Path analysis is a statistical tool used to evaluate whether the correlations between variables in a given data set reflect the causal hypotheses specified in the model.

Purpose of the Study

The purpose of this study focused on path analytical modeling of the influence of student-related variables and test-talking skill on academic achievement in mathematics in upper basic education in Abia state.

Research Questions

1. What is the most meaningful causal model for explaining the achievement of students in mathematics based on the selected student-related variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test-taking skill)?
2. What is the size of direct effect of the exogenous variables on the achievement of students in mathematics model?
3. What is the size of indirect effect of the exogenous variables on the achievement of students in mathematics model?

1.7 Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

1. The most appropriate indices of the hypothesised causal model that explained the influence achievement of students in mathematics based on the selected student-related variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test-taking skill) are not significant.

2. The size of the estimated direct, indirect and total effect of the exogenous variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test taking skill) on the academic achievement of students in mathematics in the causal model developed is not significant.

Methods

Model testing correlation research design was adopted for the study. The study was conducted in Abia state. The population of the study consisted of 31,809 upper basic education level two students for 2023/2024 academic session (Source: Abia State Universal Basic Education Board, 2024). A sample of 1080, (458 males and 622 females) upper basic two students were selected for this study using multi-stage sampling techniques. Data were collected using the following standardized instruments; student mathematics attitude inventory for junior secondary school students by Esomonu and Anekwe (2021), study habits inventory by Sakirudeen and Sanni (2017), academic self-efficacy scale by Abdul and Ashraf (2009), peer pressure inventory by Palani and Mani (2016) and Test-Taking Skill Inventory developed by Dooden (2008). Academic achievement scores in mathematics were collected from the students' cumulative examination folder in their respective schools using Proforma. The instruments were adopted because they were developed and standardized by measurement experts with well-established psychometrics properties. After collecting the data from all sources, the data were checked for missing values and restriction of range. Thereafter, assumptions of absence of outliers, nonlinearity, and non-

normality of path analysis were checked and met. After assessing the suitability of the data, a path analytic study were conducted using Mplus 7.4 version, software.

Results

Research Question 1: What is the most meaningful causal model for explaining the achievement of students in mathematics based on the selected student-related variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test-taking skill)?

To answer research question 1, the model fit indices of the initial hypothesized path causal model were examined. Thereafter, significant and meaningful path ways in the hypothesized path causal model were checked.

The overall fits indices of the initial hypothesized causal path model were all examined. The model fit was assessed using a variety of indicators and tests, more famous is the Comparative Fit Index (CFI), Tucker Lewis Index(TLI), Normed Fit Index (NFI), Standardized Root Mean Square Residual (SRMR) , Root Mean Square Error of Approximation (RMSEA) and-Chi-square and degree of freedom.

However, examination of the initial hypothesized causal path model showed 11 path ways were significant and meaningful while three path way were not significant and meaningful. The 11 path ways that were significant and meaningful have path co-efficient t-values > 1.96; while the three path way that were not significant and meaningful have path co-efficient t-value < 1.96. The path way that were not significant and meaningful include: Path way from self-efficacy to study habit, peer pressure to study habit and peer pressure to test-taking skill. See Table 1 and Fig 1 respectively.

Table 1 Path Co-efficient in the Hypothesis Causal Path Model for the Study

			Stand.Estimate	Unstand. Estimate	S.E.	t	P	Remark
AT	<---	PP	.107	.224	.062	3.614	***	Significant
SE	<---	PP	-.367	-.315	.024	-13.246	***	Significant
SH	<---	SE	.052	.119	.069	1.728	.084	Non significant
SH	<---	AT	.343	.323	.026	12.230	***	Significant
SH	<---	PP	.005	.010	.059	.162	.871	Non significant
TTS	<---	SH	.262	.494	.052	9.586	***	Significant
TTS	<---	AT	.352	.624	.049	12.838	***	Significant
TTS	<---	SE	.159	.256	.119	2.149	.032	Significant
TTS	<---	PP	.047	.176	.103	1.717	.086	Non significant
ACH	<---	SH	.143	.190	.036	5.268	***	Significant
ACH	<---	AT	.187	.233	.035	6.664	***	Significant
ACH	<---	PP	.104	.270	.069	3.911	***	Significant
ACH	<---	TTS	.354	.248	.020	12.396	***	Significant
ACH	<---	SE	.113	.344	.080	4.288	***	Significant

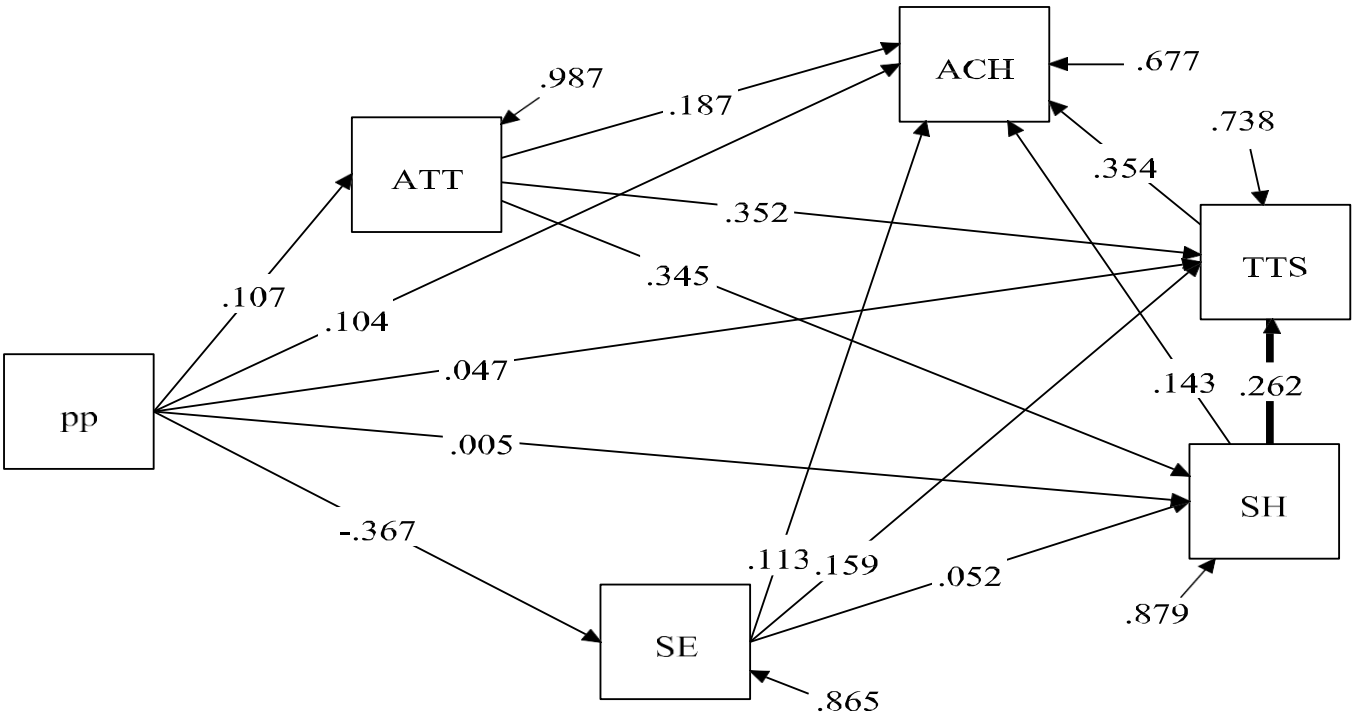

Fig 1: Path co-efficient of Hypothesized Causal Path Model

NB. ACH= Academic Achievement, TTS= Test -Taking Skill, SE= Self efficacy, ATT= attitude towards mathematics, SH=Study habit, PP= Peer Pressure.

After deleting the path way from self-efficacy to study habit, peer pressure to study habit and peer pressure to test- taking skill that were not significant and meaningful in the hypothesized path causal model, the path model was rerun. Thereafter, model fit indices, meaningful and significant path ways in the causal model were examined again. The model fit was assessed using a variety of indicators and tests. The rerun showed that all the fit statistics, taken together supported the idea that the model is satisfactory.

The various paths ways in the rerun model were also examined. The final model shows that all the paths ways were significant and meaningful. The 11 path ways that were significant and meaningful have path co-efficient t-values > 1.96. Therefore, the most meaningful causal model for explaining the achievement of students in mathematics based on the selected student-related variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test-taking skill) consist of 11 paths ways that are meaningful and significant.See Fig 2 and Table 2 for details

Table 2: Paths Ways in the Modified/Trimmed Causal Path Model for the Study

Path		Ways	Stand.Estimate	Unst. Estimate	SE	t-value	Remark
AT	<---	PP	.107	.224	.072	3.105	Significant
SH	<---	AT	.344	.324	.028	11.405	Significant
SE	<---	PP	-.367	-.315	.024	-13.208	Significant
TTS	<---	SH	.262	.494	.055	8.948	Significant
TTS	<---	AT	.356	.633	.048	13.280	Significant
TTS	<---	SE	.142	.181	.015	12.066	Significant
ACH	<---	SH	.143	.190	.038	4.938	Significant
ACH	<---	AT	.187	.233	.038	6.074	Significant
ACH	<---	PP	.104	.270	.071	3.777	Significant
ACH	<---	TTS	.354	.248	.020	12.544	Significant
ACH	<---	SE	.114	.344	.087	3.965	Significant

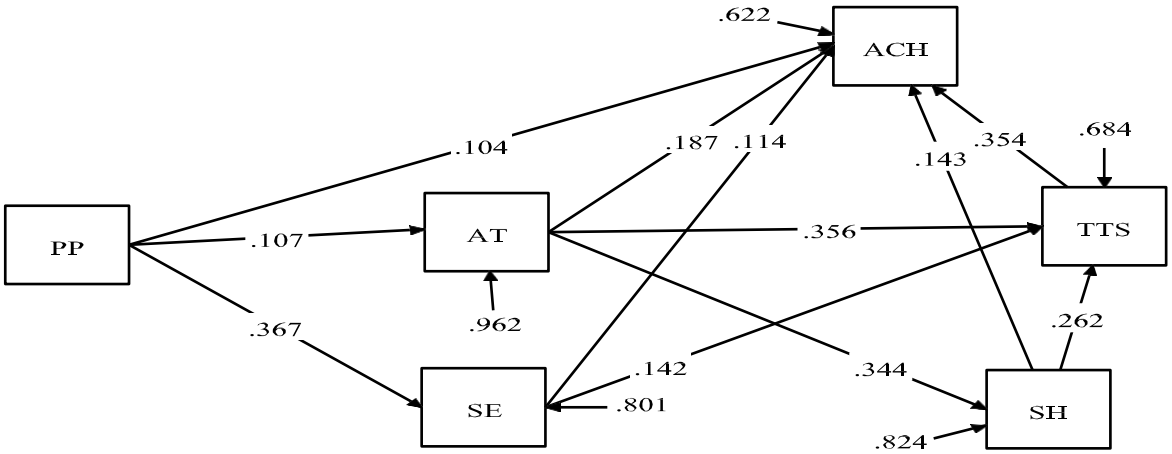

Fig 2: Final/trimmed path model for the study

NB. ACH= Academic Achievement, TTS= Test-Taking Skill, SE= Self-efficacy, AT= attitude towards mathematics, SH=Study habit, PP= Peer Pressure.

Research Question 2: What is the size of direct effect of the exogenous variables on the achievement of students in mathematics model?

The size of the direct effect of exogenous variables on the achievement of students in mathematics model was examined using standardized regression weights.A standardized regression weightsbelow .1 is small effect size, .11 to .30 is medium effect size, .31 to .50 large effect size while .51 and above very large effect size (Cohen, 1988).

Table 3: Standardized Regression Weights of the effect exogenous variables on the achievement of students in mathematics model

Path		Ways	Estimate	Strength	Direction
AT	<---	PP	.107	Medium effect size	Positive
SH	<---	AT	.344	Large effect size	Positive
SE	<---	PP	-.367	Large effect size	Negative
TTS	<---	SH	.262	Medium effect size	Positive
TTS	<---	AT	.356	Large effect size	Positive

Path		Ways	Estimate	Strength	Direction
TTS	<---	SE	.042	Small effect size	Positive
ACH	<---	SH	.143	Medium effect size	Positive
ACH	<---	AT	.187	Medium effect size	Positive
ACH	<---	PP	.104	Small effect size	Positive
ACH	<---	TTS	.354	Large effect size	Positive
ACH	<---	SE	.114	Medium effect size	Positive

NB. Ach= Academic Achievement, TTS= Test Taking Skill, SE= Self efficacy, AT= attitude towards mathematics, SH=Study habit, PP= Peer Pressure.

Table 3 shows that study habit, attitude towards mathematics and self-efficacy have medium positive direct effect size on students' academic achievement in Mathematics at Upper Basic Education in Abia State respectively , while, test-taking skill has large positive direct effect size on students' academic achievement in mathematics. However, peer pressure has a small direct effect size on students' academic achievement in mathematics at upper basic education level in Abia State.

Research Question 3: What is the size of indirect effect of the exogenous variables on the achievement of students in mathematics model?

The size of the indirect effect of exogenous variables on the achievement of students in mathematics model was examined using standardized regression weights.A standardized regression weightsbelow .1 is small indirect effect size, .11 to .30 is medium effect size, .31 to .50 large effect size while .51 and above very large effect size (Cohen, 1988).

Table 4: The size of indirect effect of the exogenous variables on the achievement of students in mathematics model

Specific Indirect Effect			Estimate	Strength	Direction
ACH	<---	TTS<---SE	.107	Medium effect size	Positive
ACH	<---	TTS<---ATT	.344	Large effect size	Positive
ACH	<---	SH<---ATT	.367	Large effect size	Positive
ACH	<---	TTS<---SH <---SE	.262	Medium effect size	Positive
ACH	<---	TTS<---SH	.356	Large effect size	Positive
ACH	<---	ATT<---PP	.020	Small effect size	Positive
ACH	<---	SE<---PP	-.042	Small effect size	Negative
ACH	<---	TTS<---SE<---PP	.005	Small effect size	Positive
ACH	<---	SH<---ATT <---PP	.005	Small effect size	Positive
ACH	<---	TTS<---SH <---ATT<---PP	.354	Large effect size	Positive
Indirect Effect					
ACH	<---	SE	.015	Small effect size	Positive
ACH	<---	ATT	.208	Medium effect size	Positive
ACH	<---	PP	-.093	Small effect size	Negative
ACH	<---	TTS	.005	Small effect size	Positive

NB. ACH= Academic Achievement, TTS= Test Taking Skill, SE= Self efficacy, ATT= attitude towards mathematics, SH=Study habit, PP= Peer Pressure.

Table 4 shows that self-efficacy and test-taking skill have small positive indirect effect size while peer pressure has small negative indirect effect size on students' academic achievement in mathematics at Upper Basic Education in Abia State respectively. However, attitude towards mathematics has a medium indirect effect size on students' academic achievement in mathematics at upper basic education level in Abia State.

In term of specific indirect effect, self-efficacy has medium effect size on students' academic achievement in mathematics through test-taking skill. Attitude towards mathematics has large positive effect size on students' achievement in mathematics through test-taking skill. Also, attitude towards mathematics has large positive effect size on students' achievement in mathematics through study habit. Furthermore, self-efficacy has large positive effect size on students' achievement in mathematics through study habit and test-taking skill. Study habit has large positive effect on students' academic achievement in mathematics through test taking skill. Peer pressure has small positive effect on academic achievement in mathematics through attitude.

Peer pressure has small negative effect on academic achievement in mathematics through self-efficacy, attitude, study habit and test-taking. Peer pressure has small positive effect on academic achievement in mathematics through attitude and test-taking skill.

The researchers found out that the most meaningful causal model for explaining the academic achievement of students in mathematics based on the selected student-related variables (attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test-taking skill) consist of 11 paths ways that are meaningful and significant. The corresponding hypotheses, shows that the model has a Chi-square of 1.98 with a p-value of .093 indicates that hypothesized causal model is empirically supported by the data. Furthermore p-value of Root Mean Square Error of Approximation (RMSEA) .851 also suggested that the hypothesized causal model is empirically supported by the data. The two indices suggested that most meaningful model is empirically supported by the data. The above finding is in line with Nwanze, and Okoli (2020) study that reported that paths ways and path coefficient are considered meaningful if path coefficient is greater than .10 with P-value less than .05. Similarly, Omar and Petek (2011) also reported that the most meaningful path models are the ones with all path significant with good theoretical foundation. Furthermore, the above findings also supported the work of Erutujiro and Esomonu (2024) that reported most meaningful path models are the ones with all path significant with good theoretical foundation and empirically supported by the data. The probable reason for similarities in findings is that when the model fit the data very well paths co-efficient become significant and meaningful.

The researchers also found out that study habit, attitude towards mathematics and self-efficacy have medium positive direct effect size on students' academic achievement in mathematics at Upper Basic Education in Abia State respectively , while, test-taking skill has large positive direct effect size

on students' academic achievement in mathematics. However, peer pressure has a small direct effect size on students' academic achievement in mathematics at upper basic education level in Abia State.

The above finding on the significant relationship between self-efficacy and students' performance in mathematics this finding is consistent with studies of Abubakar et al. (2016); Ali and Sepideh (2016); Naz et al. (2016) who found a significant relationship between self-efficacy and academic performance.This study corroborates that of Elahi and Amra (2022) who found a significant positive relationship between self-efficacy and academic achievement in high school students.

Kanmani (2018) in a divergent report found no significant relationship between self-efficacy and academic performance which contradicts the present finding. Self-efficacy significantly predicts students' performance in mathematics this finding agrees with studies of Nasir and Iqbal (2019); Odiri (2020); Negara et al. (2020); Brashi (2022) who found self-efficacy as predictor of performance in mathematics.

It was found that there was a relationship between students' study habits and their academic achievement. It means that high achievers have better study habits. The study also revealed that high academic achievers have better study habits and more positive study attitudes than low academic achievers. Good study habits accelerate scholastic performance than others with the same level of intelligence. Study habits have a vital role in the life of a student. Generally each student's success or failure is determined by one's own study habits. Study habits act as the building blocks for learning and success among students. Ajai et al., (2020), whose study also found a strong positive, high and significant correlation between study habits and academic performance of secondary school science students is in consonance with the findings of the study.

The findings are comparable to those of Boehnke (2018) , who found that when a student is positively affected and driven by peers, he or she does well at school and achieves strong academic results, however when a student is adversely motivated, academic failure ensues. The findings of this study corroborate those of Olalekan (2016), who found that when kids receive essential peer support, they are more likely to achieve and exceed their capabilities, focus more on their studies, and perform well in academic tasks at school.

This finding is in consonance with the findings of Hammad (2010) and Iza and Gil (2015) who concluded that components of test-taking skill used before test significantly contributed to the academic performance of students. Students who are knowledgeable in using test taking skill can outperform students of equal ability who lack test-taking skill. This finding is in agreement with the findings of Abu Hashim (2012), Hamadneh (2016), and Al-Mutlaq (2015) who concluded that components of test-taking strategies such as testwiseness and skimming test questions used during test significantly contributed to students' academic performance.

The positive correlation observed implies that as students' attitudes become more positive, their mathematical achievement tends to increase concurrently. This outcome aligns with prior research by Hwang and Son (2021) that has suggested a linkage between attitude towards mathematics and mathematics achievement. By having a positive attitude towards mathematics, the students will feel the importance of mathematics so as to improve their mathematics achievement and students who have negative attitudes tend to pay less attention in mathematics (Ajisuksmo and Saputri, 2017). Achievement in mathematics tends to result in more pleasant emotional perceptions of mathematics, and conversely, more positive attitudes towards mathematics lead to greater academic performance (Hwang and Son, 2021). The results of this study support the findings of earlier studies that have shown a favourable correlation between students' attitudes towards mathematics and their achievement in mathematics (Dowker and Sheridan, 2022).

The researchers also found that study habit, self-efficacy and peer pressure have medium positive indirect effect size on students' academic achievement in mathematics at Upper Basic Education in Abia State respectively. However, attitude towards mathematics has a medium indirect effect size on students' academic achievement in mathematics at upper basic education level in Abia State. The corresponding hypotheses, inthe study also shows that study habit and test-taking skill have significant indirect effect size on the academic achievement of students in mathematics as bootstrapped bias-corrected confidence interval that cross zero, at 95% probability level. However, attitude towards mathematics, academic self-efficacy, peer pressure influence, study habit and test taking skill) have significant indirect effect size on the academic achievement of students in mathematics in the causal model as bootstrapped bias-corrected confidence interval that does not cross zero, at 95% probability level.

Recommendations

1. Based on the findings the study recommends encouraging students in developing high self-efficacy considering it positive impact on performance in mathematics.
2. Good study habits lead to high academic achievements, and the undesired study habits cause low achievement. In order to improve students' academic achievements in mathematics, students should develop good study habits. Teachers may provide coaching sessions to guide students to pay attention to their studies and how to develop good time management skills.
3. Schools should implement programmes that enhance students' academic self-efficacy through mentorship, goal-setting workshops, and positive reinforcement strategies.
4. The use of test-taking skill should be incorporated into mathematics class in secondary schools because it improves students' academic performance and boost students' confidence in writing tests and examinations in mathematics.
5. Teachers should make changes in their approach to teaching mathematics, in order to eliminate negative attitude among the students towards the subject and to provide a pleasant school climate for learning mathematics.

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