Academic Engagement as a Correlate of Students' Achievement in Senior Secondary School Mathematics in Nigeria

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Abstract

This study is on academic engagement as a correlate of students' achievement in Senior Secondary School mathematics in Nigeria. A descriptive survey research design was employed. Two research questions were asked and answered. The population comprised all public Senior Secondary School year three (SSS III) students and a total of 2400 were randomly selected from the six Education Districts in Lagos State, Nigeria. Academic Engagement Scale with a reliability coefficient of 0.81 and Mathematics Achievement Test with a reliability coefficient of 0.92 were used for data collection. The collected data were analysed using descriptive and inferential statistics of mean, standard deviation, Pearson's Product Moment Correlation and Multiple Regression analysis at 0.05 level of significance. The results showed that academic engagement components (cognitive, behavioural and emotional) positively related to Senior Secondary School students' mathematics achievement; the three components of academic engagement made statistically significant contribution of 6.7% to the prediction of mathematics achievement, where cognitive and emotional engagements were significant positive predictors, behavioural engagement was a significant negative predictor of achievement in mathematics. It is recommended that mathematics teachers should utilise learner-centered approach in instruction and appropriate instructional pedagogies that will encourage intrinsic motivation and improve engagement and achievement in mathematics at the senior secondary schools.

Keywords: *Academic engagement, Behavioural engagement, Cognitive engagement, Emotional engagement, Students' achievement, Senior Secondary School Mathematics*

Introduction

Mathematics is important to everyone in one way or the other, because it builds critical thinking skills, creativity and problem solving skills useful in building reasonable,

thoughtful and productive citizens, and contributing to the development of the society. It is a compulsory subject to be passed at both the basic and senior secondary school levels in Nigeria. Given the importance and the recognition, students still dislike, disengage and perform poorly in the subject.

Improving students' performance in mathematics has continued to receive a lot of attention from many educators because low performance of students in the subject is still a concern particularly at the senior secondary school level (Iddrisu, Bornaa, Alagbela, Kwakye, Gariba, Ahusah & Badger, 2023). Alrashidi, Phan and Ngu (2016) opined that the more the students engage, the better their performance. By implication, the level of academic engagement predicts the level of academic achievement. This stresses the fact that, the more the students are engaged in any academic activities, the more the time and effort devoted to achieve their desired outcomes. Thus, higher achievement in mathematics demands higher engagement by students in their academic activities (Delfino, 2019) and requires being focused, eager to learn, and devotion of quality time and extra effort in academic activities to achieve learning outcomes.

Alrashidi. Phan and Ngu (2016) described academic engagement as the students' quality of participation, investment, commitment and identification with school and school related activities to enhance their performance. Salim and Ayub (2017) described academic engagement as a learner's willing effort in achieving a desired outcome. It also referred to the extent and intensity with which students participate in and apply themselves to learning (Shapiro, 2023). In sum, academic engagement refers to the self-regulated approaches of students to school and other learning activities. That is, students' involvement, investment, participation and commitment in academic activities.

Academic engagement has three components: Cognitive, behavioural and emotional (Alrashidi. Phan & Ngu, 2016; Delfino, 2019; Petricevic, Golub & Rovan, 2017; Salim & Ayub, 2017) which provide educators with options to pedagogically intervene to promote students' learning (Francis, Tan & Chen, 2018). According to Fredrick, Blumenfeld and Paris (2004), cognitive engagement implies students' intellectual investment, thoughtfulness and willingness to master difficult skills. Behavioural engagement – referred to students' participation or involvement in academic and extra-curricular activities; while emotional engagement is concerned with students' identification and sense of belonging such as positive and negative reaction to peers, teachers and school.

Hence, highly engaged students have a better performance in school and on standardized tests, and persist more than low engaged students thereby having improved achievement. Studies had been carried out describing the association between academic engagement and

students' achievement in mathematics. Abolmaali, Rashedi and Ajilchi (2014) found a significant direct effect of academic engagement in mathematics on students' academic achievement. Delfino (2019) involving 305 students from College of Education found students' academic engagement to be positively correlated with academic performance with behavioural engagement topping the list, followed by cognitive and emotional engagement respectively. Likewise, findings of the study of Qureshi, Wall, Humphries and Balani (2016) involving 117 first year undergraduate students indicated that students scored relatively higher on behavioural engagement than cognitive engagement and lowest on emotional engagement. In a similar vein, the study by Duron-Ramos, Mojica-Gomez, Villamizar-Gomez and Chacon-Andrade (2020) involving 621 University students indicated that cognitive engagement predicted students' achievement. The authors reported that students who were more engaged had higher levels of academic achievement. Hence, academic engagement had been found to relate significantly to students' achievement but at the tertiary education level. There is therefore the need to research the relationship between students' academic engagement and their achievement in mathematics at the senior secondary school level. The outcome may assist in improving the performance in the subject, hence, the essence of this study.

Research Questions

Two research questions guided this study.

1. What is the relationship between students' academic engagement (cognitive, behavioural and emotional) and achievement in senior secondary school mathematics?

2. What is the (joint and relative) contribution of students' academic engagement (cognitive, behavioural and emotional) to the prediction of achievement in senior secondary school mathematics?

Method

Research Design

This study employed descriptive correlational research design of the survey type. The population comprised all senior secondary school three (SSS III) students in the six Education Districts of Lagos State, Nigeria as at 2020/ 2021 session. Multi stage sampling technique was employed in this study. Six zones (Alimosho, Kosofe, Lagos Island, Apapa, Badagry and Ikeja) which made 30% of the total zones in Lagos State were randomly

selected after which two schools were randomly selected from each of the six selected zones making twelve sample schools. From each sample school, all the SSS III students available (2675) represented the respondents at the point of the administration of the instruments. At the point of collation and sorting, 2400 (90%) completely filled copies were selected while the others 275 (10%) not properly filled were discarded. Hence, 2400 SSS III students from twelve senior secondary schools in the six Education Districts in Lagos State made up the sample comprising 1260 males and 1140 females.

Instrument

Two instruments used for data collection in the study were: Academic Engagement Scale (AES) and Mathematics Achievement Test (MAT).

The Academic Engagement Scale was adapted from Delfino (2019) "Level of students' engagement scale" and Quereshi, Wall, Humphries and Balani (2016) "Student's engagement questionnaire" to make them more relevant in the context of mathematics. AES consisted twenty five (25) items anchored on a five-point Likert scale ranging from: Never-1, Rarely-2, Occasionally-3, Often-4 and Always-5. Twelve items measured cognitive engagement, eight items measured behavioural engagement and five items measured emotional engagement. The reliability coefficient of AES was $\alpha=0.81$ calculated with 200 SSS III students' questionnaire not part of the study sample and from Education District I in Lagos State using Cronbach alpha statistic.

The MAT consisted of 30 multiple-choice test items with four options A-D adapted from Senior Secondary School Examination (SSCE) past questions conducted by the West African Examinations Council between 2015 and 2020. The questions covered the major themes of WASSCE mathematics syllabus which are: Number and numeration, Algebraic processes, Geometry, Statistics and Probability as can be seen from the Table of Specification (Table 1). The 30 test items were reviewed and face validated by three senior secondary school mathematics teachers who certified that they were in line with the six levels of the cognitive domain of knowledge, comprehension, application, analysis, synthesis and evaluation in the table of specification. The face validated 30 test items were pilot tested on 200 senior secondary school students and subjected to item analysis to ensure that only the items with difficulty index 0.2 and 0.8 and discrimination power greater than or equal to 0.4 were included in the MAT. The completion time for the MAT was one hour.

Table 1

Table of Specification for MAT

Themes	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Number and Numeration	3, 5,	20	24, 27	2, 6, 22	-	1, 21, 30	11
Algebraic Processes	-	10, 13	4, 8, 19	9, 18	11, 26	7	10
Geometry	-	-	17, 23, 25, 29	-	28	-	5
Statistics and Probability	12	-	14, 16	15	-	-	4
Total	3	3	11	6	3	4	30

Thereafter, the reliability coefficient of MAT was computed using Kuder-Richardson formula 20 and a coefficient of 0.92 was calculated. Thus, the two instruments found to be both valid and reliable were utilised for the study.

Upon selecting the sample schools, permission to administer the research instruments was sought from the principals of the sample schools after which four trained research assistants helped with data collection from the field with the two instruments, AES and MAT. The AES and MAT were administered on the respondents in all the sample schools selected for the study. The involvement of the participants in the study was voluntary and all the participants remained anonymous. The administration of the instruments lasted for six weeks.

The Statistical Package for the Social Sciences (SPSS) version 23 was used for the coding of the data collected. Research question one was answered using descriptive statistic of mean, standard deviation and Pearson's Product Moment Correlation, while research question two was answered using Multiple Regression analysis at p-value of 0.05 level of significance.

Results

Research Question One:

What is the relationship between students' academic engagement (cognitive, behavioural and emotional) and achievement in senior secondary school mathematics?

Table 2

Correlations matrix for the relationship among Academic Engagement components and students' achievement in mathematics (N=2400)

		Mean	SD	1	2	3	4
1	MAT	18.674	7.850	1			
2	CE	4.166	.621	.242*	1		
3	BE	4.116	.641	.154*	.661*	1	
4	EE	3.898	.715	.215*	.618*	.648*	1

Note. MAT: Mathematics Achievement Test; CE: Cognitive Engagement; BE: Behavioural Engagement; EE: Emotional Engagement; SD: Standard Deviation

* p<.05 (correlation is significant at 0.05 level).

The results in Table 2 showed the Pearson's Product Moment Correlation to assess the relationship between students' academic engagement (cognitive, behavioural and emotional) and achievement in senior secondary school mathematics. According to the descriptive statistics in Table 2, cognitive engagement was the highest (mean=4.166, SD=.621), followed by behavioural engagement (mean=4.116, SD=.641), while emotional engagement was the least (mean=3.898, SD=.715) among senior secondary school students in mathematics.

The three components of academic engagement were found to be positively related to achievement. This means that increase in the students' cognitive, behavioural and emotional engagement was associated with an increase in achievement, reflecting a direct relationship between academic engagement and achievement. However, as indicated in Table 2, there was a significant positive correlation between students' academic engagement and achievement in senior secondary school mathematics: Cognitive engagement (r=.242, p<0.05), emotional engagement (r=.215, p<0.05) and behavioural engagement (r=.154, p<0.05) but the associations were both moderate and weak (Shortell, 2001).

Research Question Two

What is the (joint and relative) contribution of students' academic engagement (cognitive, behavioural and emotional) to the prediction of achievement in senior secondary school mathematics?

Table 3

Model summary, coefficient and t-value of multiple regression analysis of academic engagement and achievement in senior secondary school mathematics

Model Summary				
Multiple R=.260	Multiple R ^{2}=.067	Multiple R^2(Adjusted)=.066		
Standard Error Estimate=7.585	F=57.747	P<.05	df1=3	df2=2396
Model	Unstandardised Coefficients		Standardised Coefficient	t	Sig.
	B	Std Error	. ...		
Constant	5.618	1.131		4.966	.000
Cognitive Engagement (CE)	2.581	.352	.204	7.329	.000
Behavioural Engagement (BE)	- .801	.352	- .065	-2.273	.023
Emotional Engagement (EE)	1.437	.302	.131	4.763	.000

As indicated in Table 3, the R-value of .260 reveals a low correlation for the study. The multiple correlation square (R^2) of .067 described the joint contribution of the predictors (cognitive, behavioural and emotional engagements) to the explanation of variance in senior secondary school students' achievement in mathematics. This means that 6.7% of mathematics achievement could be explained by the three academic engagement

components. This percentage contribution is significant with F value of 57.747 at 0.05 level of significance.

Table 3 also revealed the relative contributions of the predictors to the explanation of the variance in the outcome measure. Cognitive engagement was the highest predictor of achievement in senior secondary school mathematics (β=.204, t=7.329, p=0.000) followed by emotional engagement (β=.131, t=4.763, p=.000), while behavioural engagement made the least negative but significant contribution to the prediction of achievement in senior secondary school mathematics (β=-.065, t= - 2.273, p=.023).

Thus, the regression equation, that is, the mathematics achievement predicting model based on predicted standard variables is as follows:

$$\text{Mathematics Achievement}_{predicted} = 5.618 + 2.581CE - .801BE + 1.437EE$$

The equation shows that one unit increase in cognitive engagement will lead to 2.581 increase in mathematics achievement; one unit increase in behavioural engagement will lead to .801 decrease in mathematics achievement; one unit increase in emotional engagement will lead to 1.437 increase in mathematics achievement.

Discussion

Academic engagement components were found to be positively related with achievement in mathematics. This implies, the higher the engagement, the higher the mathematics achievement. It reveals that the degree of students' connection to mathematics learning predicts their level of academic achievement. In other words, the more students are engaged in any academic activity, the more time and effort devoted results in the achievement of their desired outcomes. In essence, higher achievement in mathematics demands higher engagement by students in their academic activities (Delfino, 2019) and requires being focused, eager to learn, devote quality time and extra effort in academic activities to achieve desired learning outcomes.

Also, academic engagement significantly contributed to achievement but it did not highly predict achievement in mathematics in the study. The three academic engagement components (cognitive, behavioural and emotional) jointly made a significant contribution to achievement in mathematics. Only 6.7% of the variance in mathematics achievement was accounted for by the three components. 93.3% of the variance in achievement could be explained by other variables not included in this research. This demonstrates that there are other related factors (school, family or personal) which also have influence on

mathematics achievement that may require further investigations about their contributions to the prediction of mathematics achievement.

Interestingly, based on the mean average scores of the components, cognitive engagement of students ranked highest over the other two components followed by behavioural engagement and lowest on emotional engagement. Cognitive engaged students were described as those who have the ability to handle lots of information in mathematics problem-solving, who utilise cognitive strategies in the learning process and persevere in doing more than expected in solving mathematics problems (Francis, Tan & Chen, 2018). This is in agreement with the findings of Francis, Tan and Chen (2018) who reported that students who were more engaged had higher levels of academic achievement with cognitive engagement having the strongest association.

Though, the three academic engagement components contributed significantly to the prediction of senior secondary school students' achievement in mathematics. Cognitive and emotional engagements were significant positive predictors of achievement while behavioural engagement was a negative significant predictor of achievement in mathematics in this study. Cognitive engagement describes students who intelligently engage in mathematics activities, expend the efforts required to understand and master difficult tasks, utilise appropriate learning strategies, show preference for hard work, persist on tasks and could positively cope in the face of failure (Fredricks, Blumenfeld & Paris, 2004; Salim & Ayub, 2017) thereby having increased high achievement. On the other hand, emotional engagement describes students' positive and negative emotional reactions towards their academic works, classmates, teachers and school in general (Alrashidi, Phan & Ngu, 2016). Thus, emotional engagement refers to the perspective on learning mathematics, positive and negative thoughts, learning attitude and students' reactions during the teaching and learning process of mathematics. Francis, Tan and Chen (2018) believed that students with low emotional engagement result in low levels of mathematics achievement while students with positive feelings such as having enjoyment and pride in learning mathematics have the tendency to achieve higher in mathematics.

Behavioural engagement describes students' participation in learning activities. Students who are behaviourally engaged have chances for higher levels of mathematics achievement. But when students are externally compelled to participate in learning as a result of pressure from parents or teachers to avoid punishment for misbehaviour, this behavioural compliance may be insufficient when difficulties are encountered in their learning thereby affecting their achievement. Thus, there is the need for students to be intrinsically motivated to actively participate in learning, that is, have self-desire to learn

new things, seek new challenges and develop the ability to persevere in order to overcome challenges in learning mathematics.

Conclusion and recommendations

Intelligence is not the only factor that predicts learning outcomes in mathematics. By implication, intellectual ability alone does not contribute to the prediction of achievement in mathematics rather many factors contribute to the learning outcomes. This study has established that academic engagement is a contributory factor to mathematics achievement. Students need to be cognitively, behaviourally and emotionally engaged in mathematics learning for higher achievement in mathematics. Students' academic engagement is also critical and essential to the learning of mathematics. Thus, due to the positive relationships found between academic engagement components and students' achievement, it is therefore recommended that educators should utilise learner-centered approach in instruction by providing students support services and appropriate instructional pedagogies that will encourage intrinsic motivation thereby improving their engagement and achievement in mathematics.

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