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## The effects of the attributional style on the mathematics performance of senior secondary school students

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The purpose of this study was to explore the effects of the attributional style on the mathematics performance of senior secondary school students. The study involved a sequential explanatory mixed-method approach (QUANTITATIVE + qualitative). The quantitative part of the study involved 300 students drawn from 2 schools chosen in 2 education districts in Lagos State, Nigeria. The major data generation instruments for the study were the Attributional Style Questionnaire (ASQ), the mathematics performance scores of students, and focus-group interviews. Focus-group interviews with 20 students (10 students per school) were used in the qualitative part of the study. Quantitative data were analysed by calculating correlation coefficients, conducting multiple regression analyses, and performing a one-way analysis of variance to compare the subscales across gender and socio-economic status. Conversation analysis was used to analyse the qualitative data generated. The findings reveal no significant relationships between the attributional style and mathematics performance. Gender-based differences were found in the stability and globality scales, students' socio-economic status, and their attitudes towards mathematics. Future research on all the variables used in this study could be replicated on different samples. Researchers could consider exploring the use of an attributional style questionnaire on academic issues using a similar sample as in this study.

**Keywords:** attributional style; attributional style questionnaire; globality; mathematics performance; mixed-method approach; stability

### Introduction

Mathematics, as a mandatory subject in secondary school educational programmes in Nigeria, is crucial in many fields of human endeavour. Its significance for transitioning to higher educational levels in Nigeria as a developing country cannot be overemphasised (Akase, Mwekaven, Awuhe & Tombuwua, 2015). Despite its important status in school education programmes, the high failure rate in the subject is alarming (Sa'ad, Adamu & Sadiq, 2014). Many factors responsible for the poor mathematics achievement in Nigeria have been reported in the literature. These include teacher influence (Adegoke, 2011), the influence of self-concept and academic motivation (Ajayi, Lawani & Salomi, 2012), instructional methods, student attitudes to the subject (Akinsola & Olowojaiye, 2008; James, 2009), gender factors (Awofala, 2011), and class size (Olatunde, 2010). Other factors reported by Popoola and Olanrewaju (2010) include a lack of qualified teachers, the deprived background of many students, the difficulty of mathematics as a subject, a lack of concentration, inadequate teaching facilities, socio-economic factors, and a lack of enthusiasm for the subject.

Attributing reasons for what happens is a common human characteristic. Shores and Smith (2010) describe attribution as individuals' ascription of failures and successes in life to causes that are either resident in or external to people. The authors add that individuals who are internally driven ascribe their success to their own ability or effort and accept liability for such performance. Those who are externally motivated ascribe their success to elements beyond their control, such as luck or the easiness of a task (Houston, 2016). Students in mathematics, too, attribute their successes or failures to either internal or external factors. Shores and Smith (2010:24) state that "there appears to be a need to continue research on attribution, which is important to the success of students in Mathematics." In this study we investigated the attributional thinking of the students regarding success and failure in mathematics performance, which was measured in terms of the students' examination scores and correlated with socio-demographic factors such as the students' gender, socio-economic status and attitudes towards mathematics.

### Theoretical Review

#### *Reformulated learned helplessness theory (RLHT)*

When human beings realise that they cannot control or solve problems, a breakdown occurs between events and responses, leading to barriers to future learning (Dişlen Dağgöl, 2018). The extent to which human beings cannot maintain control over events they face adversely affects their behaviour and organic functioning. In some instances, learned helplessness may set in. Meece, Glienke and Burg (2006:354) state that "learned helplessness occurs when someone attributes failure to a lack of ability and gives up easily, or shows a steady regression in problem-solving strategies when confronted with failure." Learned helplessness is a behaviour that people use to justify their lack of control over situations that may make them behave in a helpless manner (Houston, 2016).

Over the years, research on learned helplessness has shown that human beings who are exposed to uncontrollable events, too, eventually manifest disruptive behaviour (Kloosterman, 1984; Suleiman, 2016). People who display learned helplessness believe that the reasons for the negative events that happen to them are permanent and that they will keep on influencing their lives. Dişlen Dağgöl (2018) describes learned helplessness as a key aspect of learning because learning is categorised as both a mental and an affective process. Hall, Goodwin, Heleski, Randle and Waran (2008), on the other hand, describe learned helplessness as a mental state in which people find it difficult to be in control of adverse circumstances, believing that all their actions are unsuccessful.

In academic settings, some students feel that, no matter how hard they study, they will fail. This kind of fear of failure has affected the academic achievement of many secondary school students, especially in Nigeria (Ajayi et al., 2012; Shores & Smith, 2010). Realising the extent of the problem at hand, in this study we explored the possibility of using the reformulated learned helplessness theory (RLHT) (Abramson, Seligman & Teasdale, 1978) as the theoretical framework for the study. Schroder and Ollis (2013) maintain that, according to RLHT, when people believe that the outcome of an assignment is beyond their control, a closely linked configuration of deficits (cognitive, motivational, and emotional) appears to affect their behaviour.

#### *Mathematics performance in Nigeria*

In Nigeria, secondary school students traditionally place a lot of emphasis on mathematics as a subject that must be passed at any level of examination, whether internal or external. Although this is necessary for improving their academic and social advancement, the results of mathematics examinations at these levels have not been encouraging. Students attribute their performance in terms of success or failure to either internal or external causes (Weiner, 1986, 2000). Researchers believe that several factors are responsible for the poor mathematics performance of Nigerian senior secondary school students. In their study, Popoola and Olanrewaju (2010) compiled a list of key factors responsible for the poor performance of secondary school students in mathematics, such as the lack of qualified teachers, the lack of incentives for teachers, teachers' absenteeism, the lack of interest of students, and students' limited understanding of mathematics. Other factors included mathematics difficulty, the abstractness of the subject, obsolete teaching materials, a lack of parental encouragement, ill-equipped libraries, and limited funds to buy textbooks.

Abdulahi and Onasanya's (2010) study on the impact of teachers' effectiveness on secondary school students' mathematics performance in Kwara State, Nigeria, revealed that some teachers were not adequately qualified to teach mathematics. The authors suggest that poor mathematics performance could be improved by qualified teachers developing sufficient teaching experience and the provision of good instructional material and activities.

In a study conducted in the northern part of Nigeria involving secondary school students, James (2009) found that the students attributed their poor performance in mathematics to a lack of textbooks, inadequate teaching materials, and unqualified teachers. In similar vein, but with different results, Yara (2009) investigated students' attitudes to mathematics in selected secondary schools in southwestern Nigeria where he found a positive attitude towards the subject. Ifamuyiwa and Akinsola (2008) report that most secondary school students have a negative attitude towards mathematics resulting in their performing poorly in internal and external examinations. Some public secondary schools in Nigeria, especially those in the large cities and towns, have an excessive number of students in classes. Olatunde (2010) found in his study that class size has an effect on mathematics performance and that teachers of large classes find it difficult to individualise their teaching, making quality teaching virtually impossible. Poor mathematics performance is also attributable to the personality and attitude of teachers (Abdulahi & Onasanya, 2010) as well as their classroom practice and pedagogy (Arends, Winnaar & Mosimege, 2017; Imms & Byers, 2017).

#### *Socio-economic status and mathematics performance*

Schulz (2005) maintains that the effect of students' socio-economic background on academic performance is one of the most consistent factors in educational research. McConney and Perry's study (2010), too, revealed a significant difference in mathematics performance between students with a low socio-economic status (SES) and those with a high SES but reported little difference in terms of school SES. In a longitudinal study, Levine, Vasilyeva, Lourenco, Newcombe and Huttenlocher's (2005) used mental transformation and syntax comprehension to determine whether the spatial advantage of boys changed in children with different SESs. It was found that boys with middle and high SES did better in mathematics than girls in the same status group while there was no difference in the task performance of boys and girls with low SES. Williams (2005) examined cross-national differences in rural mathematics performance in 24 industrialised countries (some

European countries, the United States of America, some Asian countries, the Russian Federation, and New Zealand). He found that 14 of the countries were rurally disadvantaged and urbanly advantaged while three countries were both rurally and urbanly disadvantaged. In addition, five countries were urbanly disadvantaged and two countries rurally advantaged.

Geske, Grinfelds, Dedze and Zhang's (2006) study also found that geographical location (rural and urban areas) affected SES and mathematics performance. They concluded that children with high SES would be exposed to more stimulating influences and an environment that would enhance their productivity in class activities as opposed to children with low SES and who struggled to use the few facilities at their disposal (Harris & Goodall, 2008). This, however, does not mean that children whose parents are not wealthy but have time for home lessons and assignments, will not do well academically.

#### *Gender and mathematics performance*

Research on gender differences in mathematics performance, especially among secondary school students, has attracted a lot of attention. The historical dominance of boys in subjects such as mathematics has today been largely replaced by successful competition from girls. Research suggests that female students are now showing more interest in subjects previously popular with male students such as mathematics and science (Martinot & Désert, 2007; Wilhelm, 2009), although disparities still exist regarding these subjects. Some research has revealed dominance in mathematics either by male students or female students while other research has shown that both genders performed well when the learning processes were thorough and students were able to implement what has been taught in a practical way (Combs, Slate, Moore, Bustamante & Onwuegbuzie & Edmonson, 2010; Else-Quest, Hyde & Linn, 2010; Geist & King, 2008). Kniveton (2006:37) states that "there are educational justifications, under some circumstances, for working with members of the other sex rather than the same sex or on their own."

Rogers and Hallam (2010) report that in their study no significant differences were found in the academic performance of male and female students whereas Ewumi (2012) discovered a significant difference in the academic performance of the two sexes. Matteucci and Mignani's (2011) study revealed significantly better performances by male students and generally low mathematics proficiency on the part of female students. Interestingly, significant gender differences were noted between the girls' and the boys' attributional patterns with the girls' being more self-enhancing.

Lloyd, Walsh and Yailagh's (2005) study with British Columbian public school students showed that the attributional patterns of girls were more self-enhancing, pointing to an attribution improvement in girls. The girls, however, revealed under-confidence with respect to their unique mathematics achievements in contrast to the boys who were more prone to ascribe failure in mathematics to a lack of teachers' help. Conversely, Mok, Kennedy and Moore (2011), in their investigation on attribution and gender, found that more of the female students than male students stated that the lack of ability and strategy were reasons for their academic failure.

#### *Mathematics attitudes of students*

Attitude is the inclination to categorise objects and events and to react to them in a certain manner (Sakariyau, Taiwo & Ajagbe, 2016). Attitude can also be regarded as the inclination to react with a particular goal in mind to other people, objects, circumstances, occasions, or thoughts. This led Orunaboka (2011) to conclude that a person who shows a certain attitude towards something is reacting to the conception of that thing rather than to its actual state. In addition, attitudes are shaped by individuals based on different learning backgrounds, and, if the experience is positive, an inspirational frame of mind can emerge. Sakariyau et al. (2016) maintain that human beings are not born with attitudes but acquire them in their different developmental stages. They believe that some attitudes develop because of people's experiences, knowledge, and abilities. As a result, attitudes change gradually over time and are, therefore, not permanent (Olasehinde & Olatoye, 2014). In a mathematics class, students may develop negative or positive attitudes, which may be stable and have affective as well as cognitive features (Goldin, 2002). Mathematics attitude is regarded as one of the predictors of achievement in mathematics (Moenikia & Zahed-Babelen, 2010). Sparrow and Hurst (2010) relate mathematics attitude to the emotional response to certain situations. Many researchers have noted a connection between students' frame of mind towards mathematics and their mathematics outcomes (Marchis, 2011; Nicolaidou & Philippou, 2003).

Other factors include students' belief in the usefulness of mathematics in their everyday life, their self-efficacy, and their self-judgement. Imasuen and Omorogbe's (2016) study revealed that many students developed a positive attitude towards mathematics if the teacher's method of instruction was positive and if they had a high level of awareness of the importance of mathematics for nation building. This is in line with the findings of Opara, Magnus-Arewa and Nwaukwu (2017) that

teachers' competencies and students' self-efficacy can determine students' attitudes towards mathematics.

#### *Attributional styles – internality, stability and globality*

Attributional style has also been examined as a predictive model and explanatory tool for people's understanding and outcome of self-concept (Maras, Moon & Gridley, 2014). Individual interpretation of negative thinking or behaviour is acquired through continuous exposure to inescapable negative events. Conversely, people who continuously exhibit positive attributional styles will be optimistic (Higgins & LaPointe, 2012). Askim (1999) argues that personal characteristics play a major role in explaining success or failure in terms of ability (power to carry out a task) and trying (determination to complete a task), which are two important components of positive attribution. This study was limited to the internality, stability, and globality dimensions of attributional style, which may determine success or failure in mathematics (Abramson et al., 1978).

When people think that their negative situation is not likely to end, they believe that their problem is stable (stability), and that this may lead to other problems in their lives (globality), which are caused by themselves and not the prevailing situation (internality). There may be a negative impact on mathematics performance and achievement setting when an action is internal and stable and there is a global causal belief about what happened. However, when an academic causal ascription is external, unstable, and specific, there may be positive dimensions to the performance of students (Ashforth & Fugate, 2006). Students' attributional styles (ASSs) may sharpen their perception of the future and influence their views and subsequent behaviour. Hsieh and Kang (2010) believe that the future success of students may be affected by their attributions in terms of the amount of effort they put in, their motivation, and their competence, which will eventually determine their level of achievement. These attributional style dimensions, except for internality, served as the predictor or explanatory variables of the study and were measured by students' mathematics performance scores as criterion variable. The internality dimension was not investigated as other studies have found it to have low reliability (Dykema, Bergbower, Doctora & Peterson, 1996).

#### **Conceptual Framework**

The conceptual framework comprised the attributional style dimensions (stability and globality) as independent variables and mathematics performance scores as dependent variable. The conceptual framework also includes the moderating variables used in the study, namely gender, SES and students' attitudes towards

mathematics. These variables were all measured to determine relationships in the study.

#### **Research Questions**

##### *Primary research question*

How does attributional style relate to mathematics performance in Nigerian senior secondary schools over and above socio-demographic and attitudinal factors?

##### *Secondary research questions*

- 1) How do stability and globality attributional styles relate to mathematics performance?
- 2) How well do stability and globality as well as gender and socio-economic factors predict mathematics performance?
- 3) What is the influence of socio-demographic and attitudinal factors on mathematics performance?

#### **Goals of the Study**

The goal of the study was to achieve a better understanding of the extent to which students' attributional style (AS) and socio-demographic factors such as SES, gender, and attitude towards mathematics determine the quality of the students' performance in mathematics. An additional objective was to determine the significance of AS in understanding the poor performance of students in mathematics and helping the students devise new ways of adapting to or preventing failure in mathematics.

#### **Method**

##### **Research Paradigm**

This study was premised on the pragmatic paradigm. Mixed-methods research was conducted (Ivankova, Creswell & Plano Clark, 2010) and a sequential explanatory mixed-methods approach was used where the quantitative research was accorded priority over the qualitative research (QUAN + qual). The quantitative facet of the research was given priority over the qualitative aspects. We were particularly interested in involving a sufficiently large group of participants (300) across two education districts for generalisation purposes. The qualitative study enabled us to further clarify and explain the outcomes of the research, hence our choice of a sequential explanatory mixed-method research design.

##### **Sample/Participants/Respondents**

Sampling for the quantitative phase occurred in two parts. In the first part, two education districts were chosen from the six education districts in Lagos State. The two districts selected were based on their proximity to one of the researchers. One school was chosen from each district. The districts and schools were proportionally sampled in terms of size, the number of students per class, and gender. Secondly, a sample was randomly selected from the class register (class list) of each school. One

hundred and fifty participants were selected per school. In the qualitative phase of the study, two focus-group interviews were conducted to gather data from 20 participants (10 per school). These participants were sampled from those engaged in the quantitative phase based on three main categories. Firstly, the participants were selected to include an equal number of males and females (10 each). The second category was based on the participants' level of achievement in mathematics. In addition, students who achieved 65% and above were regarded as high achievers while others were categorised as non-achievers. The third category was based on their SES which was further categorised into high and low SES. The SES was based on the participants' parents' employability. Participants where both father and mother were employed were categorised as high SES while those participants where one of the parents was employed or both parents were unemployed were categorised as low SES.

#### Instruments/Measures

##### *Attributional style questionnaire*

In this study we used Dykema et al.'s (1996) version of the negative attributional style questionnaire (ASQ) to measure the participants' AS. The questionnaire was a 7-point Likert scale and was adapted to suit the purpose of the study. The first section of the questionnaire gathered demographic information, such as age, participants' gender, the total number of family members and the employability of the parents. This information was used to indicate the differences in educational resources and facilities available to the participants; they were categorised into low and high socioeconomic status groups. The second section comprised 12 different unfortunate events or negative situations to which the participants had to react. In each of the informative events, participants were asked to write a cause for the negative situations provided, followed by answering two questions that followed the cause provided. These two questions in a situation measured the two attributional dimensions in which the respondents were expected to indicate whether their actions were respectively stable or unstable and global or specific. The third part of the questionnaire contained four questions also on a 7-point Likert scale regarding the students' attitudes towards mathematics.

##### *Mathematics performance score*

The participants' actual mathematics performance was measured by using the mathematics examination scores, which was made available by the school principals. The mathematics scores were used in correlation with the AS scores and the scores indicating the students' attitudes towards mathematics as well as socio-demographic factors, by performing multiple regression analysis.

#### *Focus-group interviews*

The participants for the focus-group interviews were selected from the sample used in the quantitative phase through the purposive sampling technique. The focus-group interviews were designed to gain an understanding of the participants' perceptions of the study instrument and their attitudes towards mathematics.

#### Procedure/Intervention

The participants were informed about the nature and purpose of the research and assented before participating. The students were not pressurised or manipulated to participate in the study in any way and they agreed to participate. The participants first completed the AS questionnaire after which the focus-group interviews were held on a different day.

#### Ethical Issues

Prior to data generation, ethical permission was obtained from the Ethics Committee of the Faculty of Education, University of Pretoria. The participants were asked to provide informed assent or consent (as indicated), informed that their participation was voluntary and assured that they could opt out of the process at any stage without any penalty or loss of benefit. As the majority of participants were under-aged (between 12 and 20 years), parental consent, too, was obtained where applicable. The research participants also completed and submitted informed consent forms indicating their willingness to participate in the research. The participants' right to privacy and confidentiality of information was ensured and protected throughout the study.

#### Data Gathering or Data Generating Approaches

Survey research was conducted to generate quantitative data while focus-group interviews were conducted to generate qualitative data.

#### Data Analysis and Interpretation/Analytic Procedures/Style (Qualitative Research) and Statistical Procedures (Quantitative Research)

Data analysis in this mixed-methods study was achieved through descriptive and inferential statistics in the quantitative research. The frequency tables and descriptive statistics were based on the demographic data that emerged from the questionnaire. The two study constructs (stability and globality) and the score for attitude towards mathematics were calculated by averaging across the relevant items. Cronbach's alpha coefficients were also computed to indicate the internal reliabilities of the study constructs. For the inferential statistics, correlation coefficients and multiple regression analysis were used to analyse the constructs in terms of their relationships. In the qualitative study, the conversation analysis was used to analyse data generated from focus-group

interviews. Finally, the quantitative as well as the qualitative data were integrated at the interpretation stage (Onwuegbuzie & Teddlie, 2003).

#### Rigour of the Study

Integrity of the research throughout the research process, especially with regard to quality assurance of the data gathering and analysis, was upheld. To ensure the integrity of the research process, trustworthiness of the research in terms of credibility, transferability, dependability and confirmability were adhered to. The participants had access to the interview guide and, after the transcriptions, were given the opportunity to ensure that what they had said was reported accurately. To have absolute confidence in the research, the participants were encouraged to ask questions about risk issues in person or to contact the first author by email or telephone.

#### Results

The first secondary research question (“How do stability and globality ASs relate to students’ performance in mathematics?”) is discussed below.

Bivariate Pearson correlation coefficients were calculated between the two sub-scales, stability and globality, and the students’ performance in mathematics. The real mathematics marks that the study participants had scored in their previous term were used as actual mathematics marks. Neither the correlation coefficient between the actual mathematics marks and stability ( $R = -0.03$ ;  $p = 0.643$ ) nor the correlation between the actual mathematics marks and globality ( $R = -0.08$ ;  $p = 0.162$ ) was significant. The results indicate that there was no significant correlation between the two sub-scales (stability and globality) ASs, and mathematics performance.

The aim of the secondary research question (“How well do stability and globality as well as gender and socio-economic factors predict mathematics performance?”) was to explore how accurately the stability and globality scales, as well as gender and SES, predicted the mathematics marks of the participating students. This question

was explored by performing multiple regression analysis, with mathematics marks as dependent variable and the stability and globality scales, gender, and SES as explanatory or independent variables. Gender and SES were categorical variables in the study, but since both had only two categories, they could be included as explanatory variables in the regression analysis.

The multiple regression model, which included all four explanatory variables, showed a poor fit ( $p = 0.172$ ); not one of the parameter estimates differed significantly from zero at the 5% level of significance. The explanatory variables were subsequently omitted from the regression analysis one by one, starting with the variable with the largest  $p$ -value and then rerunning the regression analysis. The final model showed a moderate fit ( $p = 0.097$ ), with gender the only remaining explanatory variable ( $p = 0.097$ ). Although gender was significant only at the 10% level, it was decided to do separate analyses of the two gender groups with the stability and globality scales, as well as SES, as explanatory variables. The results are first discussed for female and then for male students. When viewed together, the two scales (stability and globality) had very little or no predictive power regarding mathematics performance when analysed with gender and SES.

#### Multiple Regression Analysis of Mathematics Marks for Girls – Model 1

The results of the multiple regression analysis performed on the data for the girls appear in the tables below. The model fitted the data well ( $F = 4.883$ , degrees of freedom = 3 and 151,  $p = 0.003$ ). This meant that the  $F$ -value, which was significant with the  $p$ -value lower than 0.05 for the predicted model for girls, showed that mathematics performance (dependent variable) was indeed affected by stability, globality, but not by SES (independent variables).

The multiple regression analysis for mathematics marks for girls (Model 1) is shown in Table 1.

**Table 1** Multiple regression analysis of mathematics marks for girls – Model 1

Model		<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	Sig.
1	Regression	2041.90	3	680.63	4.883	.003
	Residual	21048.33	151	139.39		
	Total	23090.22	154			

*Note.* Dependent variable: mathematics marks verified. Predictors: (constant), socio-economic status, stability, globality. Sig. means the level of significance.

The estimated regression coefficients are

shown in Table 2.

**Table 2** Table for the estimated regression coefficients<sup>1</sup>

Model		Unstandardised coefficients		Standardised coefficients			Collinearity statistics	
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	47.41	10.05		4.72	< 0.001	.444	2.25
	Stability	8.07	2.63	.36	3.07	.003	.442	2.26
	Globality	-7.5	2.04	-.43	-3.69	< 0.001	.994	1.01
	Socio-economic status	2.35	2.13	.087	1.10	.271		

*Note.* Dependent variable: mathematics marks verified. VIF = variance inflation factor.

Since the coefficient for SES was not significantly different from zero ( $p = 0.271$ ), this variable was omitted from the model, and a final multiple regression analysis was performed (Model 2).

#### Multiple Regression Analysis of Mathematics Marks for Girls – Model 2

The following results were obtained for Model 2 in Table 3.

**Table 3** Multiple regression analysis of mathematics marks for girls – Model 2

Model		SS	df	MS	F	Sig.
1	Regression	1872.09	2	936.04	6.71	.002
	Residual	21218.13	152	139.59		
	Total	23090.22	154			

Note. Dependent variable: mathematics marks verified. Predictors: (constant), globality, stability.

The model fitted the data ( $F = 6.706$ , degrees of freedom = 2 and 152,  $p = 0.002$ ). The regression

coefficients are shown in Table 4.

**Table 4** Regression coefficients of mathematics marks for girls – Model 2

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	47.47	10.05		4.72	< 0.001	.444	2.25
	Stability	8.03	2.63	.36	3.05	.003	.444	2.25
	Globality	-7.37	2.03	-.42	-3.63	< 0.001		

Note. Dependent variable: mathematics marks verified.

The equation for regression Model 2 is provided below.

Mathematics marks of girls =

$$47.47 + 8.03 \times \text{stability} - 7.37 \times \text{globality}$$

The results indicate that stable AS for negative events had a positive effect on mathematics performance while global AS for negative events had a negative effect on mathematics performance.

The next paragraph explores the relationship between the mathematics marks and the stability

and globality scales as well as the SES of boys.

#### Regression Analysis of Mathematics Marks for Boys – Model 1

A multiple regression analysis (cf. Table 5) was also performed on the data for male students who participated in the survey. The results of the analysis are presented in the tables below. The model fitted the data well ( $F = 3.911$ , degrees of freedom 3 and 141,  $p = 0.010$ ).

**Table 5** Multiple regression analysis of mathematics marks for boys – Model 1

Model		SS	df	MS	F	Sig.
1	Regression	1874.87	3	624.96	3.911	.010
	Residual	22530.49	141	158.79		
	Total	24405.35	144			

Notes. Dependent variable: mathematics marks verified. Predictors: (constant), socio-economic status, stability, globality.

The regression coefficients for the stability scale and SES (cf. Table 6) differed significantly from zero at the 5% level of significance ( $p = 0.036$  and  $p = 0.009$  respectively). The regression

coefficient for the globality scale differed significantly from zero at the 10% level of significance ( $p = 0.009$ ).

**Table 6** Regression coefficients for stability, globality, and socio-economic status for boys – Model 1

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	57.39	12.26		4.68	< 0.001		2.14
	Stability	-6.03	2.84	-.25	-2.12	.036	.47	2.17
	Globality	5.66	2.96	.23	1.91	.058	.47	1.01
	Socio-economic status	-6.13	2.32	-.21	-2.637	.009	.99	

Note. Dependent variable: mathematics marks verified.

The equation for regression Model 1 for boys appears below:

Mathematics marks for boys =

$$57.39 - 6.03 \times \text{stability} + 5.66 \times \text{globality} - 6.13 \times \text{socio-economic status}$$



The statistical findings relating to the third secondary research question are discussed below.

Multiple regression analysis was used to explore the influence of SES and attitude on mathematics performance. The mathematics performance of male and female students was investigated by analysing separate multiple regression models for the two groups.

**Attitudinal Scale**

The students' attitudes towards mathematics was measured by their responses to four statements:

- I will use mathematics in my career one day.
- I am motivated to do well in mathematics.
- I know where to find help when I struggle with mathematics.
- I get anxious when I do mathematics.

The first step was to get an idea of the internal reliability of the attitudinal scale. Before the internal reliability of these four items could be calculated, Item 4 was reverse-coded so that it reflected a positive attitude towards mathematics.

Cronbach's alpha across the four items was low ( $\alpha = 0.310$ ), but further examination revealed that if Item 4 were deleted, Cronbach's alpha would increase to 0.635.

Scores for the students' attitude towards mathematics were computed by calculating the average across Items 1, 2, and 3. The attitudinal score had an average of 6.1, a standard deviation of 0.92, with a minimum of 1 and a maximum of 7. Since the average of 6.1 was close to 7, the maximum of the scale, it implied that on average the students had a very positive attitude towards mathematics. The influence of the attitudinal scale and SES on mathematics marks was further explored separately for female and male students.

**Multiple Regression Analysis of Mathematics Marks for Girls – Model 1**

The results in Table 7 show a poor model fit ( $F = 1.104$ , degrees of freedom 2 and 152,  $p = 0.334$ ).

**Table 7** Multiple regression analysis of mathematics marks for girls – Model 1

Model		SS	df	MS	F	Sig.
1	Regression	330.58	2	165.29	1.104	.334
	Residual	22759.64	152	149.73		
	Total	23090.22	154			

Note. Dependent variable: mathematics marks verified. Predictors: (constant), socio-economic status, attitude\_3 items.

The regression coefficients for the attitudinal scale and SES in Table 8 were also not statistically

significant ( $p = 0.229$  and  $p = 0.417$  respectively).

**Table 8** Regression coefficients for the attitudinal scale and socio-economic status for girls

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	46.65	7.38		6.323	< 0.001		
	Attitude_3 items	1.22	1.01	.10	1.29	.229	.998	1.0
	Socio-economic status	-1.79	2.20	-.07	-.81	.417	.998	1.0

Note. Dependent variable: mathematics marks verified.

Following an approach similar to that followed in the statistical analysis of the second research objective, the variable with the largest  $p$ -value was omitted and the regression analysis rerun.

**Simple Regression Analysis of Mathematics Marks for Girls – Model 2**

After SES was omitted from the regression model, the results in Table 9 again indicate a poor model fit ( $F = 1.549$ , degrees of freedom 2 and 153,  $p = 0.215$ ).

**Table 9** Simple regression analysis of mathematics marks for girls

Model		SS	df	MS	F	Sig.
1	Regression	231.38	1	231.38	1.55	.215
	Residual	22858.84	153	149.40		
	Total	23090.22	154			

Note. Dependent variable: mathematics marks verified. Predictors: (constant), attitude\_3 items.

The regression coefficient for attitude towards

mathematics was also not significant ( $p = 0.215$ ).

**Table 10** Regression coefficient for attitude towards mathematics marks

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	43.36	6.16		7.03	< 0.001		
	Attitude_3 items	1.26	1.01	.10	1.24	.215	1.000	1.000

Note. Dependent variable: mathematics marks verified.

Table 10 shows that in the case of female students, their attitude towards mathematics was not a statistically significant predictor of their performance in mathematics.

The equation for regression Model 2 for girls appears below:

$$\text{Mathematics marks for girls} = 43.36 + 1.26 \times \text{attitudinal scale}$$

#### Multiple Regression Analysis of Mathematics Marks for Boys – Model 1

The multiple regression model of mathematics marks on the attitudinal scale and SES (cf. Table 11) for the 145 male students showed a good fit ( $F = 3.995$ , degrees of freedom 2 and 142,  $p = 0.021$ ).

**Table 11** Multiple regression analysis of mathematics marks for boys – Model 1

Model		SS	df	MS	F	Sig.
1	Regression	1300.03	2	650.06	3.995	.021
	Residual	23105.32	142	162.71		
	Total	24405.35	144			

Note. Dependent variable: mathematics marks verified. Predictors: (constant), socio-economic status, attitude\_3 items.

The regression coefficients for the multiple regression are shown in the Table 12.

**Table 12** Regression coefficients for mathematics marks for boys

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	35.05	8.39		4.18	< 0.001		
	Attitude_3 items	1.34	1.25	.088	1.08	.283	.991	1.009
	Socio-economic status	5.86	2.35	.205	2.50	.014	.991	1.009

Note. Dependent variable: mathematics marks verified.

The regression coefficient for the male students' attitude towards mathematics (cf. Table 12) was not statistically significant ( $p$ -value = 0.283). However, the regression coefficient for SES differed significantly from zero at the 5% level of significance ( $p = 0.014$ ).

A final regression model of performance in mathematics with SES was fitted. The results are discussed in the next section.

#### Simple Regression Analysis of Mathematics Marks for Boys – Model 2

The simple regression model of mathematics marks as dependent variable and SES for the male students as explanatory variable (cf. Table 13) showed a good fit ( $F = 6.820$ , degrees of freedom 1 and 143,  $p = 0.010$ ).

**Table 13** Simple regression analysis of mathematics marks for boys – Model 2

Model		SS	df	MS	F	Sig.
1	Regression	1111.02	1	1111.011	6.820	.010
	Residual	23294.34	143	162.90		
	Total	24405.35	144			

Note. Dependent variable: mathematics marks verified. Predictors: (constant), socio-economic status.

The regression coefficient for SES (cf. Table 14) differed significantly from zero ( $p = 0.01$ ). The estimated regression coefficient for

SES was -6.102, representing the average decrease in the mathematics marks of male students if their SES changed from 0 (high SES) to 1 (low SES).

**Table 14** Regression analysis of socio-economics status for the boys

Model		Unstandardised coefficients		Standardised coefficients		Collinearity statistics		
		B	SE	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	55.126	1.26		43.84	< 0.001		
	Socio-economic status	-6.102	2.34	-.21	-2.61	.010	1.000	1.000

Note. Dependent variable: mathematics marks verified.

The equation for regression Model 2 for boys appears below:

Mathematics marks for boys =

55.13 - 6.10 x socio-economic status

The results imply that in the case of male students, their SES was a statistically significant predictor of their performance in mathematics ( $p = 0.01$ ).

### Discussion

In the first instance we hypothesised that there was a relationship between stability and globality AS and mathematics performance. Secondly, we hypothesised that stability and globality as well as gender and socio-economic factors predicted mathematics performance. Thirdly, we hypothesised that socio-demographic and attitudinal factors influenced mathematics performance. The analysis of the results is discussed below.

#### How Do Stability and Globality Attributional Styles Relate to Mathematics Performance?

Houston (2019) maintains that stable/unstable attribution styles emerge when individuals believe that an outcome will continue indefinitely or will be specific for a period of time. Global/Specific attribution styles relate to individuals who see outcomes as consistent and affecting many features of life activities or, conversely, who believe that outcomes are specific to a particular situation alone. From a stability and globality AS perspective, students' success or failure in mathematics depends on their interpretation of their particular situation, vis-à-vis, mathematics. We found no significant relationship between AS and mathematics performance in our research. This finding was inconsistent with the theoretical position of the study as the RLHT, on which the study was based, predicts that an internal and/or stable and global AS for negative events will correlate significantly negatively with poor academic performance in mathematics. In our study, however, neither the correlation coefficient between the actual mathematics marks and stability nor the correlation between the actual mathematics marks and globality were significant. It emerged that some of the findings of our study were inconsistent with those of some earlier studies (Gordeeva, Sheldon & Sychew, 2019; Maleva, Westcott, McKellop, McLaughlin & Widman, 2014). The study by Gordeeva et al. (2019)

consisted of two parts. Firstly, the authors found that a positive AS correlated positively with and predicted good academic performance. Secondly, they found that a negative AS correlated positively with poor academic performance. Both findings were consistent with the RLHT. However, in our study, we found that a negative AS correlated with good academic performance. This finding is not consistent with RLHT. The outcomes of our study thus do not support the findings by Gordeeva et al. (2019), namely that only a positive AS can advance good academic performance. Against the theoretical position of RLHT, we theorise that various reasons (whether temporary or permanent, positive, or negative AS) can be given for students' success or failure. In fact, failure could motivate them to succeed in their future academic endeavours. The results of our study imply that whether positive or negative, stability and globality ASs correlate positively with mathematics performance. The relationship between AS (whether positive or negative, significant, or not significant) and academic performance varies according to the academic ability and/or achievement context and is not based on the mood of the students alone (as stipulated in RLHT). If students regard assignments in mathematics as important, improved performance is more likely to be observed than decreased performance. In this regard, the theoretical position was supported and maintained by the studies of Houston (2016) and Yee, Pierce, Ptacek and Modzelesky (2003). However, some of the findings were consistent with the findings of other researchers (LaForge & Cantrell, 2003; Morris & Tiggerman, 2013; Richards, 2012).

#### How Well Do Stability and Globality as well as Gender and Socio-economic Factors Predict Mathematics Performance?

For the stability scale, the female as well as the male students' stable AS yielded positive effects on mathematics performance. In other words, the boys' and the girls' stability scales predicted success in mathematics. In the case of the globality scale, the boys and the girls achieved positive global ASs. However, whereas the girls' positive global AS influenced their mathematics performance significantly, the opposite was found in the case of the boys. Furthermore, the findings revealed that the boys' SES was a predictor of

mathematics performance. In the case of the girls, though, the opposite was found.

Khodayarifard, Brinthaup and Anshel (2010) too found that stability and globality AS as well as gender and SES predicted mathematics performance of boys and girls differently. The effects of AS events are moderated by the significance of the task the person engages in (e.g. school examinations). Enhanced performance is more likely to occur than decreased performance if students regard an assignment as important (Yeo & Tan, 2012). In our study, the boys' and the girls' stability scores predicted success in mathematics. The girls' globality scores also predicted success in mathematics. Interestingly, Wilhelm (2009) suggests that female students are showing more interest in subjects previously predominantly popular with male students such as mathematics and science (Wilhelm, 2009).

The boys' SES emerged as a predictor of mathematics performance. Regarding socio-economic factors, the findings of the study reveal that the efforts made by family members and acquaintances to improve their children's performance in mathematics included their financial commitment in providing mathematical textbooks and other necessary materials for their children. Most of the study participants reported the positive support, both financially and materially, they had received from their different homes to improve their performance in mathematics. The findings also reveal the determination of the less privileged students to acquire knowledge and excel in mathematics despite their poor family backgrounds. These findings agree with the findings by Atalmis, Yilmaz and Saatcioglu (2016) who found that SES played a significant role in predicting the mathematics performance of the students in their research. Tucker-Drob and Harden (2012) also maintain that mathematics performance is influenced positively by high SES. The literature also indicates that students with high SES are more likely to fare better academically than those with low SES (Alordiah, Akpada & Oviogbodu, 2015; Ewumi, 2012).

#### What is the Influence of Socio-demographic and Attitudinal Factors on Mathematics Performance?

The findings reveal a significant influence of the boys' SES on mathematics performance, unlike that of the girls. Only the boys' SES influenced their mathematics performance positively (which was not the case with the girls). We can only speculate on why this was the case (based on some general observations of university colleagues and senior mathematics teachers in Nigeria) (e.g. Aniwu, 2019; Ezeah & Achonwa, 2015; Fareo & Ateegu, 2020). In Nigeria, based on their culture or religion, some families sometimes deprive their

female children of the benefits that their male children enjoy. Parents at times give more attention to boys than girls believing that girls' education ends in the "kitchen", and accordingly, they invest more in the education of their male than their female children. Female children also engage more in domestic work (when they could be studying) than the male children. As a result, boys tend to be more serious about doing well in mathematics than girls. In addition, fear of failure in mathematics is more common among girls than boys with the result that fewer girls than boys are interested in studying mathematics. Furthermore, male children tend to engage more readily in educational technological-related activities than female children, which may have a positive influence on their study of mathematics.

Çelik (2018) found in his research that gender, SES, and the attitudes of students were important variables that influenced mathematics performance. The literature also indicates the significance of these three variables (gender, SES, and attitudinal factors) in mathematics performance (George & Adu, 2018; McConney & Perry, 2010; Sakariyau et al., 2016). Goldin (2002) argues that in any mathematics undertaking, attitude determines the level of good or poor performance. He adds that, in a mathematics class, students may develop negative or positive attitudes, which may be stable and have affective as well as cognitive features.

In our study, the analysis of stable and global AS, as well as the analysis of the effects of the moderating variables (gender, socioeconomic status and mathematics attitude), provide clarifications of the relationships between AS and mathematics performance. Consequently, the results of our study pose a challenge to traditional theories of the impact of AS on academic performance in general and mathematics performance in particular (Gordeeva et al., 2019).

#### Strengths and Limitations

Researchers on AS and mathematics performance have identified various shortcomings in their studies. For instance, most studies on AS and the mathematics performance of students have been conducted using quantitative methods (Basturk & Yavuz, 2010; Morris & Tiggerman, 2013; Nokelainen, Tirri & Merenti-Välämäki, 2007). Ideally, the results of quantitative studies should be supported by other methods, such as interviews. Accordingly we complemented the quantitative data with qualitative data obtained through focus-group discussions. Another strength of the study was its ability to glean students' attitudes towards mathematics as one of the moderating variables. To the best of our knowledge, no previous studies have related the attitude of students with different ASs to mathematics performance.

In addition, we investigated AS in the context of mathematics achievement in relation to gender, SES and mathematics attitude. Previously, studies on AS and mathematics performance predominantly focused on academically advantaged students only (Houston, 2016; Morris & Tiggerman, 2013). Research on AS and mathematics performance has not been studied extensively in Nigeria or other African countries (as well as other Global South countries) as compared to the Western world (Nenty, 2010; Tachie & Chireshe, 2013). From a cross-cultural point of view, this study could be added to the international literature for comparison and other purposes.

The outcomes of this study could contribute to a greater understanding of AS in respect of two major AS theoretical constructs – stability and globality. The study could, therefore, add to the existing literature on students' AS and their academic performance. The results of the study could also help in reconceptualising the potential of AS in achieving educational goals and add to the knowledge on the extent to which students' AS could impact the quality of mathematics performance specifically and academic performance generally. The study outcomes could furthermore sensitise teachers on selecting or adapting instructional techniques that could positively impact students' causal attributions and enhance the quality of their academic performance and work habits. Likewise, the outcomes could offer important insights into the educational, cultural, and emotional challenges that students face. In a practical sense, the outcomes of the study enhance school administrators' existing knowledge regarding students' needs, which, in turn, could help them devise policies to meet such needs. The outcomes could create awareness in public schools in Nigeria about the benefits of using AS to motivate students to study mathematics in particular and other subjects in general. The findings of the study could also help school psychologists and guidance counsellors design programmes that could assist students in achieving their life goals and living purposeful lives by bolstering their attributions.

The following factors could be considered limitations of the study. Firstly, the use of the ASQ domain-general instead of the domain-specific could conceivably have affected the outcomes of the study. Secondly, the truthfulness or not of the participants (students) in completing the questionnaire could be considered a limitation. Thirdly, the study was limited to two education districts in Lagos State, and the results should therefore not be extrapolated to all education districts in Nigeria. The views expressed by the

participants might or might not align with those of students in other education districts. The last factor is the dearth of literature on AS and mathematics performance. This matter could have limited the depth of the discussion of our research.

#### Recommendation for Future Research

Our study should be replicated with different samples in rural and urban contexts. An AS questionnaire that covers academic issues, such as an Academic Attributional Style Questionnaire (AASQ), should be considered. Future studies should include the following variables as moderators for the AS and mathematics performance of students: students' adjustment to school environments, students' attitudes towards school, and mathematics teacher training and experience. In addition, such studies should compare the performance of rural and urban students (especially regarding the influence of being economically disadvantaged on performance on mathematics). A new attributional scale should be developed in a developing country context (such as Nigeria or any other African country). Such a scale could be exported to and adapted elsewhere in the world as well. Better still, the scale should be developed jointly by teams from across the world.

#### Conclusion

There is a dearth of students passing senior secondary school with satisfactory marks in mathematics. So many mathematics students suffer trauma in their attempts to pass the subject. Moreover, the impact that failure in mathematics has on their personal and professional lives is substantial because the economies of all countries are driven by gateway subjects such as mathematics. Therefore, the importance of dealing with other factors in mathematics achievement (such as students' AS, that relates in a variety of ways to mathematics performance over and above socio-demographic and attitudinal factors) cannot be underestimated. Viewed through this lens, we hope that this study will help resolve some of the challenges that so many students face in their attempts to pass mathematics. Hopefully, that will enhance their chances of qualifying for fields of study that will help them not only find jobs but also become employable, live successful and meaningful lives, rekindle their sense of hope, and make meaningful contributions to the economy and the social well-being of all citizens.

#### Authors' Contributions

AO Lapite wrote the manuscript and provided data for all tables; JG Maree provided support, supervised and added to the manuscript; JG Maree and J Jordaan conducted all statistical analysis. All authors reviewed the final manuscript.

## Notes

- i. Effect sizes were calculated for all regression analyses. The  $R^2$  values were consistently very low, possibly because so many factors that played a role in this study were not considered as that was not the purpose of the research. The practical significance was, therefore, very low throughout.
- ii. Published under a Creative Commons Attribution Licence.
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