

Effects of Teachers' Self-Concept, Teaching Methods and Students' Attitudes on Mathematics Trial Examination Performance in Senior Secondary Schools in Bauchi State, Nigeria

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Abstract

Persistent underachievement in mathematics among senior secondary school students in Bauchi state, Nigeria, has raised concerns about the underlying factors contributing to this issue. Thus, this study investigated the effects of teachers' self-concept, teaching methods, and students' attitudes towards learning relate to students' performance in mathematics trial examinations. Although existing research has considered these factors individually, their combined effects within the context of Bauchi state remains unexplored. Specifically, this study aimed to determine the predictive strength of these three variables on students' performance in mathematics. A causal-comparative and correlational research design was used, involving 133 mathematics teachers and 381 senior secondary students from 25 public schools in Bauchi State, selected via random sampling. Four instruments were used: the Mathematics Teaching Methods Questionnaire (MTMQ), Teachers' Self-Concept Questionnaire (TSQ), Students' Attitude towards Mathematics Questionnaire (SAMQ), and Mathematics Trial Examination Records (MTER). Analysis with Partial Least Squares Structural Equation Modeling (PLS-SEM) revealed that teachers' self-concept significantly impacted student performance (path coefficient = 0.066, $p = 0.007$). Teaching methods and students'

attitude were not significant predictors. However, the combined indirect effect of teachers' self-concept and teaching methods was significant (path coefficient = 0.521, $p = 0.000$).

Keywords: Mathematics Performance, Teachers' Self-Concept, Teaching Methods, Students' Attitudes, Trial Examination

Introduction

Although the current education agenda is moving away from examination-oriented education, examination still holds an important place as a summative method to determine students' achievement in subjects against their peers. In numerous countries worldwide, educators are increasingly concerned about the determinants of student success, particularly in external examinations (Farooq, Chaudhry, Shafiq and Berhanu, 2011; Asamoah, Sundeme, Atta, Adom-Fynn, Ebow and Afrane, 2020).

Ramatlala and Nenty (2014) posited that student performance in trial examinations is a significant indicator that may correlate with performance in external senior secondary certificate examinations. This supports the assertion by Omirim and Ale (2008) that, trial examinations are selective, predictive, and diagnostic. This also demonstrates how teachers' instruction comprehended by students, equips them for future assessments and identifies those likely to succeed or fail in the Senior Secondary Certificate Examination (SSCE). Ultimately, this gives students as well as teachers opportunity to formulate strategies to rectify any misconceptions or challenges faced by students prior to the final examination.

Background of Study

With all the importance of Mathematics as one of the core subjects in Nigerian education system, it is disheartening however, to note that poor performance is recorded in public examinations in recent times in Bauchi state. This poor performance in mathematics in Bauchi state, according to Umar, Adamu and Abdullahi, (2014); Ojimba, (2018) said that this has a source from the students, teachers and as well as government itself, but the most critical factors that affect students' performance are teachers and students' factors (Karadag, 2012).

The West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) SSCE are qualifying examinations for entry into universities and other post-secondary institutions, offered to third-year Senior Secondary Students' (SS3). The elevated failure rate in mathematics SSCE has generated significant concern among students, parents, educators, government entities, and other pertinent stakeholders in WASSCE and NECO SSCE examinations. The annual failure rate of students in WASSCE mathematics is alarmingly high, necessitating the immediate attention of all key stakeholders to implement urgent remedial measures (Aina, 2012; Apata, 2019).

Nigeria Students' Performance in SSCE Mathematics Examination

Table 1

Statistics on Students' Performance of Public Schools in WASSCE Mathematics in Bauchi state from 2019-2021

S/N	Year	Total No. Sat	Credit Mathematics in	% Pass	% Fail
1	2019	36095	14222	39.4	60.6
2	2020	12557	5310	42.3	57.7
3	2021	12268	9266	75.5	24.5

Source: West Africa Examination Council through the National Bureau of Statistics (2024)

A total of 36095 candidates in public secondary schools in Bauchi state out of 1.58 million candidates in Nigeria sat for WASSCE in 2019. About 14222 (39.4%) candidates got 5 credits and above including mathematics while 60.6% could not get the minimum entry qualification for admission to university or any tertiary institutions in Nigeria. In 2020, the total candidates who sat for mathematics examination in Nigeria decreased to 1.3 million about (3.2%) from that of 2019. In Bauchi State the number of candidates also decreased to 12557 candidates in 2020. About 5310 candidates got 5 credits and above in mathematics constituting about 42.3 % pass level where 57.7 % failed to get the minimum requirement for admission to Nigeria Universities. In 2021, there was little decline in the number of candidates who sat for the examination but experienced a sharp and tremendous increase in students' performance in mathematics. About 9266 (75.5%) candidates obtained 5 credits and above including mathematics while 24.5% failed in the WASSCE examinations.

Nigerian Students' Performance in Trial Examination

The trial mathematics examination, part of the continuous assessment component and conducted several months prior to the national exams, has been employed as a metric and forecaster of performance in those examinations. Consequently, researchers anticipated that students' performance in the trial test would enhance their outcomes in the national examinations (Andala, Digolo & Kamande, 2014). Research regarding the validity and reliability of Trial examinations as predictors for the Nigerian SSCE examination and similar assessments globally has determined that they are very dependable (Onyebuenyi, 2009; Achor, Agogo & Orokpo, 2011; Joshua, 2014; Okey, Charles-Ogan & Ochuba, 2015).

Trial Examination Performance in Bauchi State

Table 2

Performance of Students in Mathematics Trial Examination from 2014 - 2022 in Bauchi State

Examination Year	No. of Student sat	No. passed	Percentage Passed (%)	No. Failed	Percentage Failed %
2014	26321	11259	42.78	15062	57.22
2015	28685	13012	45.36	15673	54.64
2016	29514	14296	48.44	15218	51.56
2017	36419	19232	52.81	17187	47.19
2018	22187	11012	49.63	11175	50.37
2019	21203	13011	61.36	8192	38.64
2020	35500	14,500	59.15	21000	40.85
2021	36201	15798	43.64	20403	56.36
2022	38300	16300	42.56	22000	57.44

Source: Ministry of Education Bauchi, Bauchi State (2024)

Table 2 illustrates the trend of the mathematics trial test in Bauchi State, revealing that in 2014, only 42.78% of applicants passed the mathematics examination, while 57.22% failed. In 2015 and 2016, around 51.56% of students failed the Trial examination, while the pass rates were 45.36% and 48.44%, respectively. In 2017, the percentage of students passing the Trial increased to 52.81%, which is regarded as marginally above average. In 2018, performance decreased to 49.63%, with almost 50.37% failing the Trial mathematics examination in Bauchi State. In 2019 and 2020, the pass percentages significantly increased to 61.36% and 59.15%, respectively. However, the students' performance subsequently declined to 43.64% and 42.56% in the Trial examinations in Bauchi State, respectively.

The results of the mathematics trial examinations in Bauchi State indicate that students' performance has improved over the years, which is commendable when compared to previous years and suggests a positive outcome in the external SSCE examinations. The pattern of students' performance in the trial mathematics examination is marked by fluctuations, as illustrated in Table 2. The Bauchi state government funded indigene students who participated in public test and achieved a minimum of five credit passes in the trial examination, including English and Mathematics.

The theoretical framework for this study is based on David Lewis's Counterfactual Theory of Causation, which asserts that causal relationships are explained through counterfactual conditions. In this context, the performance of students in mathematics exams is linked to both teacher- and student-related factors. If teaching influences student performance, then teaching is considered the cause of the students' performance. The study posits that if these variables are counterfactual, they will affect students' performance in mathematics exams in Bauchi State's senior secondary schools.

Additionally, Walberg's theory of academic performance (1981) guides the study. Walberg suggests that a student's psychological characteristics and immediate environment influence academic outcomes. According to Walberg, classroom learning is determined by four main factors: student ability, motivation, the quality and quantity of instruction, and four

supplementary factors: the classroom environment, home conditions, peer group, and exposure to mass media.

Research Questions

The following research questions were answered in the study.

1. What are the path coefficients strength of relationship between teachers' self- concept, teaching methods and students' attitude toward performance in mathematics trial examination among senior secondary school students in Bauchi State?
2. What are the total effects of teachers' self-concept, teaching methods and students' attitude on mathematics performance among senior secondary school students' performance in Bauchi State?
3. What are the model fit indices for the structural equation model representing the relationships among the variable affecting performance of students in mathematics trial examination in Bauchi State?

Students' Attitude towards Learning Mathematics

In the context of mathematics classrooms, attitude refers to students' feelings regarding whether they like or dislike math lessons, teachers, and the classroom environment where learning occurs, which in turn affects students' achievement in mathematics in a positive or negative way.

Several studies have shown a positive correlation between students' academic achievement and their attitude. Amongst these factors, students' attitude towards mathematics is one important factor that has been studied consistently which shows a positive relationship between students' attitude and their academic performance. Studies conducted in different countries revealed that students' attitude towards mathematics affects and influences students' performance on mathematics either negatively or positively (Tahar, Ismail, Zamani & Adnan, 2010; Maat & Zakaria, 2010; Asikhia, 2010; Eme & Iniubong, 2011; Mohammed, Mahmood & Ismail 2011; Umar, Ismail & Mahmood 2018).

Teachers' Self-Concept

Teachers' self-concept is made up of a number of convictions, mindsets and presumptions about their professional values, relationships with students and colleagues, and their accomplishments as teachers. Teachers' self-concept determines the level of self-confidence, which is based on assessment of teachers' own value and belief that are capable, helpful and successful in overcoming feelings of hopelessness, pride and shame related to teaching mathematics.

Educators who are capable and ready to enhance their communication and teaching abilities have a better understanding of themselves and their students. Numerous academics have examined the same problem, which served as the basis for this investigation (Sadeghi et al. 2015; Sampthirao, 2016; Mbuva, 2016; Asma'a, 2016).

Mathematics Teaching Methods

Teaching methods refer to specific educational processes, each involving a variety of specialized activities. These methods use classroom exercises or strategies to support student learning. A teaching method also includes a set of ideas about the nature of learning applied

in the classroom. Research shows a clear link between teaching methods and students' academic performance (Hoque, Banu, Subramaniam & Islam, 2020).

However, a review of literature indicates that little research has been done on factors related to teachers and students that affect student performance in Bauchi State's public senior secondary schools. Furthermore, the relationship between students' trial examination results and their performance on senior school certificate exams in Bauchi has not been thoroughly explored.

Methodology

Design

The study adopted causal comparative (ex-post facto) to study how the independent variables have affected the dependent variables. Both the trial mathematics examination as well as the SSCE are externally developed and administered annually to SS3 students in Bauchi state.

Correlational research design was equally used to determine the interrelationship between the variables under investigation to understand the cause and effect of each variable on the meaningful path model that measured the direct, indirect and total effect using the path analysis approach to examine the effects of teacher and student-related variables on students' performance on a trial mathematics examination in secondary schools in Bauchi State.

Study Population

The target population consisted of all mathematics teachers and SS3 students enrolled in public senior secondary schools across Bauchi state. The accessible population included those who had participated in the 2024/2025 trial mathematics examination.

Sample

From the population, a sample of 25 public senior secondary schools was selected based on their consistent participation in the annual trial mathematics examination. The sample comprised 133 mathematics teachers and 381 SS3 students, representing the three educational zones in Bauchi State. A cross-sectional quantitative approach was adopted, focusing on the use of structured questionnaires and performance data to analyze variable relationships.

To determine the sample size of mathematics teachers in senior secondary school in Bauchi State, the researchers adopted the Krejcie and Morgan (1970) table to determine sample size for students from a large population for research activities.

Sampling Technique

The simple random sampling technique was selected due to its ability to provide high representation of various demographic strata. The public Senior Secondary Schools in the 20 Local Government Areas of Bauchi State are categorized into three educational zones: Bauchi educational zone, Central educational zone, and Katagum educational zone.

Instrument for the Study

The instruments used for data collection included; Students' Attitude towards Mathematics Questionnaire (SAMQ), Teacher Self- Concept Questionnaire (TSCQ), Mathematics Teaching Method Questionnaire (MTMQ) and Mathematics Trial Examination Records (MTER).

Results and Discussion

The multivariate statistical techniques known as Partial Least Square- Structural Equation Modeling (PLS - SEM) using PLS smart 4 was employed.

Research Question 1

What are the estimates of strength of teachers' self- concept, teaching methods and students' attitude affecting performance of students in mathematics trial examination in senior secondary schools in Bauchi State?

Table 3

Beta coefficients (regression weights) of the variables

Path	Estimate (Beta-Coefficient)	S.E.	t- critical (C.E)	P	Label
Teachers' Self- Concept -> Performance	0.066	0.125	0.527	0.007	MS
Teaching Method -> Performance	-0.098	0.112	0.872	0.383	M
Students' Attitude Towards Mathematics-> Performance	0.345	0.281	1.228	0.220	M
Teachers' Self-Concept ->Teaching Method	0.521	0.115	4.542	0.000	MS
Teaching Method ->Students Attitude	0.173	0.159	1.087	0.278	M
Teachers' Self- concept -> Students' attitude	0.156	0.291	0.465	0.642	M

Note: S.E. is Standardized Estimates, C.R is Critical Ratio, Probability Label is significant at 0.05
M =Meaningful; MS = Meaningful and Significant.

Table 3 above shows that the following paths were significant:

The path from teachers' self-concept to student performance was both statistically significant ($\beta = 0.066$, $p=0.007 < 0.05$) and substantial in magnitude. This suggests that students tend to perform better in mathematics when their teachers exhibit strong confidence and belief in their instructional capacity. This aligns with prior findings by Sadeghi et al. (2015) and supports Walberg's theory, where teacher-related psychological factors influence learning outcomes. Similarly, the path from Teachers' Self-Concept to Teaching Method with the coefficient of 0.521 is meaningful and significant based on its p-value 0.000 which is less than 0.05.

Conversely, while students' attitudes and teaching methods showed positive path coefficients, they were not statistically significant. This may indicate that, although these

variables contribute to learning environments, they alone are insufficient predictors of short-term examination performance in Bauchi State's context, where instructional delivery and teacher identity may have a more immediate impact. The path from teachers' self-concept to mathematics performance with path coefficient of 0.066 is significant based on its p-value 0.007 that is less than 0.05.

The path from Teachers' Self-Concept to Teaching Method with the coefficient of 0.521 is meaningful and significant based on its p-value 0.000 which is less than 0.05.

The following paths were found to be meaningful but not significant:

The path from teaching method to mathematics performance with Path coefficient of 0.098 is meaningful but not significant based on its value 0.383 that is greater than 0.05.

The path from students' Attitude to mathematics performance with path constant of 0.345 is also meaningful but not significant based on its p-value 0.220 which is greater than 0.05.

The path from teachers' self-concept to students' attitude to mathematics with the coefficient of 0.156 is meaningful but not statistically significant based on its p-value 0.642 that is greater than 0.05.

The path from teaching method 0.173 to students' attitude towards mathematics 0.278 is meaningful but not statistically significant based on its p-value which is greater than 0.05.

Research Question 2

What is the total effect of variables affecting senior secondary school students' performance in mathematics Trial examination in Bauchi State?

Table 4

Total effect of variables affecting students' performance

Path	Teachers' Self-concept	Teaching Method	Students' Attitude towards Mathematics
Direct	-0.170	0.138	0.491
Indirect	0.018	0.160	0.168
Total Effect	-0.152	0.298	0.659

Note: Total effects of the variables on performance were 0.805 (the sum of total direct and total indirect effects).

The results from research question two revealed the overall impact of variables on students' performance in mathematics trial examinations in senior secondary schools in Bauchi State. The findings indicated that the overall impact of the variable teachers' self-concept (-0.152) was significant, as its p-value was below 0.05. This is a substantial correlation between the teacher self-concept variable and students' performance in mathematics trial examinations in senior secondary schools in Bauchi State. Consequently, this indicates that the overall effects of the variables impacted students' performance in the mathematics trial examination; conversely, the total effects of the teaching method (0.298) and students'

attitude towards mathematics (0.659) were deemed insignificant, as their total effects exceeded 0.05. The cumulative impact of these variables does not significantly influence the performance of in mathematics trial examinations in Senior Secondary Schools in Bauchi State.

Total effects reflect both the direct and indirect influence of each independent variable on student performance. The total effect of students' attitude (0.659) was the highest among the three variables, suggesting a strong combined influence, even if individual paths were not statistically significant.

This finding highlights the latent importance of students' attitudes, which may exert indirect influence through interactions with other variables such as teacher confidence or method of instruction. Although not statistically significant in isolation, the accumulated influence of positive attitudes may manifest in broader academic engagement and long-term achievement.

Research Question 3

What is the goodness of fit indices of the variables affecting performance of students in mathematics trial examination in Senior Secondary Schools in Bauchi State?

Table 5

Summary of Goodness of Fit Index

Model	CMIN	NFI	GFI	CFI	RMSEA
Default Model	32.348	0.926	0.218	0.743	0.0155
Saturated Model	32.058	0.934	0.965	0.934	0.0146

Key:

CMIN: Chi-square Mean Index

NFI: Normal Fit Index

GFI: Goodness-of-Fit Index

CFI: Comparative Fit Index

RMSEA: Root Mean Square Error Approximation.

The Chi-Square Mean Index (CMIN) measures the goodness of fit of a model, often used in SEM or CFA. It adjusts the chi-square statistic for model complexity, sample size, and degrees of freedom. A lower CMIN value suggests a better fit, while a higher value indicates a poor fit. CMIN which is a non-negative number helps researchers evaluate model fit, refine models, and compare different models. It provides an objective and standardized way to assess the effectiveness of a theoretical model. The Chi-square Fit index (CMIN) value obtained from the default model was 32.348 and the value of CMIN saturated model was 32.058. Since the chi-square value 32.348 and where the $p > 0.05$ is not significant, means that the default model was very good (moss, 2015). The Normal Fit Index (NFI) evaluates model fit by comparing it to a baseline model, with higher values indicating better fit. It helps researchers assess and improve model effectiveness. The Normal Fit Index (NFI) value of the default model was 0.926 and the value of NFI saturated model is 0.934. (Wuenssch, 2016; Ringle, Wende & Becker, 2024). A model is said to be good if the NFI is greater than 0.90. The default model was good since the NFI value (0.926) was greater than 0.90.

The Goodness of Fit Index (GFI) is used in techniques like structural equation modeling (SEM) to evaluate how well a model fits the data. A high GFI indicates a good fit, while a low GFI signals poor model fit, guiding necessary adjustments to the model. In educational research, GFI helps compare models and ensures the validity of conclusions by assessing how accurately the model reflects the data. The Goodness of Fit Index (GFI) value of default model was 0.218 and the saturated model was 0.965. A GFI value greater than 0.90 was said to show good model of fit (Wuensch, 2016). Since, the GFI of the default model was 0.965. This implies that the model was good.

The Comparative Fit Index (CFI) which ranges from 0 to 1 is used to assess how well a model fits the data in Structural Equation Modeling (SEM) by comparing it to a baseline model. The Comparative Fit Index (CFI) of default model was 0.743 and the saturated model was 0.934. According to Wuensch (2016) and Ringle, Wende & Becker (2024), an acceptable model of fit is one that has CFI value greater than 0.90, hence, the default model was good and acceptable. It helps evaluate model effectiveness and is less influenced by sample size. CFI is crucial for guiding model refinement and improvement.

The Root Mean Square Error Approximation (RMSEA) values range from 0 to 1, with lower values indicating a better fit. A value of 0 represents a perfect fit, while values above 0.08 suggest poor fit. Values of $RMSEA \leq 0.05$ indicate excellent fit, 0.05 to 0.08 indicate acceptable fit, and > 0.10 indicates poor fit.

The Root Mean Square Error of Approximation (RMSEA) value of default model was 0.0155 and saturated model was 0.0146. Since good model has RMSEA value less than 0.05, the RMSEA value of the default model was 0.0155. This indicates that the model was good (Moss, 2015).

Findings

The findings reinforce the centrality of teacher self-concept in student academic success. Teachers who perceive themselves as effective and competent appear more capable of motivating students and delivering content in a manner that enhances understanding and retention. This supports previous studies (e.g., Asma'a, 2016; Mbuva, 2016) that linked teacher identity with classroom outcomes.

Interestingly, teaching methods and student attitudes did not significantly predict performance on the mathematics trial examination. One possible explanation is that short-term academic outcomes like trial exams are more sensitive to teacher-related factors than to students' intrinsic motivation or preferences, especially in high-stakes or exam-focused environments such as Bauchi State's public schools.

These findings suggest that intervention strategies aimed at boosting student performance should prioritize teacher capacity building, including training that enhances professional self-efficacy. While student attitude and teaching strategies remain important, they may require longer timeframes or different assessment models to yield measurable impact.

The study found that teachers' self-concept directly and significantly affects students' performance in mathematics. Additionally, there is a significant indirect relationship between

teachers' self-concept and students' performance through teaching methods. However, several paths did not show significant relationships with student performance, including teaching methods to student performance, students' attitudes to performance, and the relationships between teachers' self-concept and students' attitudes, and between teaching methods and students' attitudes.

Conclusion

This study concludes that trial mathematics examinations serve not only as tools for assessment but also as indicators of broader teaching and learning dynamics within public senior secondary schools in Bauchi State. Among the variables examined, teachers' self-concept emerged as the most significant predictor of student performance, suggesting that a teacher's confidence and professional identity may be critical in shaping academic outcomes. In contrast, while teaching methods and students' attitudes were found to be positively related to performance, their effects were not statistically significant within the scope of this study. These findings support theoretical perspectives such as Walberg's theory of academic achievement and the Counterfactual Theory of Causation, both of which emphasize the importance of teacher-related factors in learning.

Practically, the study highlights the need for targeted teacher development initiatives that enhance instructional confidence and professional reflection. Educational stakeholders should consider integrating teacher self-concept enhancement strategies into professional training programs. However, given the limitations of a cross-sectional design and the localized sample, future research should adopt longitudinal approaches and consider additional mediating variables such as classroom environment or student engagement. Such efforts would further clarify the complex interactions influencing mathematics achievement in Nigerian secondary education.

The study employed Partial Least Square Structural Equation Modeling (PLS-SEM) to analyze how feedback from practice mathematics tests can help predict and improve students' performance in final examinations, focusing on senior secondary schools in Bauchi State. Grounded in the theory of parsimony and Ockham's razor, it emphasized eliminating insignificant correlations to simplify causal paths among variables. It examined the impact of teacher-related factors like self-concept and teaching methods, as well as student attitudes, on academic performance. The study identified the strength, direction, and total effects of these variables, along with model fit indices, to reveal the causal relationships influencing students' outcomes in mathematics trial SSCE examinations.

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