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RESEARCH ARTICLE

EFFECTS OF TEACHING QUALITY, TEACHING COMPETENCE, AND MATHEMATICS CONNECTION ON MATHEMATICS ACHIEVEMENT MOTIVATION AMONG SENIOR HIGH SCHOOL STUDENTS IN GHANA

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ABSTRACT

This survey assessed the direct effects of teaching quality, teaching competence and mathematics connection on mathematics achievement motivation in Senior high School students in Ghana. A descriptive survey was used in the study, which included 329 senior high school students from Barekese Senior High School. Prior to the main model estimation, preliminary studies such as Confirmatory Factor Analysis, convergent validity, discriminant validity, and internal consistency (Cronbach's Alpha) were computed. Amos (v.23) was used to do structural equation modeling (SEM) in order to assess the various assumptions. The results of path estimations revealed that mathematics connection positively and significantly influenced mathematics achievement motivation. However, teaching quality and teaching competence has no significant impact on mathematics achievement motivation.

KEYWORDS

Ghana, mathematics achievement motivation, mathematics connection, teaching competence, teaching quality

1. INTRODUCTION

For the past decades, nations have paid much attention to the advancements in teacher practice and students mathematics learning. Long term policies, expert training programs and professional developments were necessary. For example, in Ghana, four-years Bachelor of education degree (BED) in basic education replaced the initial three-years Diploma. This approach was analogous to UNESCO suggestions for improving teacher education. Later, licensure and promotion examinations were introduced to provide firm grounds for raising the standards of teaching (NTC, 2020). NTC (2020) view, that reforms of this nature are geared towards enhancing the professional, psychological, as well as affective practice of teachers in general, and mathematics teachers in particular. A study describes such policies to target and initiate programs that build certain qualities peculiar to teachers. Darling-Hammond (2000) noted, that licensing teachers by criteria such as degrees, examinations and content area expertise are the initial stages of quality and competence growth (Darling-hammond, 2000; Donkor and Amadu, 2014). Literatures revealed teaching quality, teaching competence and mathematics connection affect, to greater extent, students' performance, interest or self-efficacy in mathematics (Authors, 2019b; Authors, 2017; Boyd et al., 2007.; Goe, 2007; Goldhaber et al., 2015; Hanushek & Rivkin, 2006; Koomson et al., 2005; Ochieng et al., 2016; Sirait, 2016). These revelations can be noticed in one study in Germany (Blömeke et al., 2020).

The results showed competent teachers are capable of designing and implementing quality instructions that promote students' mathematics interest (Authors, 2019). Similarly, in Ghana, Authors (2019) found that instructor quality accounted for variations in students' interest in mathematics. Researchers examined the correlation between teacher quality and students' achievement (Bonney et al., 2015). Teachers depicted good academic and professional qualities but the achievement of students remained poor. Teacher quality was not seen to lead to higher performance as witnessed in other studies. Therefore, other understudied factors such as students' motivation shadowed the positive impact of teaching quality on students' achievement. In addition, from 1993 – 1994 schools and staffing surveys (SASS) and the national assessment in education policies, Darling-hammond (2000) argued that, be it in teacher preparation or certification, teacher quality determines the amount of students' achievement.

Similarly, some argued that teacher quality determines the quality of instruction and results in educational outcomes (Blömeke et al., 2020; Annan, 2020). The impact of teacher quality on students' performance leads to greater improvement (Authors, 2022; Blomeke et al., 2020).

"Teaching competence is an instructor characteristic which in the form of professional knowledge as well as affective and motivational skills" determines students' level of mathematics achievement. In a study, teaching competence significantly affected the reading skills of African-Americans (McRae, 2012). Teaching competence as testified by Annan (2020) is a key ingredient to the quality of instruction and students' performance in teaching and learning activities. Others agreed that teacher competence influences students' mathematics improvements. Ochieng et al., (2016) further went on to add that competent teachers are those who meet the professional standards of quality practice (Ochieng et al., 2016; Phin, 2014).

Mathematics connection involves the ability of teachers to relate mathematical concepts to real life applications and other subjects. Authors pointed that mathematics connection to the real world enables students explore the role mathematics play in explaining real life phenomena.

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Teachers identified link concepts to phenomena in the outside world, students develop the desire to learn mathematics (Authors 2017; Authors 2019; Retnawati, 2022; Wahyuddin, 2017). Nevertheless, among Ghanaian high school students, the desire to endure difficult mathematics tasks is not satisfactory. The signs of low motivation as observed by recent studies as class interaction progressed, is that a portion of students displayed undesirable behaviors including remaining passive during lessons, reluctant to speak up, and keeping silent throughout the entire duration (Akpan and Umobong, 2013). As motivation is necessary, low motivation has been found to end students in acquiring poor grades. As a matter of fact, intensive study of the irregularities of students' achievement motivation in mathematics is needful. Studies which considered the anomalies of students' mathematics learning in relation to teacher-related variables did little on students' mathematics achievement motivation, particularly regarding investigations of the discrepancies caused by teaching quality, teaching competence and mathematics connection through structural equation modelling (Authors, 2019). The present study applied SEM to investigate the direct effects of teaching quality, teaching competence and mathematics connection on high school students' mathematics achievement motivation.

1.1 Objectives of the Study

The study sought to determine;

i. The direct impact of teaching quality on mathematics achievement motivation

ii. The direct effect of teaching competence on mathematics achievement motivation

iii. The direct effect of mathematics connection on mathematics achievement motivation

1.2 Hypotheses Development

Over the past years, chunk of literatures has concentrated on the dynamics of mathematics achievement motivation (SMAM) of students (Dahl, 2011; Ruiz-alfonso et al, 2021; Ekmekci & Serrano, 2022; Clair, 2018; Rodionov & Dedovets, 2017). Mathematics achievement motivation (SMAM) was impacted by various components, including teaching quality (TQ), teaching competence (TC), and mathematic connection (MC), which are often not independent. Teaching quality (TQ) refers to teacher practices for class control and orderly presentation of concepts that fixes problems of student passiveness thereby activating students' desires for better mathematics comprehension and performance. Teaching competence (TQ) is a combination of personality features, acquaintances, skills and attitudes which are necessary for effective practice of teachers. Mathematics connection (MC) is the ability of mathematics teachers to link mathematics concepts to the real-life situation and other subject (Authors, 2018).

Figure 1 depicts the conceptual framework linkages between the variables influencing mathematics achievement motivation of students.

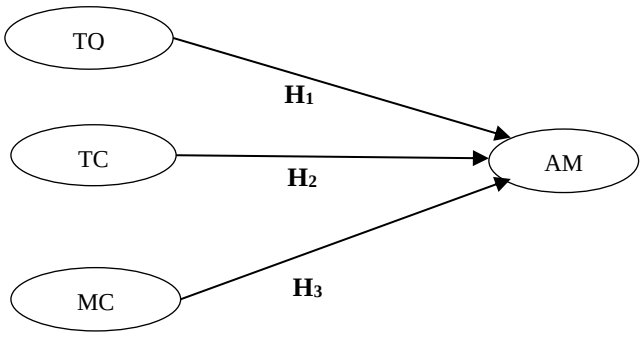

Figure 1: Conceptual Framework (Source: Field Survey, 2023)

H1: Teaching quality has a direct positive impact on mathematics achievement motivation among senior high school students

Authors associated teaching quality to various synonyms such as instructional effectiveness, instruction quality, class quality, effective practice etc. which convey similar explanation to the same variable. Studies in learning motivation suggested that, teaching quality refers to teacher practices for class control and orderly presentation of concepts that fixes problems of student passiveness thereby activating students' desires for better mathematics comprehension and performance. Teaching quality comprises instructor practices that inspires learners, encourages belongingness as well as promotes learner competence (Authur et al., 2022). On consensus worldwide, academics had witnessed the contributory role of teaching quality in mathematics education as it has revealed significant impact on understudies' achievement, interest, perceptions, attitudes and beliefs.

H2: Teaching competence has a direct positive effect on mathematics achievement motivation among senior high school students

The nature of teaching competence is evidenced from teacher's teaching abilities and determined against teacher's behavior, and pupils learning and motivation. These include content knowledge, skills, values, and individual characters relevant to develop learners' interest (Pantić et al., 2011; Sulaiman & Ismail, 2020). Subject matter knowledge, pedagogical and societal knowledge are important competences which should be developed in every mathematics teacher. For teachers to recognize their students, the learning process, classroom atmosphere, curriculum and teaching-learning resources, they need to combine pedagogical and societal knowledge (De Clercq, 2008). Teaching competence concerns content knowledge and instructional delivery techniques at the disposal of teachers to achieve desired objectives. Some researchers examined the influence of teaching competence and commitment on the performance of Madrasah teachers in Bali, Malaysia (Siri et al., 2020). Highly competent and committed teachers performed better. Wahyuddin (2017) found that teaching competence promotes the achievement of learners. Teachers should be competent enough to professionally offer competitive skills to learners to survive in our modern world (Wahyuddin, 2017; Fleming et al., 2007; Sulistiyo, 2016).

H3: Teaching competence has a direct positive effect on mathematics achievement motivation among senior high school students

Mathematics connection is the ability of mathematics teachers to link mathematics concepts to the real-life situation and other subject (Authors, 2019). Mathematics connection enables students to identify the association between concepts (Kenedi et al., 2019; Wijayanti & Abadi, 2019). It makes it easier for students to identify interconnections among mathematics concepts and real-life situations to solve problems (Selvianiresa & Prabawanto, 2017).

A study conducted on random sample of 1,263 students from ten (10) high schools in Ghana to identify teacher-factors which promotes students' interest in mathematics showed that teachers' ability to connect mathematics to real life problems is crucial to develop mathematics interest in students (Authors, 2018). This boosts students' abilities to study to make meaning from mathematics concepts and encourages them to link new concept to previous ones for understanding.

2. METHODOLOGY

2.1 Sample and Data Collection

The study adopted both non-probability sampling and probability sampling techniques in a manner that addressed the issue of sampling biases. In the view of Cohen et al. (2018), non-probability sampling makes selection from a target group of specific characteristics non-randomly whereas probability sampling ensures that individuals in a group have equal chances of being selected. The study employed two sampling techniques, which were convenience sampling and simple random sampling. Convenience sampling was implemented to select non-random volunteer classes and simple random sampling was used to select the participants from these classes using excel generated random numbers. Though sample selection was easy, inexpensive and not time consuming, convenience sampling technique is flawed to increase the risk of selection bias and make generalizations difficult (Phillips & Phillips, 2013).

2.2 Questionnaires and Measures

The study used structured questionnaires on Likert scale to collect data. The items were measured on an evaluative continuum ranging from strongly disagree (1) to strongly agree (5).

The instrument was divided into five sections. The first section consisted of three items to collect demographic information of participants including age, gender and course of study. The second part of the instrument used 6 items constructed from the characteristics of quality teachers adapted to measure teaching quality (Goe, 2007). Teaching competence construct was measured by 9 items adapted from (Siri et al., 2020). Also, to measure mathematics connection, the study adapted 6 items from (Authors, 2017). Moreover, the last section of the instrument consisted of 8 items adapted

to measure mathematics achievement motivation of students (Lim and Chapman, 2014). The researcher sought the consent of the school authority, and participants to ensure data protection, and secrecy.

2.3 Reliability and Validity of the Measures

Reliability analysis was conducted using SPSS (version 20) to determine the internal consistency of the instrument. The study computed confirmatory factor analysis by AMOS (version 23) to assess the fitness of the measurement model. During the confirmatory factor analysis, factor loadings were assessed for each measurement item on the scale. Items with factor loadings below 0.50 exited iteratively.

Table 1: Model fit Measures for Measurement Model

Measure	*Estimate*	*Threshold*	*Interpretation*
CMIN/DF	2.331	Between 1 and 3	Excellent
GFI	.901	>.90	Excellent
CFI	.962	>.95	Excellent
TLI	.952	>.90	Excellent
RMSEA	.064	<.06	Acceptable
SRMR	.071	<.08	Excellent

Due to lower factor loadings, 8 items were eliminated for further analysis. To enhance the fitness of the measurement model, modification indices were used. The model fitness was ensured using the model fit measures according to a study, criterion for CMIN/DF, GFI, CFI, TLI, SRMR, and RMSEA (Hu and Bentler, 1999). The confirmatory factor analysis ensured that CMIN/DF=2.331, GFI=.901, CFI=.962, TLI=.952, SRMR=.071, and RMSEA=0.64.

Table 2: Composite Reliability, Average Variance Explained and Cronbach Alpha

Constructs	*Composite Reliability*	*Average Variance Explained*	*Cronbach Alpha*
Teacher Quality	.909	.715	.927
Teacher Competence	.756	.884	.923
Mathematics Connection	.887	.617	.914
Mathematics Achievement Motivation	.911	.503	.924

The Cronbach's alpha (CA) was calculated by SPSS (v.23) using the retained items. Cronbach alpha of teaching quality (TQ), teaching competence (TC), mathematics connection (MC), and students' mathematics achievement motivation (SMAM) constructs were .927, .923, .914 and .924 respectively. The study ensured that Cronbach's alpha for each construct is maintained at the required threshold of 0.70 (Taber, 2018). Convergent validity is obtained when the Average Variance Extracted (AVE) of the observed variables is greater than or equal to 0.5 and the Composite reliability (CR) is greater than or equal to 0.7 (Bornmann et al., 2009; Carlson & Herdman, 2012). The results indicate that 0.503 of mathematics achievement motivation was the least Average Variance Extracted (AVE), while 0.756 of mathematics achievement motivation was the least Composite Reliability (CR), indicating this study attained convergent validity. The average variance extracted were above the minimum benchmark of 0.50 (Dos Santos & Cirillo, 2021). Hence, the instrument used in the study has the required convergent validity as shown on Table 2.

Table 3: Heterotriat-Monotrait Ratio for Discriminant Validity

	TQ	*TC*	*MC*	*SMAM*
TQ				
TC	.66			
MC	.22	.26		
SMAM	.04	.10	.54	

Earlier studies considered the assessment of discriminant validity using Fornell and Larker Criterion (Hamid et al., 2017). However, recent criticisms of the Fornell and Larker Criterion had caused rapid utilization of the Heterotriat-Monotrait (HTMT) ratio. The present study utilized Heterotriat-Monotrait ratio to determine the discriminant validity. In using HTMT ratio, all values were ensured to be less than 0.85 (Henseler et al., 2015; Roemer et al., 2021). Therefore, discriminant validity was achieved on the dataset. Table 3 displays the results of the discriminant validity.

3. Results

A structural equation model was generated by Analysis of Moment Structure (AMOS) (Barnidge & Zúñiga, 2017; Mustafa et al., 2020). The structural equation model was used to test the relationships between the constructs under study. Another key factor to consider when running CFA is the model's fitness. The CMIN / DF should be less than 3, CFI and TLI should be at least 0.9, RMR and RMSEA should be at least 0.8, while P-close should also be greater than 0.05 (Hair et al., 2010). CMIN measures minimal inconsistency in the model; RMSEA represent perfectly identical indices by evaluating the deviation of the hypothesis model from the perfect model; while CFI and TLI represent incremental agreement indices by comparing how well the hypothesis model fits the baseline model (evaluating least agreement) (Xia & Yang, 2019). The limit values for CFI and TLI are based on the maximum probabilities of normal continuous data theory. P-close is also expected to be statistically insignificant at 5% (above 0.05).

Table 4: Model Fit Measures for Structural Equation Model

Measures	Estimate	Threshold	Interpretation
CMIN/DF	2.331	Between 1 and 3	Excellent
GFI	.910	>.90	Excellent
CFI	.965	>.95	Excellent
TLI	.956	>.90	Excellent
RMSEA	.061	<.06	Acceptable
SRMR	.056	<.08	Excellent

The value generated by the Confirmatory Fit Index (CFI) was equal to 0.965, which was greater than 0.90, which means that this model is valid and has a high correlation between the model and the data. The resulting Goodness-of-Fit Indices (GFI) value was 0.910. This means that the resulting model is good. In addition, the resulting Root Mean Square Error Approximation (RMSEA) value was 0.061; this is less than 0.08, which means an acceptable value for RMSEA. This shows that the basic factors of the four constructs are valid and acceptable. The Tucker and Lewis Index (TLI), value was 0.956 and Standard Root Mean Square (SRMR) was 0.056 which were all ensured within their tolerable range (Hu & Bentler, 1999). Table 4 shows that the fitness indices are at their suitable thresholds. As part of the fitness assessments, CMIN / DF value was 2.331 which was less than 3.

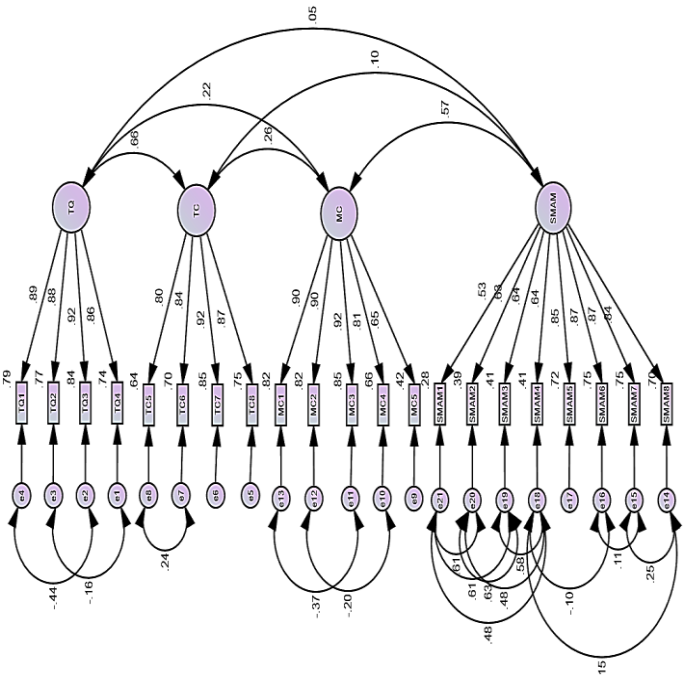

Figure 1: Confirmatory Factor Analysis Model (Source: Field Survey, 2023)

Table 4: Hypotheses Testing				
Hypothesized Relationship	*Unstandardized Estimates*	*t-value*	*p-value*	*Decision*
TQ-->SMAM	-.054	-.807	.420	Reject H1
MC-->SMAM	.681	10.698	<.001	Accept H3
TC-->SMAM	-.105	.681	.124	Reject H2

The study explored the influence of teaching quality, teaching competence and mathematics connection on students' mathematics achievement motivation. The impact of teaching quality on mathematics achievement motivation was negative and insignificant (b=-.054, t=-.807, p=.420), thus H1 was rejected meaning teaching quality had no impact on mathematics achievement motivation. The impact of teaching competence on mathematics achievement motivation was negative and insignificant (b=-.105, t=-1.539, p=.124), *H2: Teaching competence has a direct positive effect on mathematics achievement motivation among senior high school students was thus rejected.* However, the impact of mathematics connection on mathematics achievement motivation was positive and significant (b=.681, t=10.698, p<.001), *H3:* Mathematics connection *has a direct positive effect on mathematics achievement motivation among senior high school students was thus confirmed.* Table 5 reports the results of the hypothesized relationships.

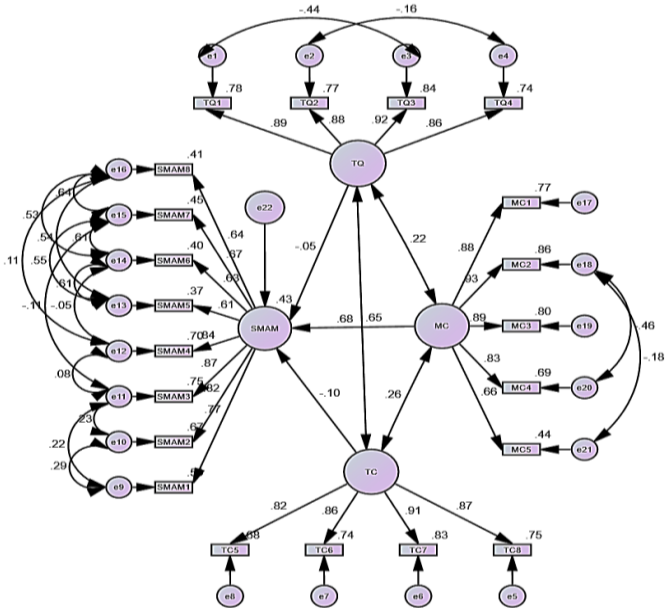

Figure 2: Structural paths (Source: Field Survey, 2023)

4. Discussion

Researchers agreed that teaching quality had a significant influence on student motivation in mathematics learning (Dahl, 2011; Ruiz-alfonso et al., 2021). When mathematics lessons are presented by teachers who had sufficient degree of comprehension of concept, students acquire fully meaningful motivation and interests. Quality instructors also use their motivating skills to enhance student self-control, preparedness, and endurance in difficult mathematical circumstances (Sirait, 2016). The current study discovered a negative association between teaching quality and mathematics achievement motivation; however, the relationship was minor. This finding contradicted the findings of other researchers, who discovered a direct positive and significant influence of teaching quality on students' motivation (Dahl, 2011; Ekmekci & Serrano, 2022; Johnson, 2017; Ruiz-alfonso et al., 2021).

Teaching competence has been identified as an effective teacher-factor of consideration by studies researchers (Fauth et al., 2019; Lillvist et al., 2013; Richards, 2009; Sulaiman & Ismail, 2020). Previous research found that teaching competence has a beneficial impact on student motivation in mathematics learning and accomplishment. It has been observed that highly skilled and devoted teachers increase student interest and motivation to study mathematics; however, the findings of the current study contradict this result. In contrast to the findings of earlier investigations, a negative and insignificant relationship was discovered (Stipek et al., 1998; Tambunan et al., 2021). However, the current findings are consistent with the notion that different students have diverse perspectives on the nature of teaching competence and mathematics motivation, as evidenced by cultural diversity, age, or gender (Eccles & Wigfield, 2020). The ability of teachers to relate mathematics principles to other disciplines and students' daily lives is referred to as mathematics connection (Authors, 2017).

Mathematics connection assists students in identifying links between mathematics ideas and real-life events in order to solve problems (Selvianiresa & Prabawanto, 2017). The present study found that mathematics connection is positively and strongly correlated with learners' mathematics achievement motivation. The conclusion was consistent and it adds to the body of research on the influence of mathematics connections on student motivation in mathematics learning (Clair, 2018; Rodionov & Dedovets, 2017).

5. Conclusion

From the results of the data analysis, the study concluded that teaching quality and teaching competence had no effect on mathematics achievement motivation of students. However, mathematics connection had positive direct effect on mathematics achievement motivation.

Recommendations

The study recommends that mathematics teachers should use pedagogical approaches which allow them to relate mathematics taught in class to real life problems and other disciplines. This will arouse students' motivation to achieve in mathematics. The study also recommends to teachers to adopt techniques to motivate students in mathematics teaching and learning since achievement motivation is principal variable in students' mathematics learning and performance.

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The authors would like to thank the anonymous reviewers for their comments and suggestions. We really appreciated their efforts to improve the quality and presentation of this work.

Ethical Approval

A letter was issued to the selected SHS school requesting permission to perform the study. The privacy and anonymity of the participants were respected.

Data Sharing Statement

Data supporting the findings and conclusions are available upon request from the corresponding author.

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