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Effect of Instructor Quality and Availability on Ghanaian Students' Interest in Mathematics Using Regression and Principal Component Analysis

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Authors' contributions

This work was produced through collaboration between all authors. Author YDA gathered all literature materials and designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors SAA and CKA initiated the study design and supervised the statistical analysis as well as given valuable inputs into analysis. All authors read and approved the final manuscript.

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ABSTRACT

The study investigated the effect of instructor quality and availability on Ghanaian students' interest in Mathematics. The study used structured questionnaire to randomly select 1,263 students from 10 public secondary schools in the Ashanti Region of Ghana. The study performed principal component analysis on the instructor quality and availability construct as well as regression analysis to ascertain the contribution of instructor quality on students' interest development. Here, the results showed that the instructor quality construct with Cronbach's alpha value of 0.699 can be further categorized into two principal components with the first component explaining 41.7% while the second component explains 12.8% with a total cumulative variance of 54.5%. The results from the multiple regression analysis showed significant ($p < 0.0001$) in predicting students' interest in Mathematics. The model could predict 7.4% of the variability in students' interest in Mathematics.

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The study finally concluded that students' interest in Mathematics can be enhanced through quality of instruction and availability of qualified instructors. The study recommends to the education ministry to take cognizance of the result in their recruitment of Mathematics teachers for the various levels of education especially in the first and second cycle schools.

Keywords: Instructor quality; instructor availability mathematics education; interest; Ghana.

1. INTRODUCTION

Instructor's quality and availability construct remains paramount in educational career and teaching and learning of mathematics. There are many qualities that exist for mathematics instructors and such qualities include but not limited to student-instructor interaction, responsiveness, organization and likeability or concern shown by instructor to students, being patient to student during lesson as well as adopting teaching methods and strategies that helps in developing students interest in Mathematics [1]. A teachers' ability to establish the needed rapport during lesson will help engage and attract attention of students [2].

The student-teacher interaction refers to teachers' ability to create the needed environment for students to interact freely with them during and after lessons. The quality of mathematics instructors create academic friendship between the teacher and the students which helps to ask questions by the students during and after mathematics lessons [3,4]. The creation of good teacher-students relationship and academic friendly environment offers students' the needed opportunity also learn freely and ask questions in class to further their understanding and clarity [1,5-7]. The opportunity for students' to ask questions to help them construct their own ideas in the teaching and learning of mathematics. The kind of teaching methods adopted by teachers influence students' interest and likeability of the content being learnt.

The cordial relationship between instructors and students provides non-threatening teaching method that offers students the needed opportunity to participate in class activities without fear [1,8]. The student-teacher relational effect on instruction is crucial since the instructors' ability to help student retain what is taught in class is influenced by their relationship with the students and further influences the students perception of the pedagogical affect [5]. It is therefore very crucial for Mathematics teachers to exercise great patience during lesson

to help them cope with students. Previous studies [1,5] have emphasized that strong existence of student-instructor relationship impacts on instructors' involvement since engaged instructors will impact on their students. The instructors' responsiveness to addressing students' concern has also been an issue of concern by educators and educational leadership. The responsiveness in educational perspective refers to promptness and the willingness to help or attend to the students' needs [1,9] In Mathematics education psychology, teachers who have received training in the area of Mathematics education should be able to have enough patience to deal with problems during lessons. Trained Mathematics teachers become essential in the training of student in Mathematics.

The ability of the teacher to know the students' needs and promptly respond to these needs influences the student interest in mathematics [5,10]. The responsibility lies with the teacher to engage in systematic teaching to help students learn by practicing what they learn [11-13].

Mathematics instructors also have the responsibility of organizing and structuring the learning of the student by organizing the presentation in the classroom very well to accelerate students understanding. The instructors' level of clarity, comprehensiveness and general organizational approach to teaching is of great importance to the students' interest in learning any subject [14]. This involves the systematic presentation and linkages between the course structure, what is taught and the cause direction [15]. The instructors' ability to coordinate and structure the course being taught will make student comfortable and further impact positive on their interest in the subject. The instructor will help students understand when they organize their presentations of lessons with clarity and this will in turn influence students' likeability of the instructors. The teaching method and strategy adopted by the teacher in the delivery of the lesson will inform how the classroom organization and structuring will be done. The responsibility is on the teacher to

choose appropriate teaching method that will impact on students' understanding and for optimum clarity and interest of the students in mathematics [16,17].

The likeability of the instructor occurs when the instructor is able to exhibit some level of caring disposition for his or her students [18,19]. The students sometime look beyond just being knowledgeable and focus on the likeability which may improve on their interest in the subject [1,20]. The students' involvement in class is highly motivated and influenced by the teaching style with some personal attributes combined with some degree of entertainment and this will help students' interest development process. The teacher who adopts teaching methods that allow students participation will mostly receive some level of likability by the student since their methods are good for students' understanding [21,22]. Conversely poor and bad teaching method adopted by teachers will receive high level of dislike of teacher by the students since it does not improve their learning and interest in the subject [23,24].

The studies in school instruction and its effects on students' interest and performance in recent times has taken a new dimension which demands an integrative approach. The integrative perspective combines teachers personality attributes, instructional strategies as with some individuals prerequisites [2,25].

The study by [26–28] expresses the that instruction is been regarded as an offer for which students may choose to benefit or not, having in mind that both cognitive and non-cognitive factors in teaching and learning are related to each other. Although this study will utilized this perspectives to investigate the instructor quality and availability in learning teaching of Mathematics as an expansion of the cognitive and non-cognitive strategies for student interest development the section below throws more light on the theoretical underpinning of the study.

1.1 Theoretical Background

The study will use the interest theoretical approaches by [29,30]. This theoretical approach has been the backbone for the investigation of subject specific interest like Mathematic. The self-determination theory of motivation by [31] and the subject-specific interest and learning motivation theory by [29,30]. The study of subject-specific interest is connected by the student and the object which in this case is a

mathematical concept or topic. The study by [29,30] categorised interest into either situational or individual in any given object of interaction. The situational interest though does not last longer but has a longer way to induce individual interest which is last longer and may not be dependent on the present situations. Their study further enlightens that though individual interest is independent on present situation, the interest created by the present situation when sustained will lead to a lasting individual interest. In furtherance to the interest theory is the self-determination theory by [31,32] which postulates based on the assumption that individuals achievement of highest level of internalization occurs based on their adoption of values and objectives. The determination by learners to integrate the goal and objectives set out to be achieved in a learning a subject specific topics into their value and belief system [33].

The self-determination theory as well as subject objects theory has inherent characteristics that influence the social environment as a contributor of learners' individual intrinsic motivation. The analysis of school instruction where varieties of social processes interact is of great importance to this study in the expansion of subject-object theory. The study explored the influence of instructor quality and availability construct as perceived by learner of Mathematics as an expansion of literature especially Mathematics education. It was assumed that the students' perception depends substantially on the quality of a particular instructor in the classroom [18,34]. The study by [35] however explained that step-by-step individual experiences regarding interest and motivation improves. These systematics approaches may occur when qualified instructors are engaged to deliver quality instruction. This further implies that, the quality of the instructor and availability of the trained and qualified instructors will give rise to student interest development in Mathematics. The interest in learning is a form of intrinsic motivation investigated by many authors see [31,36–38] which is generally assumed to induce deeper understanding and elaboration specific subject content. The development of subject specific interest is known to correlates with performance [39].

1.2 Problem Statement

Trained and qualify Mathematics teachers are scares in Ghanaian basic and Senior High Schools (SHS).

In most of our basic and Junior High Schools (JHS) anybody can teach Mathematics not because they can teach it well or better but because the trained and qualified mathematic teachers are mostly not available or inadequate. The study hypothesize lack of qualified mathematics instructors in basic schools and SHS has resulted in the lack of interest and poor performance of Mathematics at all levels of education which is serious for national technological and industrial development. The problem of instructor quality and availability is crucial for investigation since it is a determinant of the student interest and further influence performance. The current study sought to explore and explain the effect of instructor quality and availability on students' interest in Mathematics. The instructor quality will be examined based on their methods and strategy for instruction. The shortage of qualified Mathematics teachers as well students to teacher ratio as indicated in the construct.

1.3 Research Objectives

The study was set out to achieve the following specific objective.

- i. To determine the effects of instructor impatience during instruction in Mathematics on students' interest in Mathematics.
- ii. To examine the effects of untrained Mathematics teachers on students interest in Mathematics.
- iii. To analyze the instructor quality and availability construct to ascertain its reliability and suitability for principal component analysis.
- iv. To investigate the extent to which instructor quality and availability influence students' interest in Mathematics.
- v. To investigate the effects of the principal components extracted contribute to the prediction of student interest in Mathematics.

1.4 Research Questions

- i. Does the instructor quality and availability construct pass the test for principal component analysis?
- ii. To how many principal components can there be in instructor quality and availability construct?
- iii. To what extent does the does instructor quality and availability influence the

prediction of student interest in Mathematics?

- iv. How does the principal component extracted individually influence the prediction of the prediction of student interest in Mathematics?

1.5 Research Hypothesis

- i. There is significant correlation between the measurement of the instructor quality and availability construct.
- ii. The instructor quality and availability construct influence students interest in Mathematics significantly.
- iii. The principal component extracted significantly contributes to the prediction of students' interest in Mathematics.

2. RESEARCH METHODS

The study population consisted of 10 SHS and students in the Ashanti Region of Ghana. The study used two stages of sampling. The first part of the sampling procedure included selection of SHS to be included in the study and the second stage involves the selection of participants from the selected high schools to be included in the study. The study adopted survey approach to administer 1500 questionnaires to participants randomly selected from 10 randomly selected public SHS. The questionnaires valid for analyses were 1,263 representing 84.2% response rate. The questionnaire items were all closed ended consisting of demographic characteristics and construct measured using the five-point Likert scale was purposed to elicit views from participant for quantitative research. The participants were made to rank the factors in the construct as they contribute in students' interest development in Mathematics. The study used both descriptive and inferential statistical techniques to arrive at the objectives stated. The study items were test for reliability and consistency to ascertain further use for analysis.

3. DATA ANALYSIS, RESULTS AND FINDINGS

The study used eight (8) measurement variables to measure the instructor quality and availability construct (IQAC). The construct variables were made up of shortage of qualified Mathematics teachers, bad teaching methods adopted by teachers, poor illustration methods adopted by teachers, lack of patience on the part of the teachers, lack of trained Mathematics teachers

,large students to teacher ratio, and poor teaching strategies adopted by teachers. The measurements were descriptively analyzed to ascertain their perceive strength as they contribute in the students' interest building process in Mathematics.

The study investigated the how shortage of qualified Mathematics teachers affects students interest in Mathematics. The participants were made to respond to a Likert-scaled question as to whether shortage of qualified Mathematics teachers affects students' interest in Mathematics. The results showed that cumulatively (21.2%) of the total participants disagreed that shortage of qualified Mathematics teachers affects their interest in Mathematics, however the study found greater proportion (64.5%) of the participants to agree to the fact that shortage of qualified Mathematics teachers affect students' interest in Mathematics. The study moreover observed that, the participants mean (3.7) rating of the shortage of qualified Mathematics teachers was above average with standard deviation (1.49) and relative importance index value of 0.73 which good enough to give it a relatively good position in the factor ranking.

The study also found how bad teaching methods adopted by Mathematics teachers affected students' interest in Mathematics. The participants were made to rank they agree or disagree with the statement that bad teaching methods adopted by teachers affects student interest in Mathematics. The study found that, 70% of the total participants cumulatively agree to the facts that bad teaching methods adopted by Mathematics teachers affects their interest in Mathematics, however 14% and 16% of the participants disagreed and stay indifferent respectively about the effect of bad teaching methods on students interest in Mathematics. The study found that the mean (4.0) ranking of student perceived effect of bad teaching methods adopted by Mathematics teacher on student interest was very high above average with standard deviation of 2.08 and relative importance index of 0.79. The study found that bad teaching methods adopted by Mathematics teachers as the most important factor that affect students' interest in the study of Mathematics.

In the attempt to confirm the response by the participants on the effects of bad teaching methods adopted by Mathematics teachers and their effect on their students' interest in Mathematics, the study further required of the

respondents to rank the effect of poor illustration methods adopted by Mathematics teachers and their effect on the student interest in Mathematics. The study found that, 65.1% of the total participant cumulatively agreed that poor illustration methods adopted by teachers negatively affect their interest in Mathematics, nonetheless, 13.6% and 21.2% of the total participants disagreed and neutral respectively to the statement that poor illustration method adopted by Mathematics teacher affect their interest in Mathematics. Moreover the study found in advanced to the percentages the mean of 3.9 and standard deviation of 1.19 with relative importance index of 0.77. This results confirms that bad teaching methods negatively affect the students' interest in Mathematics.

The study further examined the effect of impatience of Mathematics teachers and their effect on students interest in Mathematics, the study found that 69.7% of the participants agreed to the fact that lack of patience on the part of Mathematics teacher will affect their interest in Mathematics, nonetheless, 18.7% and 10.6% of the total respondents disagreed and neutral to the statement that lack of patience on the part of the teacher will negatively affects the students interest in Mathematics. The study also presented a mean (3.9) and the standard deviation (1.88) of the participants ranking of statement that, lack of patient by Mathematics teachers will affect their interest in Mathematics with relative importance index of 0.77. The study results implies that if Mathematics teachers exercise patience in their engagement with students during and after lessons, students will develop interest in Mathematics for better performance.

The study scrutinized the effect of lack of trained Mathematics teachers on students' interest in Mathematics on the students' interest in Mathematics. The results showed that cumulatively, 70.9% total participants agreed to the statement that lack of trained Mathematics teachers affect their interest in Mathematics. The study on the other side found that 19.7% and 10.6% disagree and neutral respectively on the statement that student's interest in Mathematics is affected by the lack of trained Mathematics teachers. The mean and the standard deviation of the students perceive ranking of the lack of trained Mathematics teacher as cause of negative interest among senior high schools were 3.9 and 1.88 respectively with relative importance index of 0.77 as shown in Table 1 [16].

The study investigated the effect of large student to teacher ratio on the student interest in Mathematics, although the study found 55.4% of the respondent agreeing to the fact that large student to teacher ratio affect their interest in Mathematics, however, 23.1% and 21.5% of the respondents disagreed and indifferent respectively as large student to teacher ratio affect their interest in Mathematics. The extended analysis from percentages reveals that, the mean and the standard deviation of participants perceived ranking of large class size was 3.6 and 2.41, respectively with relative importance index of 0.69 as shown in Table 1.

The study also investigated the effect of refreshing student on their previous knowledge in Mathematics and its effect on their interest development. The study results showed that 46.5% of the participants agreed on the statement that refreshing students mind on the previous Mathematics topics will help improve their interest in Mathematics, although 22.9% and 30.5% of the respondent disagreed and indifferent respectively that, refreshing their mind on previous Mathematics topics will improve their interest in Mathematics. Moreover, the study, observed that, the participants mean (3.3) rating of teachers refreshing students mind on previous lesson was above average with standard deviation (1.79) and relative importance index

value of 0.66 which good enough to give it a relatively good position in the factor ranking.

The study examined the suitability of instructor quality and availability construct for the principal component analysis (PCA) after the descriptive statistical analysis. Before the conduct of PCA for the determination of number of principal component, the study considered some information provided in the out from the exploratory factor analysis (EFA). The study determined the sampling adequacy using the KMO and Bartlett's test of sampling adequacy which proved significant hence passing the data test to running the principal component analysis. To determine the number of components in the eight (8) item measuring instructor quality and availability construct, the Kaiser's criterion was used to determine the number of components with Eigen values of 1 or more. The study finally retained two factors in the rotated component matrix which indicates that the eight (8) factors form the construct instructor quality and availability was further reduced to two principal components. After the rotation the first factor (Instructor quality) made up of six (6) factors accounted for 41.64% of the variance while the second component (Instructor shortage) which is made up of two factors accounted 12.81% as shown in the Table 3. The scree plot in Fig. 1 presents the rotated structured component using the Eigen values.

Table 1. Descriptive statistical analysis of instructor quality and availability construct

Factors	SD	D	N	A	SA	RII	M	SD
Shortage of qualified Mathematics teachers affects student interest in Mathematics	9.3%	11.9%	14.3%	32%	32.5%	0.73	3.7	1.49
Bad teaching methods adopted by teachers affects student interest in Mathematics	5.3%	8.7%	16%	24.6%	45.4%	0.79	4	2.08
Poor illustration methods adopted by teachers affects student interest in Mathematics	5.8%	7.8%	21.2%	25.9%	39.2%	0.77	3.9	1.19
Lack of patience on the part of the teachers affects student interest in Mathematics	7.8%	11.9%	10.6%	29.5%	40.2%	0.77	3.9	1.88
Lack of trained Mathematics teachers affects student interest in Mathematics	7.8%	11.9%	10.6%	29.5%	40.2%	0.77	3.8	1.29
Large students to teacher ratio affects student interest in Mathematics	8.4%	14.7%	21.5%	32.3%	23.1%	0.69	3.6	2.41
Students are refreshed on their previous knowledge in Mathematics.	9.3%	13.6%	30.5%	31.2%	15.3%	0.66	3.3	1.79
Poor teaching strategies adopted by teachers affect students' interest in Mathematics	7.2%	8.7%	16.3%	27.4%	40.3%	0.77	3.9	1.24

The study used the extracted component namely the Instructor quality (IQ) and instructor shortage (IS) to predict students' interest in Mathematics. The study examined first correlation between instructor quality and instructor shortage on students interest in Mathematics as shown in Table 5. The results reveal significant correlation between the two component although IQ presents much stronger correlation as compared with the 'IS'. The multiple correlation analysis showed significant but weak correlation between students' interest and instructor quality and instructor shortage. The multiple regression analysis on the instructor quality and availability and instructor shortage proved significant with predictive strength of 7.2% of the total variation in student interest in Mathematics. The result from the multiple regression analysis shows that instructor quality and availability construct can explain 7.2% of problem of student interest in Mathematics. This result further posits that instructor quality and availability can positively influence student interest and the reverse of the finding will impact negatively.

Table 2. KMO and Bartlett's test of sampling adequacy

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		
		0.859
Bartlett's Test of Sphericity	Approx. Chi-Square	2507
	Df	28
	Sig.	0

4. DISCUSSION OF RESULTS

The results in the present showed that instructor quality and availability adequately and significantly contribute to students' interest in mathematics. The study also indicated a strong and statistically significant relationship between

students' interest in mathematics and instructor quality and availability. These further suggest that the more qualified instructors are recruited for the teaching and learning of mathematics the better the students' interest. The result is in consonant with the studies by [3,4] which posits that quality of mathematics instructors create academic friendship between the teacher and the students which helps the students ask questions during and after mathematics lessons. This academic friendship between students and mathematics teachers is one of the oldest threats in the life of teaching and learning of mathematics in Ghana. Students are most often afraid of their mathematics teachers and this fear has always created a gap between the students and the teacher. The fear of mathematics teachers has also limited the extent of communication between the students and the mathematics teachers; however, with the quality and available trained mathematics teacher these gaps in the teaching and learning of mathematics can be solved or better still be minimized. Furthermore, the result is also consistent with the study by [1,5–7], which suggested that creation of good teacher students relationship and academic friendly environment offers students' the needed opportunity also learn freely and ask questions in class to further their understanding and clarity. The instructor quality of promptly responding to students questions during and after lessons is also an important instructor quality that improves students interest in mathematics which is consistent with the findings in [1]. The implication for this study is that since instructor quality and availability is a very important construct in the teaching and learning of mathematics, the curriculum for the mathematics teachers should strongly emphasize on the need to get good conceptual understanding of the teaching and learning of mathematic.

Table 3. Total variance explained the factors

Component	Total variance explained					
	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	3.332	41.651	41.651	3.332	41.651	41.651
2	1.024	12.805	54.456	1.024	12.805	54.456
3	0.908	11.347	65.803			
4	0.812	10.151	75.954			
5	0.644	8.046	84			
6	0.568	7.099	91.099			
7	0.391	4.888	95.988			
8	0.321	4.012	100			

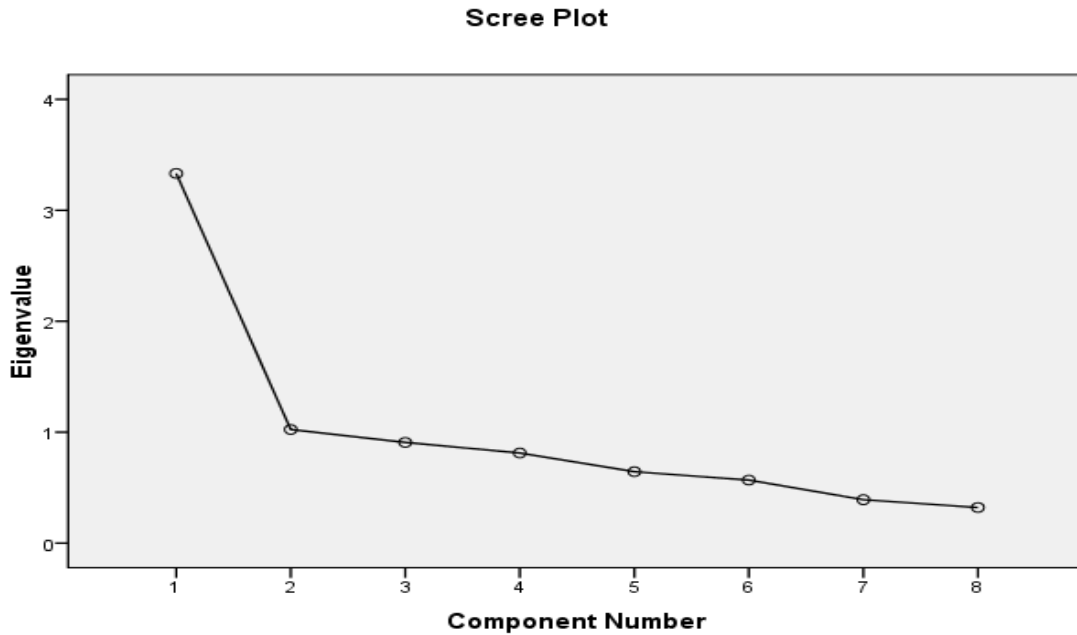


Fig. 1. Scree plot rotated structure components

Table 4. The two-component rotated structure matrix

Rotated component matrix		
	Component	
	1	2
Shortage of qualified Mathematics teachers affects students interest in Mathematics	0.666	
Bad teaching methods adopted by teachers affects students interest in Mathematics	0.547	
Poor illustration methods adopted by teachers affects students interest in Mathematics	0.847	
Lack of patience on the part of teachers affects students interest in Mathematics	0.672	
Lack of trained Mathematics teachers affects students interest in Mathematics	0.801	
Large students to teacher ratio affects students interest in Mathematics		0.744
Students are refreshed on their previous knowledge in Mathematics		0.65
Poor teaching strategies adopted by teachers	0.802	

Table 5. Correlation and descriptive statistical analysis of instructor quality factors

	Correlations			Descriptive statistics	
	Interest	IQ	IS	Mean	Std. deviation
Interest	1	0.27**	0.076*	3.6342	0.94471
IQ		1	0.329**	3.8238	1.05255
IS			1	3.4236	1.33743

*P-value < 0.005

**P-value < 0.001

Table 5a. Model summary of statistics on instructor quality factors

Model Summary					
R	R Square	Adjusted R square	Std. error of the estimate	Change statistics	
				R square change	F change
.271	0.073	0.072	0.91017	0.073	49.794
ANOVA					
	Sum of squares	Df	Mean Square	F	P-value
Regression	82.5	2	41.25	49.794	.000
Residual	1043.795	1260	0.828		
Total	1126.294	1262			
Coefficients					
	Unstandardized coefficients	Std. Error	Standardized coefficients	T	P-value
			Beta		
(Constant)	2.725	0.103		26.363	0
IQ	0.247	0.026	0.275	9.579	0
IS	-0.01	0.02	-0.015	-0.511	0.609

5. CONCLUSIONS AND RECOMMENDATIONS

The result for the first objective of the study concludes that lack of patience on the part of teachers affect the students' interest in Mathematics. The finding that leads to this conclusion was crucial since students' interest in Mathematics is determined substantially by the teachers. The teacher affect students possibly be through exercising enough patience especially when students cannot comprehend with what is being taught or exercise given after cognitive instruction is given by the teacher. This result is consistent with the study by [1,5] which suggest that prompt response by teachers to students question improves and further the students interest.

The result of the second objective also concludes that lack of trained and qualified teachers affects students' interest in Mathematics negatively. The teachers training which form very important component of the Mathematics cognitive training of learners will have strong effect on the student interest. The more trained and qualified Mathematics teachers teach students Mathematics the more interested the students will be in the study of Mathematics. Thus the quality of teaching experienced by students will influence their interest in Mathematics. The study items correlated efficiently with each other making it possible for the PCA. The study further concluded that, instructor quality and availability construct was reliable and suitable for PCA with

two principal components namely the instructor quality (IQ) and instructor shortage (IS). The study moreover concluded that, instructor quality and availability construct can significantly adequately predict 7.2% of student interest in Mathematics. The instructor quality and availability construct explains approximately 7% of the total variance in student interest in Mathematics. Though there are other factors which contribute to interest in Mathematics but an extensive work on instructor quality and availability will help improve 7% of the problem students have with interest in Mathematics.

The study recommends that further investigation on instructor quality and instructor shortage as construct that predict student interest using SEM ascertain the further relationship and dependencies be carried out.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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