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Connecting Mathematics to Real Life Problem using Instructor Quality and Availability, Mathematics Facility and Teacher Motivation for Prediction

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Abstract

The mode of instruction in mathematics education has received a lot of criticisms where many have advocated a paradigm shift from traditional method of instruction to methods that emphasises on conceptual understanding. The major aim of this study is to investigate by means of confirmatory factor analysis the factors that influence teachers' ability to connect mathematics to real life problem. The study deplored probability sampling techniques to randomly select 1,263 participants from over 80,000 students' population in the Ashanti region of Ghana. The partial least squares (PLS) linear structural equation modelling (SEM) techniques was adopted to verify goodness of fit effects among the overall model, structural model and the measurement model. The results and the findings from the study revealed that, teachers ability to connect mathematics to real life problem is significantly influenced by instructor quality and availability as well as teacher motivation ,however mathematics facility have positive but statistically have no significant influence on teachers ability to connect mathematics to real life problem. The study concluded that teachers' ability to connect mathematics to real life problem is directly influenced by teacher motivation, instructor quality and availability as well as mathematics facility availability. The study concluded further that teacher motivation and availability of mathematics facilities influence instructor quality while teacher motivation is further influence by mathematics learning facilities. The study recommended for improvement in mathematics facility, instructor quality and teacher motivation for better connectedness in teaching and learning of mathematics.

Keywords: Connecting Mathematics, Mathematics Facility, Instructor Quality, Teacher Motivation.

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INTRODUCTION

The educational criteria students need to meet for their upward progression in the educational ladder has made passing mathematics in both basic education certificate examination (BECE) and the west Africa secondary school certificate examination (WASSCE) very crucial in Ghana and many west Africa countries. The struggle students' goes through to succeed in mathematics and algebra in specific to some people is known to impact significantly on high school students education (Ketterlin-Geller & Chard, 2011). Across the world, students at different level of education require some grades in mathematics before proceeding to the other levels education.

Mathematics Teachers and Mathematics Connectedness

The mode of instruction in mathematics education has received a lot of criticisms where many have advocated a paradigm shift from traditional method of instruction to methods that emphasises on conceptual understanding. This conceptual understanding in mathematics content delivery will mean teachers of mathematics should make conscious effect to connect mathematics content to other subject areas and the immediate environment. The mathematics teachers ability to connect mathematics to real life and the immediate environment has been found to impact positively and significantly in student achievement (Rakes, Valentine, McGatha, & Ronau, 2010)

Teacher from other parts of the world have made effect by themselves to connect mathematics to real life problem as well as connecting mathematics to other subject areas. This result supports the fact that the teacher have the greatest influences of mathematics connection since mathematics textbooks used are insufficient in providing the needed connections its demands (Gainsburg, 2008). The used of real world problem in teaching mathematics has been influenced by the extent of motivation it provide to the student to engage in mathematics. Thus connecting mathematics to real life problem influence students' motivation in learning mathematics and improve their level of understanding (Gainsburg, 2008). It can be concluded that, mathematics educators need to double up the steps in connecting mathematics to real life problem since it increases their motivation, interest and their level of understanding in the subject matter.

The students' willingness and curiosity to learn may also increase as students feel what they learn has connection to their lives. This imply that, the designers of mathematics curriculum to connect to their immediate environment is crucial and requires greater insight since curriculum limited to the classroom will not improve their interest as far as it has no connections with other subject areas and the immediate environment. Stemhagen and Smith has further indicated the meaningfulness of connecting mathematics to the real life through the argument that ,mathematical knowledge should not be acquired for knowledge acquisition sake but rather, the knowledge acquired should relate to their lives (Stemhagen & Smith, 2008). Moreover, the age long problem of mathematics education where mathematics has been instructed through the traditional ways of teaching and learning has not received sufficient upgrade although many reform effort by educational experts and philosophers (Stemhagen & Smith, 2008). The expert in the field of educational theories and philosophies believes that reforms in teaching methods and strategies where curriculum content is instructed to connect with real life and other subject will influence student interest create understanding and promote meaningful growth in students' academic achievement.

The dominance nature of traditional teaching and learning by mathematics to many has accounted for the falling standard of mathematics education and urgent attention is required by educational leadership and stakeholder to turn away from the old traditional style

of instruction. In most cases, leaners are seen as passive learner where learning is done on mechanical obsolete procedures. The old method of instructions in mathematics education requires pragmatist approach where instruction integrates content to real life problem to produce better understanding for students (Khairani & Sahari-Nordin, 2011; Stemhagen & Smith, 2008).The presentation of contents in the mathematics classroom is one of the traditional ways that exist in mathematics education. This old fashioned traditional mode of presenting mathematics content has given rise to real life connectivity paradigm where teaching of mathematics shifted towards real life applications. The mathematics education community stresses the importance of connecting mathematics content to real life and further encourage mathematics educators to frequently incorporate real life problem in the classroom instruction (Gainsburg, 2008; Palm, 2008).The lack of connectivity of mathematics to real life problem has also been blamed on examination oriented nature of the curriculum which does not encourage thinking (Cooper & Harries, 2002).

Teacher Motivation, Mathematics Facility and Instructor Quality

Building on the advice of (Ganyaupfu, 2013; Peters, 2013) to reform curriculum delivery from teacher centred to learner centred approach will require that the teacher is motivated delivery the content. The students ability to comprehend with the content taught greatly depends on the teachers ability deliver in a way that ignites students interest, relates content to prior knowledge, connect content to real life problem as well as their course areas (Bradford, 2005; Carpenter, 2006; Kao, Lin, & Sun, 2008). This integration in the mathematics curriculum will promote learning, motivate students and enhance students' achievement in mathematics. The relevance of what students learn is expressed in how meaningful they see the content learnt (Gaspard et al., 2015). The teachers' ability to help them connect more to the curriculum further enhances the understanding and interest in the subject matter. The teacher motivation in teaching mathematics may require some level of input from both the central government and the immediate school leadership. The school leadership ability to provide the necessary teaching and learning materials for mathematics instruction will motivates teachers to deliver content and enhanced connectedness to real life and other subject areas (Blase & Blase, 2000; Robinson, Lloyd, & Rowe, 2008). The teachers' ability to connect mathematics to real life problem would give students some level of personal meaning, relevance, as well as renewed perception. This will help relates mathematics learning to students' personal interest, goals, and needs that motivates students to greater involvement in the learning process that facilities greater achievement (Firmender, Gavin, & McCoach, 2014; Kupermintz, 2003).

The availability of learning facility has been a problem in many field of study in most Africa country and Ghana is no exception. The issue of infrastructure and necessary facilities has been raised by (Levin & Thurston, 1996; Philson, 1999) as factors that affect implementation of successful online learning. This shows how lack of mathematics facility can militate against teachers' ability to connect mathematics to real life problem. The teaching and learning materials needed by mathematics teachers to enhance teaching and learning if not available will affect the teachers' classroom delivery and student interest and performance. The mathematics teaching facilities such as information communication and technology tools such as mathematics software help connect mathematics better to other subject areas and real life problem. The further motivates teachers to deliver since teaching and learning can be made easier when these facilities exist as well as improves students interest in mathematics (Clark, 2008).The teacher motivation is not only generated from the central government ,parents or educational leaders, however, Good attitude shown by

students in school could motivate/encourage teachers which positively affects teaching practices (Tella, 2007).

The quality of teacher training received count in the content delivery of the mathematics curriculum. The teachers level of education in the content and availability of quality subject area teachers have great influence on the teachers ability to connect mathematics to real life and other subject area. In most cases, in Ghana unqualified and untrained teachers teach mathematics due to unavailability of qualified trained mathematics teachers and this has somewhat negative effect on mathematics performance the students (Shymansky & Aldridge, 1982).The quality of instructors have unique influence on student understanding, motivates students and delivers students from anxiety (Cave & Brown, 2010; Van De Gaer, Pustjens, Van Damme, & De Munter, 2008). This manifest sometimes in the way they answer students question when they require clarification on content learnt. A trained qualified teacher does not answer students questions angrily, takes time to clarify issues that boils on students understanding of the content learnt, gives better and sufficient explanation when students ask questions (Jackson & Leffingwell, 1999)

The expansion of mathematics connectedness literature and further expansion on what influences mathematics teachers ability to connect mathematics to real life problem has called for this study. There exist a gap in connecting mathematics to real life and other subject areas especially in Africa and this study seeks to contribute its findings in bridging the gap.

Research Objective

The present study generally seeks to model students' perceived mathematics teachers' ability to connect mathematics to real life problem based on teacher oriented factors. The rational for the study was to investigate the determinants of Mathematics teachers' ability to connect mathematics to real life problem and other course areas. The results of the study attempted to provide evidence for the need to integrate mathematics to real life problem as well as providing empirical evidence for determinants of teachers' ability to connect mathematic to real life problem. The study proposed the following specific objective:

- To predict teachers ability to connect mathematics to real life problem and the immediate environment using mathematics facility and availability of qualified instructors;
- To ascertain the influence of teacher motivation and availability of mathematics facility on instructor quality and availability; and
- To establish the influence of mathematics facility on mathematics teachers' motivation for teaching mathematics.

Research Questions

The research questions below were posed to help further achieve the stated objectives:

- Does teachers' ability to connect mathematics to real life problem and the immediate environment influenced by availability of mathematics facility as well as qualified instructor availability?
- Is quality of mathematics instruction and availability of qualified mathematics teachers influenced by mathematics facilities available as well as teacher motivation?
- Does teachers motivation to teach mathematics influenced by availability of mathematics facility?

Hypotheses

The study tested the following hypotheses to help respond to the research questions asked:

- H1: Teachers ability to connect mathematics to real life problem and the immediate environment is not predicted significantly by availability of mathematics facility and availability of qualified instructors.
- H2: Quality of mathematics instruction as well as availability of qualified mathematics instructors is influenced significantly by teachers' motivation as well as availability of mathematics facility.
- H3: Mathematics teachers' motivation to teach mathematics is significantly influenced by the availability of mathematics facility.

METHODS

Participants and Data Collections

The present study used 1,263 participants, who are in the public senior high school (SHS) in the Ashanti region of Ghana. The participants who are in SHS1 (200), SHS2 (298) and SHS 3(712).The participants were drawn from three grade of schools, grade A(554),grade B(546) and grade C (156).The study included both male (551) and female (700).The study used self-designed questionnaire instrument for measuring teacher motivation, instructor quality and availability, mathematics connection and mathematics facility. The questionnaire instrument was administered to participants. The participants were told that participation in the study was voluntary and their responses would be kept anonymous. The full questionnaire instrument is made up of 84 items and some demographic characteristics. The student were made to rate on five point scale ranging from strongly agree to strongly disagree. The study used purely quantitative approach to research to analyse the data obtained from the survey. Partial least square structural equation model (PLS-SEM) was adopted for the analysis of data obtained. The results generated from the data are presented in the section below.

RESULTS

The present study estimated the measurement using Smart-PLS 3.0 (Ringle, Wende, & and Becker, 2015; Wong, 2013) using PLS algorithm for n=1,263 as well as the quality criteria established by (Hair, Hult, Ringle, & Sarstedt, 2014; Hair, Ringle, & Sarstedt, 2011; Wong, 2013).The results of the outer model estimations are presented in Figure 2 for the initial model and the final model in Figure 3.The assessment of PLS-SEM models using reflective scales and model items was presented for confirmation of validity and reliability vis-à-vis the predictive ability of the model to predict mathematics connectedness(MACO), instructor quality and availability (IQA) and teacher motivation (TM).

As indicated in Figure 2 and Figure 3 the coefficient of determination R square values of 0.156 and 0.179 and 0.08 represent the explanatory power of latent variables as low. The results from the measurement model are standardized loads of the reflective construct. The reflective model was evaluated using based on the reliability and validity of the constructs. The composite reliability was used to estimate the internal consistency of the constructs. The results in Table 1 shows that the value of the composite reliability for MACO, IQA, TM and MF constructs exceeds 0.7 showing internal consistency in the constructs of the model. The results in Table 1 further present's complete analysis of results indicating the Cronbach's alpha, and Average variance extracted (AVE). The measurement of validity of reflective

measurement model focuses on the convergent validity and discriminant validity. For convergent validity, the value of AVE should be greater than 0.5 for all construct, however, for this study, the teacher motivation construct has AVE value less than 0.5 as shown in Table 1 indicating that all construct except teacher motivation demonstrated sufficient degree of convergent validity meaning all construct explains more than half of the variance in comparison to their corresponding indicators (Hair et al., 2011) as indicated in the Table 2.

The study further assessed the internal model using bootstrapping algorithm with 5000 cases. The results are shown in Figure 3 and Figure 4. The values of the external measurement model and the structural model as shown on the arrows represent the values of the student T-test of latent variables and the test of latent variables and their indicators. The R-square is the key determinant of structural models and the significant level of the path coefficients. The study yielded R^2 value for instructor quality and availability (IQA), Mathematics connections(MACO) and teacher motivation (TM) as 15.5%,17.9% and 8.1% as indicated in Figure 4. The p-values for the endogenous and their respective t-values are indicated in Table 5. The variance inflation factor (VIF) of the constructs measurement are found in Table 3 thus confirming the causal relationships, exploratory power of the structural model and the statistical power of the model and absence of significant effect of multicollinearity. In assessing the level of significant of the path coefficient the bootstrap was used and the construct with T critical values 2.58 and 1.96 for two-tailed and one-tailed at 1% and 5% level of significance respectively as shown in Table 5. The study showed that except for the values of math facility -> math connection, with T-value not statistically significant, the rest of the values were significant at 1% as indicated in Table 5 and Table 6.

DISCUSSION

The influence of mathematics facility and availability of qualified instructors on teachers' ability to connect mathematics was assessed. The results showed a direct relationship between mathematics facility availability and teacher ability to connect mathematic to real life problem. This indicates that, the extent to which mathematic facilities are made available to aid in the teaching and learning process in mathematics the better it will aid the mathematics teachers' ability to connect mathematics to real life problem. This suggest further that provision of needed teaching and learning aids will help improve teachers ability to connect mathematics to real life problem. The results is consistent with other authors(Levin & Thurston, 1996; Philson, 1999) with the views that issues of infrastructure and necessary facility has effects on implementation of successful online learning .

The effect of available qualified instructors has contributed directly and significantly to the instructors' ability to connect mathematics to real life problem. The results suggest that the level of instructors' knowledge the content being taught will determine the instructors' ability to connect the mathematical concepts to real life problem. The result also indicates that as qualified mathematics teachers are trained and recruited to teach at various levels of education, their level of connecting mathematics to other subject areas and their immediate environment could be improved .The result is consistent with the studies in (Crosnoe et al., 2010; Darling-Hammond & Snyder, 2000; Ruzek et al., 2016) which posits that teacher quality is the largest factor that impact student learning. The result from the structure equation model indicated that the instructor quality and availability is the strongest predictor of teachers' ability to connect mathematics to real life problem and our immediate environment. The results is consistent with the study by (Cave & Brown, 2010) which indicated that professional development of the mathematics instructors significantly improves student mathematics achievement. The study further confirms the works of (Cave & Brown,

2010; Van De Gaer et al., 2008) in consistent finding that suggest that mathematics instructor quality is the largest factor that impact students learning.

The further investigation to ascertain the influence of teacher motivation and availability of mathematics facility on instructor quality and availability revealed that direct relationship exist between teacher motivation and availability of qualified mathematics instructors. The result indicates that the more mathematics teachers are motivated the more available they will be in the service for teaching and learning of mathematics. Furthermore, the study also indicated that availability of mathematics facility directory influenced availability of qualified instructors for teaching and learning of mathematics. The results implies that, although teachers may love to impart knowledge but if teacher are not sure of material and tools needed for smooth delivery of their services they may not as well be trained. The availability of qualified instructors depend directory and significantly on availability of mathematics facility for smooth delivery of instructions.

To establish the influence of mathematics facility availability on mathematics teachers' motivation for teaching mathematics, the study advanced the argument that teachers will be motivated if teaching and learning aid is made available. The more these facilities are made available to the teacher will some way raise their motivation for the teaching and learning of mathematics. The integration of technology aid instruction in mathematics can complement the teachers' effort to advance students interest. The teacher motivation will increase as the needed tools and equipment needed for smooth implementation of mathematical instruction are made available.

CONCLUSION

The study modelled mathematics teachers' ability to connect mathematics to real life problem and other subject specific areas. The study made the following conclusions and recommendations as a contribution to expand the existing literature. The section below presents the major conclusions and recommendations from the study.

For this study self- designed questionnaire instrument was analysed and the items related to the four factors named, teacher motivation, Mathematics facility, instructor quality and availability as well as teachers ability to connect mathematics to real life problem are studied. The study summarised its conclusions as follows:

- Availability of qualified mathematics instructors positively and significantly influences teachers' ability to connect mathematics to real life problem and other subject areas;
- The ability for school leadership to provide the needed mathematics facilities for the teaching and learning of mathematics will positively and significantly affect the quality of instruction delivered by the mathematics teachers;
- The availability of mathematics facility positively influences teachers' ability to connect mathematics to real life problem and other subject areas; however, the contribution is not significant at 0.5% alpha level;
- The availability of mathematics facility positively and significantly affects teacher motivation to teacher mathematic;
- The extent to which the teacher is motivated to teach mathematics positively and significantly influences the teachers' quality of instruction; an
- Teacher motivation positively and significantly affects the teachers' ability to connect mathematics to real life problem and other subject areas.

Recommendations

The study findings established the need for mathematics teachers' to connect mathematics to real life problem and other subject areas and recommended for central governments and stakeholder of mathematics education to field quality instructors, motivates mathematics teachers and provide mathematics teaching and learning facilities help the mathematics real life connection paradigm shift. Although the study found greater significance for above mentioned constructs further work is necessary for purposes of solidifying the literature of mathematics connectedness. The study recommended for improvement in mathematics facility, instructor quality and teacher motivation for better connectedness in teaching and learning of mathematics. Moreover, mathematics teachers are also reminded to adopt different teaching methods and strategies that will also contribute to the quest of mathematics connectedness

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Appendices

Table 1: Construct Reliability and Validity

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Instructor quality	0.907	0.911	0.928	0.682
Math connection	0.677	0.718	0.804	0.514
Math facility	0.747	0.765	0.839	0.567
Teacher motivation	0.393	0.396	0.709	0.450

Table 2: Discriminant Validity Fornell-Larcker Criterion

	Instructor quality	Math connection	Math facility	Teacher motivation
Instructor quality	0.826			
Math connection	0.382	0.717		
Math facility	0.339	0.172	0.753	
Teacher motivation	0.288	0.285	0.285	0.671

Table 3: Outer VIF Values

Indicator variables	VIF
IQA1	2.027
IQA2	2.500
IQA3	2.660
IQA4	2.574
IQA5	2.183
IQA7	2.105
MACO1	1.158
MACO2	1.449
MACO3	1.517
MACO4	1.318
MF3	1.445
MF4	1.419
MF5	1.664
MF6	1.383
TM1	1.106
TM2	1.047
TM3	1.064

Table 4: Fit Summary

	Saturated Model	Estimated Model
SRMR	0.082	0.082
d_ULS	1.028	1.028
d_G	0.289	0.289
Chi-Square	1,763.588	1,763.588
NFI	0.776	0.776

Table 5: Path Coefficient Mean, STDEV, T-Values, P-Values

Path coefficient	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Instructor quality -> math connection	0.325	0.327	0.031	10.411	0.000
Math facility -> instructor quality	0.280	0.281	0.030	9.270	0.000
Math facility -> math connection	0.008	0.007	0.030	0.252	0.801
Math facility -> teacher motivation	0.285	0.287	0.035	8.260	0.000
Teacher motivation -> instructor quality	0.208	0.209	0.034	6.178	0.000
Teacher motivation -> math connection	0.189	0.190	0.030	6.267	0.000

Table 6: Heterotrait-Monotrait Ratio (HTMT) Mean, STDEV, T-Values, P-Values

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Math connection -> instructor quality	0.472	0.473	0.037	12.795	0.000
Math facility -> instructor quality	0.396	0.396	0.033	11.925	0.000
Math facility -> math connection	0.221	0.233	0.032	6.938	0.000
Teacher motivation -> instructor quality	0.459	0.460	0.049	9.444	0.000
Teacher motivation -> math connection	0.527	0.531	0.058	9.042	0.000
Teacher motivation -> math facility	0.573	0.577	0.056	10.276	0.000

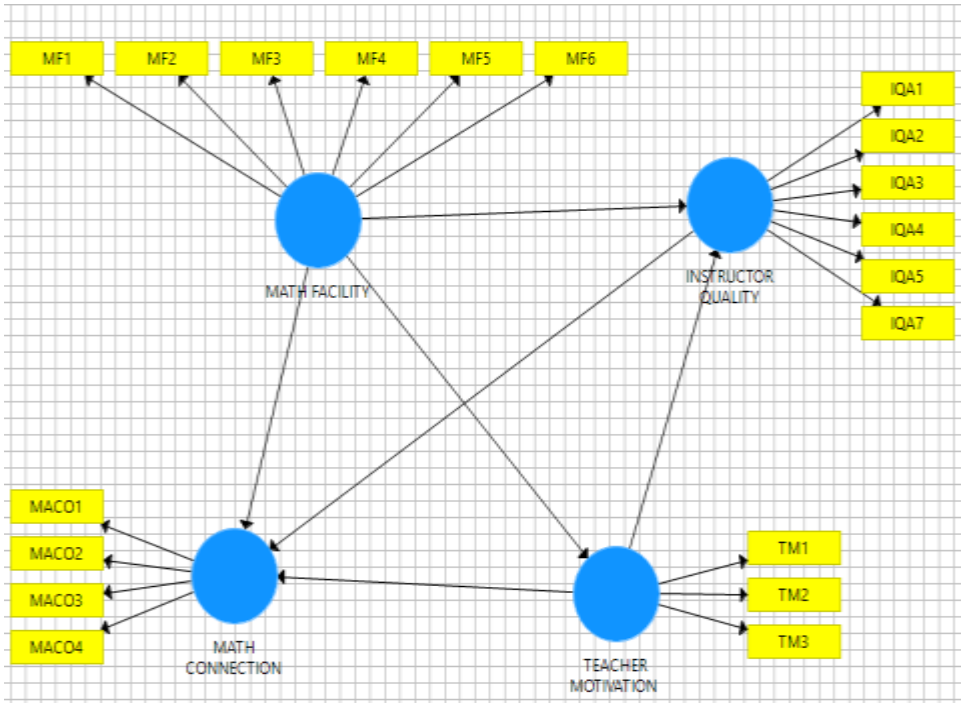

Figure 1: Conceptual model for teacher mathematics connectedness

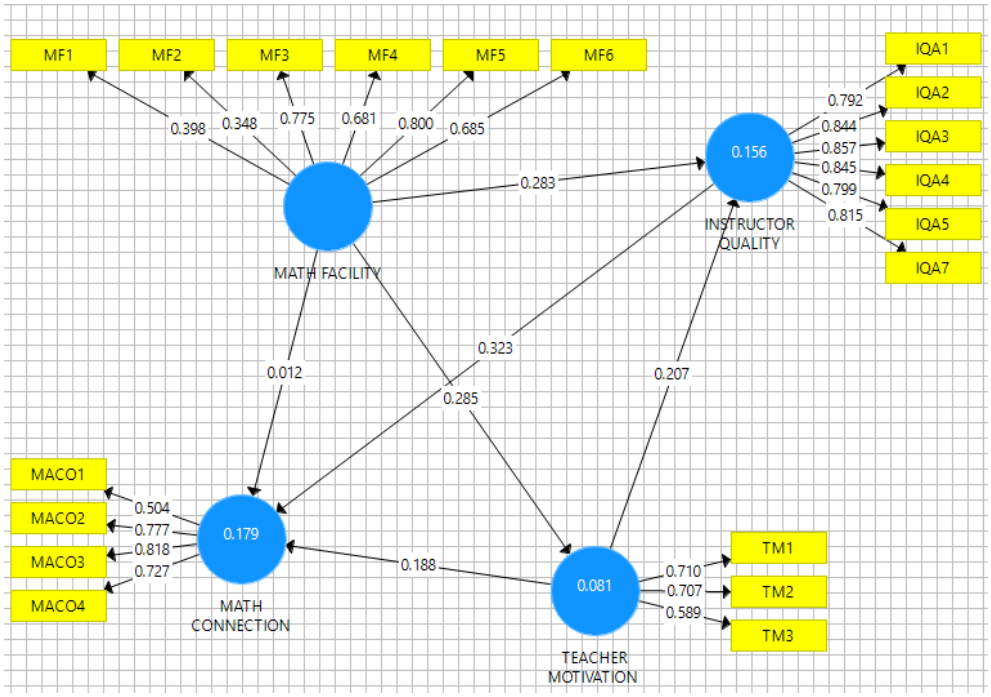

Figure 2: Empirical model for teacher mathematics connectedness

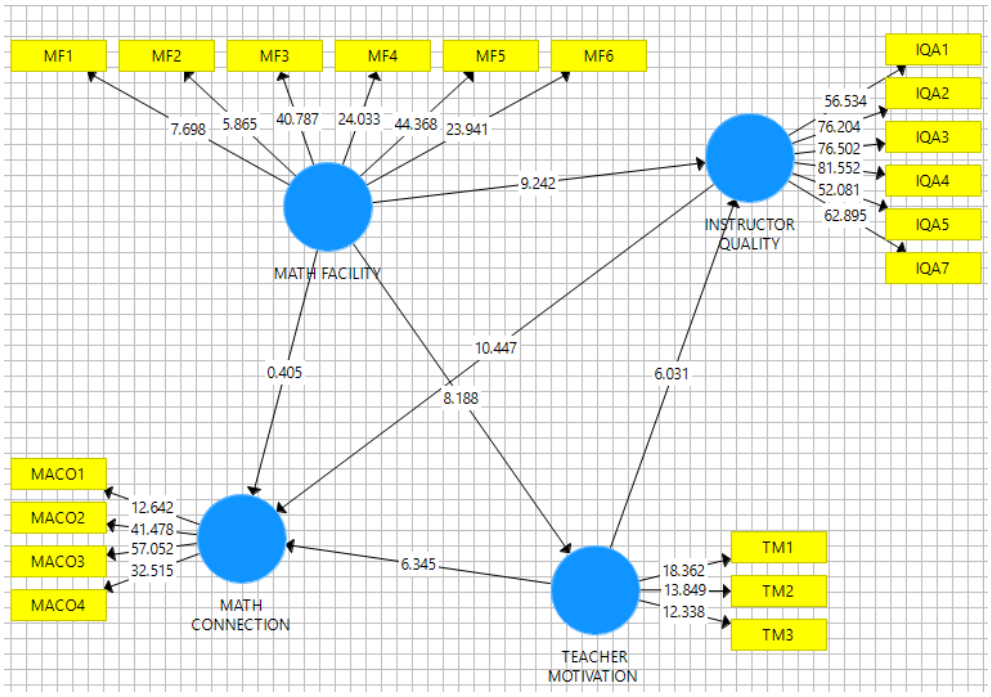

Figure 3: Bootstrap empirical model for teacher mathematics connectedness

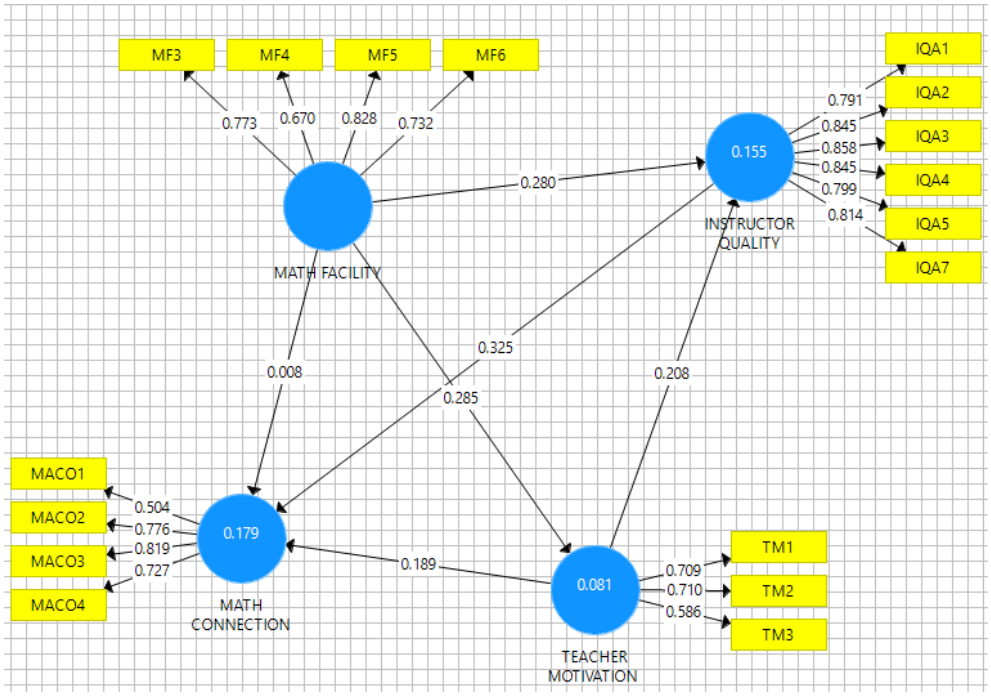

Figure 4: Modified empirical model for teacher mathematics connectedness

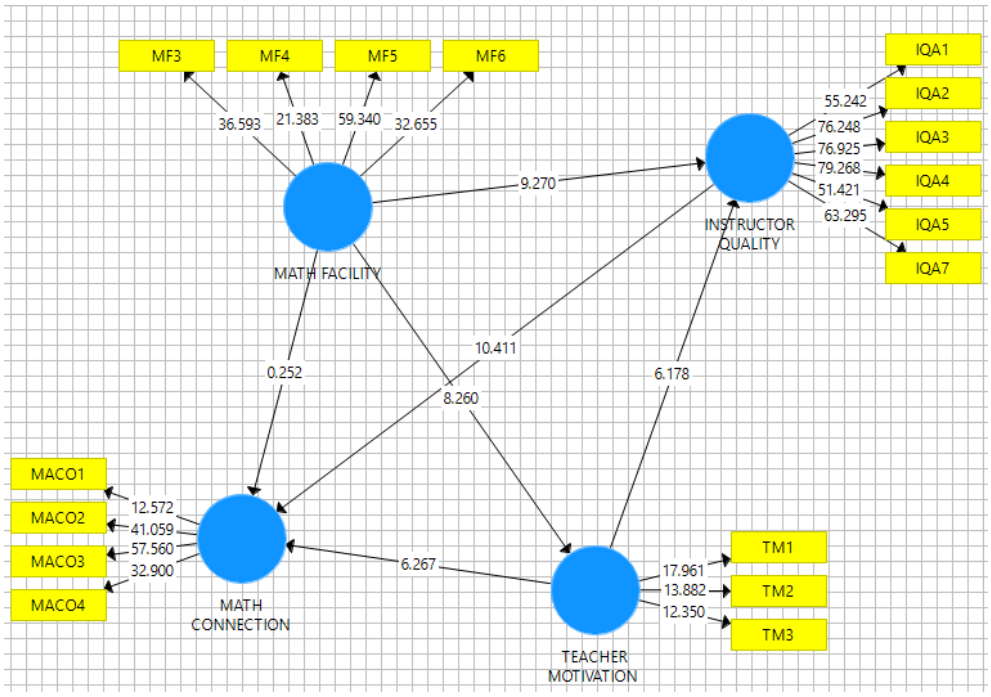

Figure 5: Bootstrap modified empirical model for teacher mathematics connectedness