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Quality Mathematics Teaching; Expressing Ghanaian Teachers' Views

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Abstract
Research on teacher observation has established teacher-content, teacher-student and student-content as three key relationships pertinent to effective mathematics teaching. This study expresses Ghanaian teachers' views about the three key relationships as they occur in mathematics lessons. The study also attempts to find out how these three relationships differ in views among JHS and SHS mathematics teachers. Well-constructed five-point Likert scale questionnaire were used to collect data from 50 JHS and 42 SHS mathematics teachers in one particular district in Ghana. Data was analysed using independent t-tests and effect sizes. The results showed an overall high expression of teachers' views about quality mathematics teaching. Significant differences existed between SHS and JHS mathematics teachers' views in teacher-content and student content relationships constructs of quality mathematics teaching. This study has implication for mathematics teaching and teacher professional development.

Key Words: *Quality, quality mathematics teaching, mathematical quality of instruction, construct, teachers' views.*

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I. Introduction

Mathematics is often seen as the most critical and important tool to use for the advancement of society. However, despite this understanding of its relevance in society the general performance of students in mathematics has continued to remain low over the years of which Ghana as a sub-Saharan country in Africa is no exception. In Ghana, student's general performance in mathematics in both BECE and WASSSE has continued to be low over the years. The gap in students' achievement is as a result of the gap in quality teaching (Darling-Hammond, 2011).

Ghana's education system has gone through a lot of educational reforms processes intended to enhance quality teaching and learning. One of such known reform is the "Free Compulsory Universal Basic Education (FCUBE)" which came as a result of the Dzobo committee report, 1996. FCUBE was developed based on three thematic areas of which one of these was to promote quality teaching and learning through reviewing and revising of training materials, introduction of new teacher incentives and regular in-service training for teachers. Another committee known as Anamuah-Mensah committee on educational review was set up in 2002 to investigate the educational structure and content. They identified Poor quality teaching by teachers at the Junior Secondary School (JSS) as a major hindrance in the reform process. Sullivan & Mousley (1994), in the analyses of the responses to an open-ended item of 125 Mathematics Teacher Educators' views on quality mathematics teaching, identified: "developing understanding, communicating"**,** active involvement**, "**problem solving**,** nurturing and organising for learning" as the main components of quality mathematics teaching. Among these key components, they identified and placed building mathematical understanding at the Centre of quality mathematics teaching which all other components help to develop. Darling-Hammond (2011), has identified characteristics of quality teaching to include students' active involvement in learning, using cognitive challenging tasks, using varied teaching approaches, always assessing student learning and adopting teaching to cater for the student needs, creating effective scaffolds and supports, providing clear standards, giving prompt feedback, and opportunities for revising work and developing cooperative classroom activities in which all students feel the sense of belonging. Romberg (2000), identified one of the basic assumptions of teaching mathematics that, meaningful learning of mathematics is the learning that builds on the child's previous knowledge through purposeful engagement and interaction (cited in Education Alliance, 2006). Despite several

researches done in the area of quality mathematics teaching there is still a problem of quality mathematics teaching reflecting in most mathematics classrooms. Agyei & Voogt (2011), reported that the receptive mode (lecture method) of teaching is the most frequently used method of teaching in the Senior High Schools where the teacher talks and writes on the board for students to listen and copy. Ampiah et al. (2004) as in Agyei & Voogt (2011) reported that the teacher-centred approaches to learning dominate pre-service and in-service mathematics learning programmes. To develop Science, Mathematics and ICT (SMICT) education in Sub-Saharan Africa calls for changes to the teacher's way of teaching from knowledge transmission and drilling to participatory teaching and learning (Ottevanger et al., 2007).

This study seeks to collate teachers' views on what constitutes quality mathematics teaching with the aim of identifying if teachers hold the right or positive views about quality mathematics teaching. There are several models of observing quality mathematics teaching including; the "International System for Teacher Observation and Feedback (ISTOF)" model, the "Quality of Teaching framework (QOT)", the "Mathematics Education Traditions of Europe project (METE)","Mathematical Quality of Instruction (MQI)" framework, "Knowledge Quartet (KQ)" and "Watson's" framework. The several models of observing quality mathematics teaching means it is not easy to identify what constitute quality mathematics teaching. In this study quality mathematics teaching will be conceptualized using the 'Mathematical Quality of Instruction (MQI)' framework which uses three main relationships commonly implored in mathematics education research, mostly referred to as 'the didactic triangle'. The relationships are: teacher - content; teacher - students; and student - content. Five different dimensions namely: "richness of the mathematics; errors and imprecision; working with students and mathematics; student participation in meaning making and reasoning; and connections between classroom work and mathematics are used to assess the relationships" (Ingram, Sammons, & Lindorff, 2018; Hill et al, 2008).

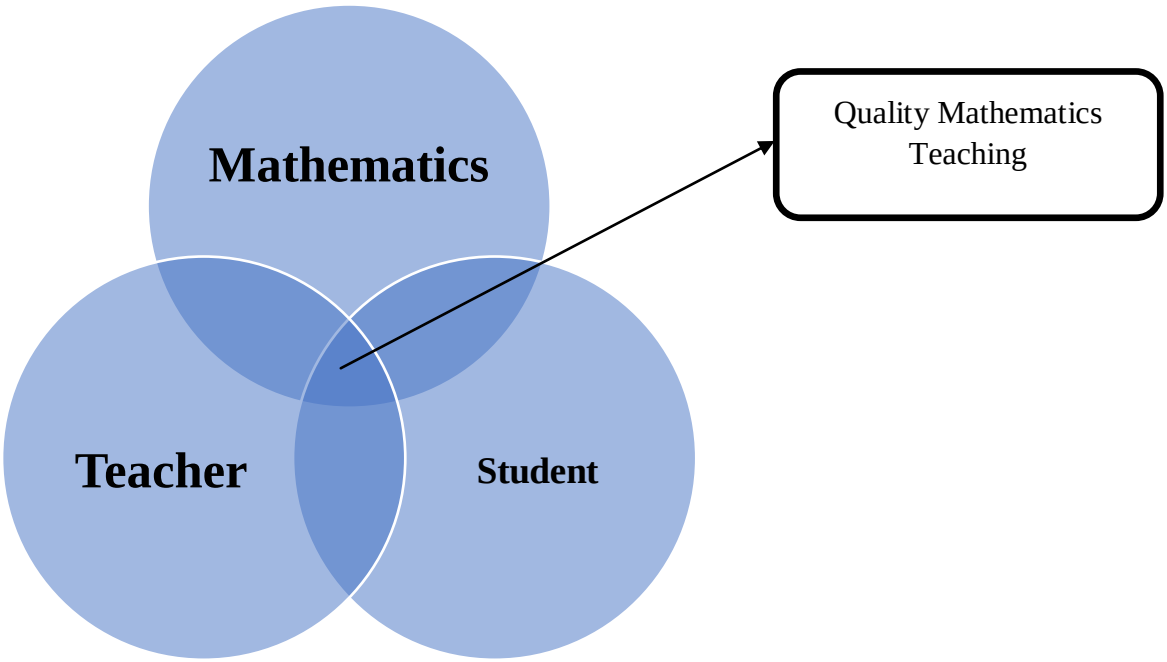

Figure 1: Mathematics Quality of Instruction framework showing the three relationships

MQI Constructs

Teacher–content relationship

This includes richness of the mathematics, and errors and imprecision. Richness of the mathematics comprise attending to the meaning of mathematical contents and making use of right practices and language in mathematics. Making meaning involves explaining and establishing connections among mathematical ideas or using multiple representations of the same idea. Different solution methods are given and compared for acceptability or efficacy. Mathematical generalisations are made from specific examples and mathematics language is used fluently and precisely. Errors and imprecision involve the teacher continuous making of errors in teaching that shows gaps in mathematical knowledge; teacher's misrepresentation of content in class through undistinguishable delivery of concepts; and/or showing impreciseness in the presentation of content.

Teacher–student relationship

This represents how a teacher works with students and mathematics content. This represents how a teacher interprets and responds to students' ideas in mathematics accurately. It also shows how a teacher adequately corrects students' errors, taking notice of specific misunderstandings that led to the errors.

Student–content relationship

This involves how students participate and reason with mathematics and connect classroom work to mathematics. Students' participation and reasoning includes student's engagement with mathematical content, especially how students ask questions and reason about mathematics; how students provide explanations to mathematical contents on their own or in response to questions asked by the teacher; how students find patterns, draw connections or explain and/or justify their conclusions. Connecting classroom work and mathematics is to ensure that classroom work has a mathematical point, or use instructional time only on activities that develop mathematical ideas.

The main research question to guide our study is: What are teachers' views about quality mathematics teaching? The following sub-research questions are formulated to answer the main research question.

1. What are the views of teachers about the three relationships constructs of mathematical quality of instruction?
2. What are the differences in views between JHS and SHS mathematics teachers about quality mathematics teaching?

II. Methodology

Research Design

The descriptive survey research design was used in order to identify and describe teachers' views about quality mathematics teaching.

Participants

Participants for the study comprised 50 Junior High School (JHS) and 42 Senior High school (SHS) mathematics teachers in Wenchi Municipal. Participants were selected using the purposeful non-probability random sampling technique.

Data Collecting Instruments

A questionnaire was used to collect data for this study. The researcher developed a 22 items questionnaire using key expressions of the five different dimensions in the MQI framework. The 22 items were organized into three sub-scales to measure teachers' views about the three key relationships (teacher-content, teacher-student and student-content relationships) involved in quality mathematics teaching. For all the 22 items, a five-point likert scale (1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often and 5 = Very often) was used. The scores are interpreted as follows: 1 is the lowest possible score, which represents a very low expression of teachers views, whiles 5 is the highest possible score which represents a very high expression of teachers views. The 22 items questionnaire was sent to 50 JHS mathematics teachers and 42 SHS mathematics teachers to be answered. All the 92 teachers answered and returned the questionnaire. 19 items out of 22 items on the questionnaire were scored and used in this report. Rescaling of two items (making errors in mathematics contents, making unclear articulation of concepts) was done, so that a high score on these items could be interpreted as lack of errors and unclear articulations. **Table 1** shows the sub-scales and the items under each. The reliability for the three sub-scales and the overall scale are shown in **table 2**.

Table 1: The three sub-scales and items on questionnaire

Sub-scale	Items
Teacher-content relationship	Explaining of mathematical ideas.
	Drawing connections among different mathematical ideas.
	Making use of different representations of the same idea.
	Representing mathematical practices by multiple solution methods.
	Developing mathematical generalisations from examples.
	Making errors in mathematics contents.
	Making unclear articulation of concepts.
Teacher-student relationship	Interpreting students' mathematical ideas.
	Responding to students' mathematical ideas.
	Correcting students' errors thoroughly.
Student-content relationship	Asking questions and reason about mathematics.
	Providing mathematical explanations independently.
	Responding to teachers' questions.

Finding patterns in mathematics.
Drawing connections among different mathematics ideas.
Explaining their solutions in class.
Coming out with a solution of a mathematics problem.
Justifying their solutions or conclusions.
Connecting classroom work to mathematics.

Data Collection and Analysis Procedures

The questionnaire was sent in person to each teacher in their respective schools to answer. Data was analysed using descriptive statistics (mean and standard deviation) and independent t-tests. Cohen's d effect sizes were calculated to show the magnitude of the difference between the views of JHS and SHS teachers in terms of standard deviation units (Cohen, 1969). Cohen (1969) as in Rice & Harris (2005), provides the following interpretation of effect sizes. An effect size of 0.2 is considered to be small, 0.5 is considered as medium and 0.8 is considered as large effect size.

III. Results

Reliability Statistics

Reliability refers to the consistency produced in results of a scale or variable when measured or observed in a repeated number of times. Reliability analysis thus refers to the analysis on reliability. In the analysis of reliability, a high reliability coefficient means the scale or variable produces results that are consistent and hence reliable.

A common measure of reliability is the Cronbach's alpha. It is often used in a survey or Likert scale questionnaire where the reliability of the questions that form a scale need to checked.

In this study there are three constructs or subscales with each containing different number of items or questions that form the construct. The researcher therefore present cronbach's alpha reliability for each construct as shown in **Table 2.**

Obtaining a reliability coefficient of 0.7 and above in social science research is a good measure (Pallant, 2013). Our study reveals an overall reliability of 0.789. Notwithstanding this, the study has shown reliability of less than 0.7 in two constructs or sub-scales. This is partly due to small sample size used. We will have better reliability results if sample size was increased.

Teachers' Views

A comparison between the views of JHS and SHS mathematics teachers on quality mathematics teaching as shown in **Table 2** revealed the following results. The overall mean of teachers views was (M) = 3.9731, 4.2237 for JHS and SHS mathematics teachers respectively. This appears to suggest high expression of teachers views about quality mathematics teaching. The results also showed the mean of teachers' views above 3.4 in each of the three constructs of MQI. The results (M = 3.9771 for JHS and M = 4.4252 for SHS mathematics teachers) obtained in teacher-content relationship construct seems to indicate high expression of teachers views about teacher-content relationship in quality mathematics teaching. The results (M = 4.4667 and 4.4048 for JHS and SHS mathematics teachers respectively) obtained in teacher-student relationship construct appear to show a very high expression of teachers views about teacher-student relationship in quality mathematics teaching. The results (M = 3.4756for JHS and M = 3.8413 for SHS mathematics teachers) obtained in the student-content relationship construct suggest a moderate to high expression of teachers views about the student-content relationship in quality mathematics teaching. The results revealed that of the three relationships constructs however, student-content relationships recorded the lowest mean whilst teacher-student relationship construct had the highest mean for each category of teachers. The results with p (0.000) < 0.001 indicated an apparently significant difference in overall expression of teachers' views between the JHS and SHS mathematics teachers about what constitutes quality mathematics teaching. The results, p (0.000) < 0.001 each, showed very significant differences in the expression of teachers' views between the two categories of teachers about the two relationships (teacher-content and student-content) involved in quality mathematics teaching. The results p (0.461) > 0.05 however, did not show any significant difference in the expression of teachers' views between the two groups of teachers about teacher-student relationship construct.

The results revealed large effect size (d = 0.78) difference in overall expression of teachers views between JHS and SHS mathematics teachers. The results seem to show very large effect size (d = 1.11) difference in expression of teachers views about teacher-content relationship construct of quality mathematics teaching. The results also indicate large effect size (d = 0.77) difference in expression of teachers views about student-content relationship construct. The results, however, showed a low effect size (d = -0.14) difference in expression of teachers' views about teacher-student construct.

Table 2:Reliability and differences in the views of JHS and SHS teachers on quality mathematics teaching

Subscale	Reliability (Cronbach's alpha)	JHS Teachers		SHS Teachers		Sig	Effect size
		M	SD	M	SD		
Teacher-Content	0.638	3.9771	0.4034	4.4252	0.3832	0.000	1.11
Teacher-Student	0.456	4.4667	0.4312	4.4048	0.3572	0.461	- 0.14
Student-Content	0.841	3.4756	0.578	3.8413	0.3699	0.000	0.77
Overall Perception	0.789	3.9731	0.3199	4.2237	0.2530	0.000	0.78

IV. Discussion

This study expressed JHS and SHS mathematics teachers' views about quality mathematics teaching in Ghana, using the Mathematics Quality of Instruction framework with the three relationships (teacher-content, teacher-student and student-content). Both JHS and SHs teachers showed high expression of teachers' views about the three relationship constructs of quality mathematics teaching. Obtaining a mean of teachers' views above 3.4 in each of the relationship construct suggest that the JHS and SHS teachers believe that all the three constructs constitute quality mathematics teaching. However, there were differences in teachers' views about the three relationships constructs of quality mathematics teaching and these differences were significant for teacher-content and student-content relationship constructs. SHS mathematics teachers' expressed higher views in teacher-content and student-content than JHS mathematics teachers. Moreover, JHS and SHS mathematics teachers have higher expression of teachers' views in teacher-content and teacher-student relationships than student-content relationship which appears that teachers rely on their knowledge to take centre-stage of the teaching and learning process and rather give limited opportunities to students to engage in the activities or the contents of mathematics lessons. This means that students are not given enough opportunities to participate in meaning making, reasoning and to connect between classroom work and mathematics. This is consistent with findings of previously related study by Agyei & Voogt (2011), which reported that the most frequently used method of teaching at the SHS is by transmission from teacher to students (Lecture Method). The study showed an apparent difference between SHS and JHS mathematics teachers. SHS mathematics teachers seem to express high views about student-content relationship than JHS mathematics teachers This means that despite limited opportunities giving to student's engagement with the content of mathematics, SHS mathematics teachers were more student-engaging than JHS mathematics teachers. This contradicts earlier findings that teachers at the lower level do actively engage students in mathematics activities than teachers at the higher level (Marks, 2000).

Both JHS and SHS teachers expressed high views in teacher-content relationship as key to quality mathematics teaching. However, a pronounced difference between the two groups seems to suggest that SHS mathematics teachers believe more than JHS mathematics teachers that, a very high teacher-content knowledge is a great asset for them to use in correcting students' errors and misunderstandings in mathematics at the SHS level. This confirms findings that teacher's mathematical knowledge serves as a great asset in correcting students' errors and misunderstandings when teaching mathematics (Baumert, et al, 2010; An, Kulm& Wu,2004).

V. Conclusion

The purpose of the study was achieved through careful administering of questionnaire to JHS and SHS mathematics teachers. The results indicated that SHS and JHS mathematics teachers expressed high views about the three constructs of quality mathematics teaching. SHS and JHS mathematics teachers believe that all the three constructs of MQI are necessary to produce quality mathematics teaching. However, there were pronounced differences between SHS and JHS mathematics teachers' views about quality mathematics teaching.

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