Integrating Problem Solving and Investigations in Mathematics: Ghanaian Teachers' Assessment Practices

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Abstract

This study investigated Ghanaian teachers' assessment practices and challenges of integrating problem solving and investigations in teaching mathematics. Using a questionnaire consisting of both closed-ended and open-ended items, 159 certificated teachers' assessment practices and challenges of integrating problem solving and investigations were examined. Data were analyzed using qualitative content analysis. Results indicated that many practicing teachers integrated and used multiple assessment techniques in their problem solving and investigation lessons. A majority of the teachers' comments (62.65%) indicated the use of traditional rather than alternative assessment techniques. Teachers identified pedagogical issues, motivation, social learning, diagnosis, and student thinking as the reasons for their choice of assessment techniques. Three major challenges limited the use of problem solving and investigations: curriculum, student-related, and teacher-related issues. Ghana should make problem solving and investigations in mathematics integral parts of in-service professional development and teacher education programs.

Keywords: Assessment practices, Ghana, investigations, mathematics, problem solving

1.0Introduction

The ultimate aim of education is to foster and enhance student personal and academic potential. Achieving this aim requires a shift from developing specific content knowledge to enhancing problem solving skills.Monaghan, Pool, Roper, and Threlfall (2009) questioned the use of learning mathematics if it cannot be used to solve problems. Research (Monaghan et al., 2009; Nelson, 2011; Rittle-Johnson, Mathews, Taylor, &McEldoon, 2010) indicates that the development of students' problem-solving abilities is the primary concern of mathematics education in most countries. Thus, many mathematics education programs emphasizethedevelopment ofproblem solving competencies and skills that will enable the learner to function in school and beyond.In Ghana, the mathematics teaching syllabus requiresthat students are taught to apply their knowledge, develop analytical thinking skills, develop plans, generate ideas and creative solutions, and addresseveryday mathematical situations. Problem solving and investigations indeed are at the heart of the revised Ghanaian mathematics curriculum.The Ministry of Education (MOE; 2007a; 2007b) has carefully designedthe mathematics curriculum content for pre-university education with the goal of helping learners to develop problemsolving skillsand mathematical ideas to carry out investigations with diligence, perseverance and confidence.

Problem solving is not a stand-alone topic in the Ghanaian mathematics curriculum.Rather,teachersareexpected to incorporate problem solving activities in every lessonto develop learners' competencies and skills for a functional life. Specifically, teachers are expected to include appropriate and realistic problems and mathematical investigations that will require the use of mathematical processes and provide opportunities for students to explore mathematical ideas (MOE, 2007b).By engaging students in solving everyday real problems, they learn to become flexible thinkers and good problem solvers in practical situations.

Real-life problems have multiple solution pathways, multiple evaluation criteria,and constraints that make problem solving challenging.However, for students to be able to apply concepts learned in one context to solve problems in a different context,teachers must employ assessment techniques that incorporate problem solving skills (Greiff, Wüstenberg, Holt, Goldhammer &Funke, 2013).

1.1 Assessing Problem Solving and Investigations in Mathematics

Assessing problem solving and investigation activitiesensure that studenttasks mirror the desired mathematical processes outlinedin the curriculum. Problem solving and mathematical investigations involve cognitive skills and abilities thatcannot easily be measured by traditional assessment techniques.Often comments from traditional assessments are open to different interpretations (Montgomery, 2002) and specific criteria for assessment are not explained in advance by the instructor (Hargreaves, Earl, & Schmidt, 2002; Montgomery, 2002). These weaknesses of traditional assessment limit their formative value.

It is essential to assess students holisticallyto capture the demonstration of what they know, how they know it and their ability to apply the knowledge acquired. Monaghan et al. (2009) point out that while most of mathematics requires convergent thinking, problem solving requires some degree of divergent thinking which is best assessed by authentic assessment approaches. The understanding that an effective assessment system relies on a variety of assessment techniques is well documented (Glanfield, Bush, & Stenmark, 2003; Kennedy, Tipps, & Johnson, 2004; McMillan, Myran & Workman, 2002). For example, formal assessment alone cannot capture holistic information about a student (Kennedy et al., 2004), as paper and pencil tests offer only a glimpse of what students know and think (Glanfield et al., 2003).Therefore, to tapthe full range of student information, teachers need to utilizea wide range ofassessment alternatives.

1.3 Research onAssessing Problem Solving and Investigations in Mathematics

Assessment of problem solving and investigations require access to evidence of processes in which students produce extended responses from which the problem solving process can be inferred (Monaghan et al., 2009). Using multiple assessments in mathematical investigations provide a big picture of student learning (Kennedy et al., 2004). Common techniques for assessing problem solving skills includeinformal observation, interviews,journal writing, and project report. Morony and Olssen (1994) noted that observations provide rich information and enhance teacher confidence in student evaluations.They argued that observations and student self-assessments are part of a comprehensive range of contemporary alternative assessment practices that facilitate student learning.

Furthermore, teachers can learn more aboutstudents when they engagethemin conversations, observe their actions, and read their reflections (Glanfield et al., 2003). Various studies have explored the possibility of alternative assessments for problem solving and investigations. Iannone and Simpson (2012), for example, examined the practicalities of replacing coursework with one-on-one oral assessment of students.

Their findings indicate that although oral assessment is challengingand potentially a source of anxiety and stress, it promotes student thinking, understanding, and aids retention. Students continue to see written examination as the best form of assessment because it provides clearer instructions, makes them think more, learn more, and brings ideas together. Similarly, Nelson's (2011) study on the effect of oral assessment on at-risk students' performance in calculus problems revealed that students in the experimental group did not only perform significantly better on the overall examination, but also on conceptualand procedural questions. These studies suggest oral assessment as an effective form of assessment for problem solving.

Rittle-Johnson et al. (2010) used aconstruct-modeling approachto assess children's problem solving ability on mathematical equivalence. They reported that theconstruct-modeling approach captureda wide range of children's performancesand provided diagnostic information for differentiated instruction. They concluded that theconstruct assessment model was a powerful tool for understanding knowledge progression and assessing the effectiveness of interventions.

Monaghan et al. (2009) proposed open-start problems for assessing problem solving. They noted that using open-start problems could help solve the challenges of assessing problem solving in ways that could positively influence mathematics teaching. Leatham, Lawrence, and Mewborn (2005), for instance, reported that open-ended assessment items significantly improved fourth graders' reasoning, self-confidence, and willingness to share their mathematical thinking. Thus open assessments provide a new dimension for capturing process skills in problem solving.

These findings suggest the potential of alternative forms of assessment to increase and promotethe understandingof students' problem-solving abilities.The resultsof these studiesopened a new window of alternative assessment pathways for capturingprocesses and skills in students' mathematical tasks for informed decisions.In Ghana, the National Education Assessment (NEA)forPrimary 3 (grade 3) and Primary 6 (grade 6) students in 2011 showed varying achievements in students'mathematics competency and proficiency. The percentage of Primary 3 students achieving minimum competency and proficiency levels were 52.6 and 18.2 respectively, whereas the percentage of Primary 6 students achieving these levels were 56.9 and 16.1 respectively.

The 2007 Trends in International Mathematics and Science Study (TIMSS) showed that Ghana scored 309on the mathematics test (Anamuah-Mensah, Mereku, & Ghartey-Ampiah, 2008), a value far below the TIMSS average scale of 500.To curtail future poor performances, assessment instruments should be analytic, and be able tocapture information that would be helpful in improving students' understanding andprogress, andcurriculum development and implementation.Consequently, teachers' assessment techniques should adequately capture evidence of students' conceptual understandings and skills to inform their progress.

1.4 Problem Statement

Classroom assessments are controlled by teachers who,by their professional training,knowwhat to teach, how to teach, and how to assess. Practiceseems to suggestthat teachers integrate problem solving in their mathematics lessons. However, there is no research evidence on how teachers assess their mathematical problem solving and investigationactivities in the classroom. Often teachers'instructional problem solving assessmenttechniquestend to be insensitive to the ultimate goal of producing individualscapable of solvingor exploring everyday mathematical situations.Instructionally insensitive mathematics assessments lead to abysmal performance as evidenced in the results of the national (NEA, 2011) and international (Anamuah-Mensah, et al., 2008) tests. Thus recurring student failures in problem solving tests warrant investigations into the problem solving and mathematics exploration assessment techniques of Ghanaian teachers.

1.5 Purpose of the Study

The fluency with which students solve problems is an important goal of mathematics instruction. Research onteachers' informal assessment practices indicate that teachers underestimate the role of interpretation of evidence (Watson, 2000). Valid assessments that account for educational progress must be sensitive to educationalobjectives.

Instructional insensitive tests are incapable of measuring the effects of instruction on student progress and often lead to abysmal results (Lederman & Burnstein, 2006). Therefore the purpose of the current study was to examineteachers' assessment practicesand challenges in teaching and assessing problem solving and investigationactivities in Ghanaian mathematics lessons.

1.6 Research Questions

In reporting students' progress of achievement, it is essential that judgments are based on sound assessment practices. In this context, the study attempted to answer the following questions:

1. What proportion of Ghanaian teachers engages students in problem solving and investigations in their mathematics lessons?
2. What assessment practices do Ghanaian teachers use for reporting students' achievements in mathematical problem solving and investigations?
3. What are teachers' reasons for their choice of assessment techniques in mathematics?
4. What are the challenges in assessing problem solving and investigations in Ghanaian mathematics lessons?

1.7 Significance of the study

Assessment feedback influence students' beliefs about their own abilities to succeed in mathematics (National Council of Teachers of Mathematics [NCTM], 2000) and provide information to parents on the value of their investment.The quality of instructional decisionsdependson the assessment techniques and the number of assessmentsources. This study is an effort to unearth the assessment techniques that are used to holistically capture students' abilities and progress. Authentic holistic evidence of students' progress wouldpotentially improves student performance in mathematical problem solving and investigations. It would, in turn, inform instructional decisions and policy formulation.

2.0 Method

2.1 Participants and Setting

Convenience sampling was used to select 159 (134 [84.3%] males, 25 [15.7%] females) practicing teachers in pre-tertiary institutions namely the basic schools, senior high schools, and Colleges of Education.The frequency (percentage) distribution of their academic qualifications is as follows:62 (39%) Diploma, 77 (48.4%) Bachelor's Degree, 13 (8.2%) Master's degree, and 7(4.4%) Certificate-A-teachers.The sample included participants from all the 10 administrative regions of Ghana. As an exploratory study, the heterogeneity of teachers will provide a glimpse of what pertains across the educational system for a more comprehensive study. The regional distribution of the participants is shown in Table 1.

2.2 Instrument

The study utilized a questionnaire made up of two sections. Section A elicited participants' biographical information namely gender, number of years teaching mathematics, highest level of education attained, and grade level they taught. Section B, consisting of closed and open-ended items, asked participants to: (a) Indicate whether or not they engaged students in mathematical problem solving, (b) Indicate whether or not they assessed mathematical problem solving, (c) List the assessment techniques they used for problem solving, if applicable, (d) State reasons for their choice of assessments, and (e) Describe the challenges of teaching and assessing mathematics problem solving.

2.3 Data Collection Procedure

The second author administered the questionnairestopracticing teacherswith varying academic degrees and experiences in teaching at the basic schools,senior secondary schools and Colleges of Education.Those teachers who agreed to take part in the studyreturned the completed questionnaires to the second author. The instructions indicated to the teachers that there was no right or wrong answers to the questionnaire items; and encouraged teachers to be as truthful as possible.

Data generated from the open-ended questions were analyzed using qualitative content analysis (Mayring, 2000; Johnson & Christensen, 2000; Patton, 2002). Qualitative content analysiswas deemed appropriate for analyzing the data both qualitatively and quantitatively as it may include deductive reasoning (Patton, 2002).

2.3.1 Inductive analysis. All the authors independently read and re-read teachers' qualitative responses to determine tentative categories. Next, the authors discussed the tentative categories and attained consensus on the final categories.

2.3.2 Deductive analysis. The authors utilized a three-step procedure for the deductive analysis. First, they defined each category that was derived from the inductive analysis. Second, the first and second authors independently coded 15 randomly selected questionnaires utilizing frequency counts, with an inter-rater agreement of 85%. Third, the first and second authors then coded 54 and 73 questionnaires of teachers who indicated they integrated and assessed problem solving in their mathematics lessons. Finally, the analyzed data were presented in frequency counts and percentages (see Tables 3, 4b, and 5b).

3.0 Results

3.1 Integration of Problem Solving in Mathematics

The study explored159 classroom teachers' practices regarding the integrationand assessment practices of problem solving and teachers' perceived barriers inintegrating and assessing problem solving and investigations in their mathematics classrooms.Out of the 159 teachers who responded to the questionnaire, 79.9% (127) engaged their students inproblem solving while20.1% (32) teachers did not(see Table 2).This suggests that majority of Ghanaian teachers appear to integrate problem solving and investigations in their lessons. Responses from the 127 teachers who engaged their students in problem solving and investigations provided data for further analysis.

3.2 Teachers' Problem Solving Assessment Practices

3.2.1 Qualitative data. The inductive analysis indicated teachers' problem solving assessment practices were in two categories: traditional and alternative assessments. These categories were further divided into four and seven sub-categories respectively. The sub-categories under traditional assessments were: class exercise, tests, homework, and others. The sub-categories under alternative assessments included: oral presentations, discussions, interview, group work, project work, observation and participation.

3.2.2. Quantitative data. Table 3 presents data on teachers' problem solving assessment techniques. The data indicate that the teachers utilized more traditional (62.65%) than alternative (37.35%) assessment techniques. The highest percentage of traditional assessments the teachers utilized were class exercise and tests (23.29% each), followed by homework (15.26%) and others (0.81%) respectively.The highest percentage of alternative assessments the teachers utilized was oral presentation (12.44%), followed by group work (9.64%), project work (7.63%), discussion (3.61%), observation (2.01 %), participation (1.21%), and interview (0.81%).

3.3 Teachers' Reasons for the Choice of Assessment Techniques

3.3.1 Qualitative data. Qualitative data on participants' responses for the choice of assessment techniques are presented in Table 4a. Theinductive analysis revealed that teachers identified pedagogical issues, motivation, social learning, diagnosis, and student thinking as the reasons for their choice of assessment techniques. The sub-categories for pedagogical issues were: pedagogical decisions, immediate feedback to students, and gaining in-depth knowledge of students' ability.

Three sub-categories were identified under motivation: student learning, confidence, and promoting teacher work. The social learning category comprised: self-learning, student involvement, and student socialization. Three sub-categories were also identified under diagnosis: student strengths and weaknesses, progress, and knowledge level. Finally, the student thinking category comprised of critical thinking and independent work.

3.3.2 Quantitative data. Teachers'reasons for their choice of assessment techniques were further quantified based on the five inductive categories in Table 4a. These are presentedin Table 4b.Table 4b indicates that themost common reason for thechoice of assessment techniques stated by 41.67% of the teachers' commentswas pedagogical. Approximately11.54% of teachers' comments indicated the use of assessment techniques for motivational reasons.Table 4balso shows that 22.44% of teachers' statementsindicated they usedhomework, class exercises, and group assignments to encourage social learning.

The teachers believed that such assessment techniques encouraged students to self-learn through exploration, practice, and socialization. Diagnosis of student learning accounted for15.38% of teachers' statements. These included ascertaining student strengths and weaknesses and measuring student potential and attainment levels.

Finally, the lowest percentage of statements (8.97%) showed teachers 'choice of assessment techniques reflected student thinking. The analysis of the results in Table 4b suggests that the teachers had divergent reasons for selecting a particular assessmenttechnique for problem solving and investigations.

3.4. Challenges of Integrating Problem Solving in Mathematics

3.4.1. Qualitative data. Qualitative data on teachers' perceived challenges of integrating problem solving in mathematics are presented in Table 5a. The inductive analysis indicated three categories: curriculum, student-related, and teacher-related issues.

3.4.2. Quantitative data. Table5bpresents quantitative data on teachers' challenges of integrating problem solving and investigations in their mathematics lessons. The dataindicatedthat the highest percentage of challenges teachers encountered were curriculum (56.33%), followed by student-related (34.81%), and teacher-related (8.86%) issues.The highest percentage of comments under the curriculum categorywas lackof relevant teaching and learning materials (TLMs) (24.68%), followed by limited time for problem solving and investigation activities (24.05%), and a loaded curriculum (7.60%).

Data inTable 5b also showed that student-relatedchallenges included: cognitively demanding (15.82%), students' negative attitudes (12.66%), and large class sizes (6.33%). Teacher-related sub-categories included teacher incompetency (5.06%) and low teacher motivation (3.80%). The data suggest that the nature of the curriculum, coupled with lack of instructional resources, presented the greatest challenge to the teachers' efforts to integrate problem solving and investigations in mathematics lessons.

4.0 Discussion and Conclusions

The present study explored teachers' integration and assessment of problem solving and investigations inmathematics lessons.The data revealed that most teachers (79.9%) engaged their students in problem solving and investigation activities.Teachers in this study useda wide variety of traditional and alternative assessment techniques identified in pedagogical literature. However, many teachers tended to use traditional rather than alternative assessments**.** Even though teachers can use traditional assessments to establishthe state of the actual knowledge of the student (Watson, 2000), they are limited in their capability to respond to learners' active construction of knowledge, thereby limiting their formative value. The minimal use of alternative assessment techniques may be a result of the teachers' incompetence in problem solving and investigations.

The finding that teacher assessment techniques were to informpedagogical decisions, social learning, diagnostic purpose, andpromote student thinking is consistent with the research literature (Hargreaves et al., 2002; Kennedy et al., 2004). However, it is worrisome that very few of the teachers' comments pertained to social learning and promoting student thinking. Oral discussions and student thinking skills encourage students to actively construct mathematical knowledge through problem solving (Monaghan et al., 2009**).**Teachers'challenges in teaching and assessing problemsolving and investigation activities in their lessons ranged fromlarge class sizes, limited time, lack ofmaterials and resources, lack of assessment model, deficiency in teacher knowledge, to the challenging nature of problem solving and investigations. It is interesting that a curriculum innovation that recognized problem solving and investigations as the heart of doing mathematics failed to provide adequate human and material resources necessary for its successful implementation.

The findings of limited problem solving and investigations activities in textbooks, teacher incompetency, and lack of resource materials to engage and assess students are serious concerns. The evidencethat more than 20% of teachers neither engaged nor assessedproblem solving and or investigationssuggests that these topics were used as "bolt-on" activities (Bottle, 2005), rather than an integral part of everyday mathematics teaching and learning. Integrating problem solving and investigation is an excellent way of teaching mathematical principles and procedures for understanding. Thus it isimportant that teachers are provided with the relevant teaching and learning materials to enable them to integrate problem solving and investigations in all mathematics lessons.

The West African Examinations Council (WAEC) is the main external examining body responsible for: developing and maintaining internationally-accepted procedures in examinations, and providing qualitative and reliable educational assessment. Examinations conducted by WAEC are valued by students, teachers and parents.

Consequently, students, parents, and even teachers perceive excellent performance on WAEC conducted examinations as a guarantee for progression in the academic ladder. As a result, teachers teach to have their studentsdo well in WAEC examinations.

Perhaps the teachers in this study did not involve students in real problem solving and investigations because these topics do not feature on WAEC examinations. Perceiving problem solving and investigations to be cognitively demanding in addition to not being featured on WAEC examinations, the obvious conclusion for teachers is that they are not worth struggling for. In conclusion, problem solving and investigations in the curriculum are a result of paradigm shift from the behaviourist to the constructivist conceptions of learning and therecognitionthat problem solving and investigations are central to developing skills and personal construction of mathematical knowledge. The study investigated teachers' integration and assessment practices of problem solving and investigations among Ghanaian mathematics teachers.A majority of teachers in the study integrated problem solving and investigations in their lessons.

They recognized the value of capturing the full range of students' capabilities and useda blend of traditional and alternative assessments in their assessment practices. Teachers' assessment practices are purposefully selected to make judgments about student learning, to use feedback in teaching, and make informed pedagogical decisions. Although teachers' assessments were purposeful, most of their choices (traditional techniques) lack the capacity to develop the desired skills outlined in the curriculum. Teachers' assessment efforts in problem solving and investigations are challenged by lack of curricular resources, incompetence, and student attitudes. Concerted efforts must be made to address these challenges in order to achieve the objectives of thecurriculum.

Findings in the present study have implications for in-service professional development and teacher education.First, the Ghana Education Service (GES) would do well to organize in-service training programs on problem solving and investigations for basic and senior high school mathematics teachers. Second, we recommend that the GES develops teacher and student manuals on problem solving and investigations to supplement course textbooks— teachers and students should have access to the manuals. More importantly, the GES, through supervisory practices, should hold teachers accountable for integrating and assessing problem solving and investigations in their classrooms. Third, problem solving and investigations should be integral parts of mathematics teacher education programs in Ghana.

The present study did not observe teachers in real classroom settings. Therefore, it cannot be confirmed that those who indicated they integrated and or assessed problem solving and investigations in their lessons actually did so. Also, some teachers indicated that they did not integrate or assess problem solving and investigations in their instructional practices. A study that would observe how teachers administer their assessments, and explore reasons why a significant 20.1% of the teachers did not integrate or assessproblem solving and investigations is recommended.

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Table 1: Distribution of participants by region

Region	Participants	
	F	%
Central	34	21.4
Greater-Accra	20	12.6
Upper West	20	12.6
Ashanti	19	11.9
Volta	16	10.1
Brong-Ahafo	14	8.8
Eastern	14	8.8
Northern	9	5.6
Western	9	5.6
Upper East	4	2.5

Table 2: Integrating problem solving in mathematics (n = 159)

Region	Yes		No	
	f	%	f	%
Integrated problem solving	127	79.87	32	20.13
Assessed problem solving	127	79.87	32	20.13

Table 3: Teachers' problem solving assessment practices (n=127)

Assessment Technique	f	%
Traditional Assessment techniques		*62.65*
Class exercise	58	23.29
Tests	58	23.29
Home work/Assignment	38	15.26
Others	2	0.81
Alternative Assessment techniques		*37.35*
Oral presentations	31	12.44
Discussions	9	3.61
Interview	2	0.81
Group work	24	9.64
Project work	19	7.63
Observation	5	2.01
Participation	3	1.21
Total	249	100

Table 4a: Representative quotes of teachers' reasons for choice of assessment techniques

Category	Teachers' Representative Quotes
Pedagogical Issues	"Investigations help determine the weakness of the child for the needed assistance and to inform decisions to change or maintain their teaching methods" (Male, Basic School Teacher). "When students demonstrate, they understand better than [the teacher] telling them how the problem is solved" (Female, Basic School Teacher).
Motivation	"Techniques [assessments] such as oral and written exercises were to develop and sustain [students'] interest in problem solving, and to motivate them to learn more on their own" (Male, Basic School Teacher).
Social learning	"Project work allows students to work on their own, involve each student, make students active learners as well as encourage students to explore mathematical ideas to discover things for themselves" (Male, College Teacher).
Diagnosis	"Oral work, exercises and class tests to assess students' real understandings, their strengths and weaknesses, effectiveness of their teaching and learning and to measure the accuracy and speed of my students" (Female, Basic School Teacher).
Student thinking	"When children embark on project work they effectively use their senses to enhance their capability, critical thinking and discover firsthand information about mathematics" (Male, Senior High School Teacher).

Table 4b: Teachers' reasons for choice of assessment techniques (n=127)

Category	F	%
Pedagogical Issues	65	41.67
Inform pedagogical decisions	17	10.90
Immediate feedback to students	3	1.92
Get student understanding	39	25
In-depth knowledge of students' ability	6	3.85
Give confidence	2	1.28
Promotes teacher work	2	1.28
Motivation	18	11.54
Student learning	14	8.98
Confidence	2	1.28
Teacher Work	2	1.28
Social learning	35	22.44
Self-learn through collaborative exploration	10	6.41
Students involvement	18	11.54
Students to socialize	7	4.49
Diagnosis	24	15.38
Ascertain student strengths and weaknesses	15	9.62
Measure student potential	6	3.84
To determine student attainments	3	1.92
Student thinking	14	8.97
Critical thinking	10	6.41
Independent work	4	2.56
Total	156	100

Table 5a: Representative quotes of teachers' challenges of integrating of problem solving in mathematics lessons (n=127)

Challenge	Teachers' Representative Quotes
Curriculum	"The curriculum is too loaded, too rigid and does not give room for dealing with investigations in detail" (Male, Senior High School Teacher.).
	"Lack of materials in our schools, lack of TLMs for practical activities in problem solving, and insufficient curriculum materials to promote problem solving and investigations"(Female, Basic School Teacher).
Student	"Problem solving and investigations are not easy for most students to understand because they are not used to them from the early stages and the context in which words or phrases are used pose problems to learners (Male, Basic School Teacher).
	"Some [students] find it difficult to model problems mathematically; others are used to formulas and see investigations boring" (Male, College of Education Teacher).
Teacher	"There is no model for assessing problem solving/investigations, they cannot identify the topics that involve problem solving and are handicapped in the area of mathematics investigations" (Female, Basic School Teacher).
	"… we [teachers] cannot identify the topics that involve problem solving and are handicapped in the area of mathematics investigations"(Female, Basic School Teacher)

Table 5b: Challenges of integrating of PS and investigations in mathematics lessons (n=127)

Challenge	f	%
Curriculum	*89*	*56.33*
Lack of TLMs materials	39	24.68
Limited time	38	24.05
Curriculum loaded	12	7.60
Student	*55*	*34.81*
Cognitively demanding	25	15.82
Students negative attitude	20	12.66
Large class size	10	6.33
Teacher	*14*	*8.86*
Teacher incompetency	8	5.06
Low teacher motivation	6	3.80
Total	158	100