

**CLASSROOM ASSESSMENT PRACTICES BY MATHEMATICS TEACHERS
IN SECONDARY SCHOOLS OF KENYA**

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BY

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DECLARATION

I Kemboi Eliud Kipkorir, hereby declare that this is my original work and has never been presented to any university for the award of a Masters degree in Education, Measurement and Evaluation of the University of Nairobi.

Signed:

Date:

Supervisor:

This research project has been submitted for examination with my approval as the University supervisor.

Signature:

Date.....

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DEDICATION

This scholarly work is dedicated to my parents, teachers and lecturers of the University of Nairobi for having struggled tirelessly in educating me to the level I am in now. I am also deeply indebted to my wife Eunice, my children, Elsie, Euan and Effie and to my brother, Shadrack for their moral and financial support of my studies.

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ABSTRACT

This study examined classroom assessment practices by Secondary school mathematics teachers in Nandi Central Sub-County. The objectives of the study were:-

1. To investigate the common teachers' classroom assessment practices used in school across teaching levels
2. To establish common assessment tools/formats applied by math teachers for classroom assessment
3. To establish how the math teachers used assessment information collected from students
4. To establish how often math teachers considered the mathematics competencies as they prepared assessment tools for classroom assessment practices.

The study used both quantitative and qualitative research designs to collect and analyze the data. Data was collected through questionnaires, interviews and analyzed documented data (School records). The information from the questionnaires was presented in figures and percentages, in tables and graphs while the information obtained from interviews were analyzed using qualitative techniques. Quantitative data was analyzed using the statistical software package for social sciences (SPSS). The findings were that discourse, observation, students' self-assessment and peer assessment were the common classroom assessment practices reported. Open-ended questions, select-type items and super items were the common assessment formats used across school categories. Assessment information were mainly used to give students grades or marks, diagnose students' learning problems and to assign them to different programs or tasks and mathematical competencies often considered when math teachers prepared assessment tools across school categories included communication, problem solving, mathematical reasoning and use of symbols and formal language. Recommendations, implications, and suggestions for practice and future research are discussed.

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LIST OF ABBREVIATIONS AND ACRONYMS

KCSE	–	Kenya Certificate of Secondary Education
KNEC	–	Kenya National Examination Council
SPSS	–	Statistical Software Package for Social Sciences
AFT	–	American Federation of Teachers
NCTM	–	National Council on Measurement in Education
NEA	–	National Education Association
UNESCO	–	United Nations Organization for Education, Science and Culture
IEA	–	International Association for the Evaluation of educational Achievement
TIMSS	–	Trends in International Mathematics and Sciences Study
PIRLS	–	Progress for international Reading Literacy Study
OECD	–	Organization for Economic Co-operation and Development
PISA	–	Program for International Student Achievement
MLA	–	Monitoring Learning Achievement
LABORATORIO	–	Latin American Laboratory for Assessment of Quality in Education
SACMEQ	–	South African Consortium for the Monitoring of Education Quality
PASEC	–	Program for the Analysis of Educational Systems of the confemer
CATS	–	Continuous Assessment Tests
CAPS	–	Classroom Assessment Practices
DOS	–	Director of Studies

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CHAPTER ONE

INTRODUCTION

1.1 Background of study

It is becoming more and more evident that classroom assessment is an integral component of the teaching and learning process (Gipps, 1990; Black and William, 1998). Many researches on classroom assessment as an essential aspect of effective teaching and learning are being now done than before (Bryant and Driscoll, 1998; McMillan, Myran and Workman, 2002; Stiggins, 2002).

While classroom assessment research has focused primarily on issues of validity and reliability of traditional paper-and-pencil testing, during the last two decades, a dramatic shift has occurred in classroom measurement with educators becoming increasingly aware of the need to focus on alternative means of assessing students that would, “directly examine performance on worthy intellectual tasks”(Wiggins, 1990, p. 1), and validly measure important classroom objectives and use assessment to promote learning.

Most research studies in both education and cognitive psychology have reported weaknesses in the way mathematics is taught. The most serious weakness is the psychological assumption about how mathematics is learned which is based on the “stimulus-response” theory (Althouse, 1994; Cathcart, Pothier, Vance & Bezuk, 2001; Sheffield & Cruikshank, 2000). The “stimulus-response” theory states that learning occurs when a “bond” is established between some stimulus and a person’s response to it (Cathcart, Pothier, Vance & Bezuk, 2001). Cathcart et al.(2001) went further to say that, in the above scenario, drill becomes a major component in the instructional process because the more often a correct response is made to stimulus, the more established the bond becomes. Under this theory students are given lengthy and often

complex problems, particularly computations with the belief that the exercises will strengthen the mind. Schools and teachers need to realize that great philosophers, psychologists, scientists, mathematicians and many others created knowledge through investigation and experimentation (Baroody & Coslick, 1998; Phillips, 2000). They understood cause and effect through curiosity and investigation. They were free to study nature and phenomenon, as they existed. This is why today, learning mathematics seems to suggest repeating operations that were already done by other people and examinations that seek to fulfill the same pattern (Brooks & Brooks, 1999).

This study is about classroom assessment practices targeting mathematics teachers in secondary schools of Kenya. The study investigated teachers' common classroom assessments practices in mathematics and sought to gain an understanding of the extent to which teachers use different classroom assessment methods and tools to understand and to support both the learning and teaching processes.

Teachers spend a considerable amount of time conducting a range of activities related to the assessment and evaluation of student achievement (Stiggins & Conklin, 1992). They generally believe that the information they gather through these assessment activities is important for improving student performance (Stiggins & Chappuis, 2005) hence their competencies and knowledge skills in CAPS are critical. Teachers are considered a cornerstone for bringing change and preparing students for future endeavors. It is very essential to understand their teaching practices particularly how they assess and evaluate student learning outcomes. It is for this reason that Reynolds, Livingston & Wilson, 2009; McMillan, 2008; and Nitro, 2001 maintain the common argument that classroom assessment plays an important role in schools and as teachers spend a lot of their time engaged in assessment-related activities they should master some basic assessment competencies. The National Council of Teachers of

Mathematics (NCTM, 2000) regards assessment as a tool for learning mathematics. The NCTM contends that effective mathematics teaching requires understanding what students know and need to know.

Assessment is a systematic process for collecting information that can be used to make inferences about characteristics of people or objects (Reynolds, Livingstone, & Wilson, 2009). Assessment is not just about collecting data, but is also a processes used to appraise students' knowledge, understanding, abilities or skills and it is inextricably linked to a course or program's intended learning outcomes (Marriot & Lau, 2008).

The overall scope of assessment can be viewed within five main dimensions:

- a) Why assess? Deciding why assessment is to be carried out and what outcomes the assessment is expected to produce.
- b) What to assess? Deciding, realizing or otherwise coming to an awareness of what one is looking for in people being assessed.
- c) How to assess? Selecting from among available means, those assessments we regard as being most truthful and fair for various sorts of valued knowledge.
- d) How to interpret? Making sense of the outcomes of the observations or measurement or impressions we gather through whatever means we employ; explaining, appreciating, and attaching meaning to the raw 'events' of assessments.
- e) How to respond? Finding appropriate ways of expressing our response to whatever has been assessed and communicating it to those concerned (Rowntree, 1977, p.11).

These dimensions make an important contribution to the framework in which classroom assessment practices should be viewed.

Researchers, in effective strategies for student performance in statewide high-stakes tests, suggest exposure of students to testing formats that help prepare them for large-scale standardized assessments (Kopriva&Saez, 1997). Other research supports the use of authentic assessment, which includes direct examination of a student's ability to perform tasks (Echevarria& Short, 2000; McMillan, 2004a). Rather than rote learning and passive test-taking, authentic assessment math tests focus on a student's analytical skills and the ability to integrate what they have learned along with creativity with written and oral skills. Also evaluated are the results of collaborative efforts of group projects. It is not just learning the process of computation that is important to know, but also how to take the finished product and apply it to another situation. In addition, the use of multiple assessments, that is, multiple pathways for students to demonstrate their meaning of the content is suggested as an effective assessment and instructional method for students (Echevarria& Short, 2000).

Communicating assessment results and using assessment information in decision-making constitute two important aspects of classroom assessment. To communicate assessment results effectively, teachers must understand the strengths and limitations of various assessment methods, and be able to use appropriate assessment terminology and communication techniques (Schafer, 1991; Stiggins, 1997). Specific comments rather than judgmental feedback (e.g., "fair") are recommended to motivate students to improve performance (Brookhart, 1997). When using assessment results, teachers should protect students' confidentiality (Airasian, 1994). Teachers should also be able to use assessment results to make decisions about students' educational placement, promotion, and graduation, as well as to make judgment about class and school improvement (Stiggins, 1992). Furthermore, teachers' perceptions about the relative value of standardized tests compared with classroom assessments will

naturally influence their assessment of students. A teacher who relies mostly on standardized tests could reach widely different judgments about student achievement than one who places greater value on teacher-made quizzes, effort, and participation in the classroom. It is for these reasons that classroom assessment practices by teachers, more so, math teachers in secondary schools in Kenya were sought.

1.2 Statement of the Problem

For more than three decades, researchers have been conducting research meant to shed some light in the understanding of the nature and scope of teacher classroom assessment strategies (CAS). There is evidence that teachers lack an adequate knowledge base regarding testing and measurement procedures as classroom assessment tools. In their study, Daniel and King (1998) acknowledged findings made by Schafer and Lissirz (1987) who more than a decade earlier hoped that teachers' knowledge of testing and measurement would improve. A decade later, Daniel and King (1998) found that teachers still lacked an adequate knowledge base regarding testing and measurement procedures. Another decade later researchers found that when evaluating students' academic learning, teachers failed to adhere to recommended classroom assessment practices (Campbell & Evans, 2000).

Previous research does confirm that teachers' classroom assessment practices (CAPs) have been taken for granted as educators have placed more focus on research meant to improve the use and quality of standardized examinations and very minimal or no attention on the quality of classroom assessments. Measurement professionals are more interested on issues related to test development and the technical quality of standardized measures than in classroom assessment and grading practices (Smith, 2003, p. 99). This state of affairs leads to many arguments regarding how educators and teachers view CAPs.

According to Policy View (2008), the over-emphasis on examinations has limited schemes for making learning and training programmes practical-oriented. The learners are taught content that is predicted to be examined while sometimes the same content is repeated several times for the students to memorize. According to Countryman (1992), the rules and procedures for school mathematics make little or no sense to many students. They memorize examples, they follow instructions, they do their homework, and they take tests, but they cannot say what their answers mean. From the study by Boit, Njoki and Chang'ach (2012), pressure to pass examinations has a greater influence in the skills one would desire to impart in the learners. It is also evident from the responses in the study that students are not aware of what these skills are and that teachers teach the various skills last in the syllabus instead of integrating them in the various topics. According to Khalid (2007), the repercussion of this is that teachers would think that they would only have to deal with mathematical thinking and problem solving last, after they have completed the topics and not to weave these skills throughout the syllabus. Thus the learner needs to learn the skill of mathematical thinking, not just to calculate sums but to build a long term strong foundation on mathematical concepts which will be useful to them in future. Mathematics as a subject is applicable in many areas of further learning and also in life therefore when the skill is learnt and internalized; it is an asset to the learner. It is for these reasons that the research focused on identifying the common CAPs mathematics teachers employed in the classroom.

1.3 Purpose of the Study

The purpose of this study was to identify the classroom assessment practices and assessment formats/methods used by mathematics teachers in secondary schools in Kenya. In addition, the use of assessment information obtained from students and the

math teacher's consideration of the existing mathematical competences necessary in preparing assessment tools to be used for classroom assessment were determined.

1.4 Objectives of the Study

The study was guided by the following objectives:

- 1) To determine the common classroom assessment practices used by mathematics teachers in secondary school.
- 2) To establish the common assessment tools/formats applied by mathematics teachers in secondary school in the math class.
- 3) To establish how mathematics teachers in secondary school use assessment information collected from the students in the classroom.
- 4) To determine mathematical competencies that math teachers in secondary school often considered when constructing items for classroom assessment.

1.5 Research Questions

The study was guided by the following questions:

- 1) What classroom assessment practices are commonly used by mathematics teachers in secondary school?
- 2) What assessment tools/formats do mathematics teachers use for assessment in the classroom?
- 3) How do mathematics teachers in secondary school use assessment information gathered from students in the classroom?
- 4) What mathematical competencies do math teachers in secondary school considered when preparing items for classroom assessment?

1.6 Significance of the Study

It is expected that the findings of this study will enable math teachers, school administrators, educators, KNEC and other policy makers implement, use or formulate educational policies governing educational assessment to improve the quality of secondary education in Kenya. It is also expected that the CAPs being investigated will be an important means of improving teacher assessment practices in the classroom and must necessarily be accompanied by changes in the instructional process and improved learner achievement in mathematics education.

The study results will provide a framework to support teachers in making the new assessment approaches more relevant for their classroom assessment practices and may also influence scholarly research, theory and practice leading to an educational intervention on the issues of classroom assessment in secondary education. The findings may also lead to the improvement of teacher assessment practices through development of prototypes that can serve as a supporting tool for the ministry in monitoring the quality of education. The ministry of education has to rely on assessment data as indicators of the performance of the system and finally, the findings may form a basis for further research for master's students in the department of psychology, school of education, measurement and evaluation who may want to pursue the area of CAPs by teachers in secondary school.

1.7 Limitation of the Study

The questionnaires, the math teachers and interviews all had inherent impediments. There was the risk of misinterpretation of questions in the questionnaire by the math teachers or a lack of understanding of the terms used in the survey instrument. Math teachers frequently develop their own assessment instruments and techniques and may have been reluctant to share them publicly. The time and place of administration may

also have affected the internal validity and was controlled as carefully as possible in each school. The teachers participating in the survey were not a representative of all the secondary schools in Kenya. Data analysis could be subject to misinterpretation, bias and error. In relation to external validity, it is difficult to generalize the results to other settings since each school and Sub County has a unique set of beliefs and practices regarding assessment.

1.8 Delimitation of the Study.

According to Best and Kahn (1993), delimitation of the study is the boundary within which the study is to be carried out. The study was limited to mathematics teachers and Directors of studies (DOS) of Secondary Schools in Nandi Central Sub-County. The study focused on the public secondary schools that had presented candidates for KCSE and had completed a full Secondary School cycle. Newly established and Private Secondary Schools were excluded yet they could provide useful information.

1.9 Assumptions of the Study

It was assumed that the responses by the research subjects were based on honesty and integrity and that the respondents are a true representative of the population. It was assumed that an equal representation of participants in all the identified categories would be achieved so that there was a fair comparison of the groups by (gender, years of teaching experience, nature of teacher training program, and location of the school and form level). It was also assumed that the variables under investigation were measurable and that the instruments used for data collection are valid and reliable. It was assumed that the results of the study after analysis is completed are generalizable beyond the sample being studied and that the same results will be relevant to the stakeholders. The researcher assumed also that the data collected was normally distributed and that the statistical procedures selected were appropriate to address the research questions stated.

1.10 Definition of Significant Terms

Achievement – what one has learned from formal instruction in school

Assessment – the process of collecting, synthesizing and interpreting information to aid classroom decision making

Classroom Assessment Practices - The term classroom assessment practices covers a wide range of issues starting from teachers' beliefs and the value they have regarding assessment of students, their perceptions about assessment training, their test planning, construction, to grading and use of assessment results (McMillan, 2008; Nitko, 2001; Popham, 2008; Reynolds, Livingstone & Wilson, 2009).

Evaluation – judging the quality or goodness of a performance

Standardized tests - These are national examinations constructed by tests specialists used for making high-stakes decisions that include selection and placement of students to higher levels of learning, they are summative in nature (Popham, 2008; Reynolds, Livingstone & Wilson, 2009).

Teacher Made/Classroom Assessment - These are tests constructed, administered and graded by teachers as formative evaluation of student learning. They are used for purposes of monitoring students' learning and feedback.

Test – a formal, systematic procedure for obtaining a sample of student's behaviour.

CHAPTER TWO

LITERATURE REVIEW

2.1 Related Studies on Classroom Assessments Practices

Student assessment is an integral part of teaching and learning. Teachers play a major role in this process, for this reason, their competencies and knowledge skills in CAPs are critical. It is very essential to understand their teaching practices particularly how they assess and evaluate student learning outcomes. McMillan, Myran and Workman (2002) in their study, aimed at describing the nature of classroom assessment and grading practices, found that teachers were mostly interested in assessing students' mastery or achievement and that performance assessment was used frequently. Morgan and Watson (2002) reported that most middle and high school teachers used teacher-constructed tests to assess students' achievement. Cooney (1992) surveyed high school mathematics teachers' assessment practices across the United States and reported that teachers mostly used short-answer tests for assessment. The study further reported that there was a strong influence of publisher's assessment materials on classroom practices. Teachers used the ready-made tests without making modifications to them (Cooney, 1992; Garet & Mills, 1995).

Sgroi (1995) believes that using assessment to monitor students' understanding of mathematics concepts is very critical and classrooms should be organized to promote active participation and to give students the freedom to explore mathematical ideas. He further noted that teachers should use different methods to monitor students' progress in mathematics.

A study by William J.S.B.(2005) on teachers' perceptions and practices in mathematics classroom revealed that teachers had limited ways and methods of assessing their students and mainly used tests to assess their students. He found that

though teachers gave individual exercises toward the end of every lesson, the exercises were given to the students to practice and consolidate what the teacher had just demonstrated. This kind of approach encourages memorization of procedures and processes. The study recommended that teachers needed to use different strategies to monitor students' progress in mathematics. Strategies such as journal writing, learning logs, probing questions, observation, clinical interview, and thinking aloud would help teachers to understand the mental processes that students engage in as they solve mathematics problems (Fennema and Romberg, 2001).

Barsdale-Ladd and Thomas (2000) conducted a study with in-service teachers and they identified some essential aspects of classroom assessment competencies that teachers should adopt as they assess students. They indicate that teachers should: (a) provide students with feedback for purposes of improving students' learning, (b) take assessment as part of a student's work, (c) exercise some level of flexibility in assessment so as to ensure that assessment does not dominate the curriculum, (d) ensure that assessment informs instruction to improve teachers' instructional methods, and (e) use multiple assessment methods to evaluate students' learning.

Vandeyar and Killen, (2003) argued that regardless of educational setting, high-quality assessment practices should satisfy essential principles such as validity, reliability, fairness, discrimination, and meaningfulness. For Vandeyar and Killen, if teachers have a clear understanding of these principles; they can have an informed framework of using assessment results to make better informed decisions. When teachers misunderstand these principles, their assessment practices are more likely to generate worthless information. Campbell and Evans (2000) evaluated pre-service teachers who had completed coursework in educational measurement and found that student teachers did not follow many assessment practices recommended during their

coursework. Beckmann, Senk and Thompson (1997) identified three reasons why teachers do not use multiple assessment methods. First, some teachers had limited knowledge of different forms of assessment. Second, teachers felt they had no time to create different forms of assessment. Third, teachers felt there was little or no professional guidance; therefore, they (teachers) were not confident enough to try out other forms of assessments. McMillan (2001) studied the actual classroom assessment and grading practices of secondary school teachers in relation to specific class and determined whether meaningful relationships existed between teacher's assessment practices, grade level, subject matter, and ability levels of students. McMillan found that there was no significant relationship between teacher's assessment practices, grade level, subject matter and ability level.

2.2. Review of Related Literature

2.2.1. Assessment

Assessment is defined as “the process of obtaining information that is used to make educational decisions about students, to give feedback to the student about his or her progress, strengths and weaknesses, to judge instructional effectiveness and curricular adequacy and to inform policy”(AFT, NCME, NEA, 1990: 1). Greaney (2001) defines assessment as any procedure or activity that is designed to collect information about the knowledge, attitude, or skills of the learner or group of learners. This process usually involves a range of different qualitative and quantitative techniques. For example, the language ability of learners can be assessed using standardized tests, oral exams, portfolios, and practical exercises. It is important to note that two broad categories within classroom assessment exist, and these are assessment of learning (Summative assessment) and assessment for learning (formative assessment) (Stiggins, 1998). Generally, tests are good tools for assessment of learning while other

methods and tools such as journal writing, diagnostic interviews and observations are good for assessment for learning (Pophan, 1999; Stiggins, 1998). Since the teachers mentioned tests as the tools they use to assess their students, one could conclude that the teachers mainly emphasized assessment of learning. It is important to assess what students have achieved but more important also to assess how they are learning. Brooks and Brooks (1999) contend that emphasis on assessment for learning is likely to improve students' achievement. In summary, assessment for learning takes care of assessment of learning.

2.2.2. Types of Assessments

To complement the categorization of the different roles of assessment, the following is a brief overview of the different types of assessments that are typically employed by most countries. These are described more extensively in a report issued by UNESCO (2000).

School-based assessments

These assessments are usually devised and administered by class teachers or other instructional staff. They have an advantage over centralized assessments in that the results are immediately available to the teacher and, presumably, the learners and can influence the course of instruction. While these assessments can play an important role in promotion to the next grade, they are rarely used for high-stakes decisions such as admission to the next level of the education ladder such as to university. Black and William (1998) make a strong case for the potential of school-based assessment to accelerate learning for all students. The key to effective assessment at this level is to devise questions or probes that can elicit learner responses relevant to the learning goals, while ensuring that teachers are capable of interpreting the results in ways that are pedagogically useful and have sufficient resources to guide learners appropriately.

Public Examinations

These are assessments that can fulfill one or more of the following roles: selecting learners for admission to secondary or tertiary education, credentialing learners for the world of work, and/or providing data for holding school staff accountable for their performance. While such examinations are an important component of every nation's education system, they are particularly critical in developing countries, where the number of candidates for advancement is usually many times greater than the number of places available. In many countries, these are standardized multiple choice examinations, while in others they comprise various forms of performance assessment, sometimes in conjunction with multiple choice components. Typically, they are designed, developed, and administered centrally with an almost exclusive focus on academic subjects. There is meager feedback to the school except the scores and/or pass rate, and, as a result, they offer little utility for school improvement programs beyond an exhortation to do better next time.

National assessments

These are studies focused on generating specific information that policymakers need to evaluate various aspects of the educational system. The results can be used for accountability purposes, to make resource allocation decisions, and even to heighten public awareness of education issues. These assessments may be administered to an entire cohort (census testing) or to a statistically chosen group (sample testing) and may also include background questionnaires for different participants (learners, teachers, administrators) to provide a meaningful context for interpreting test results. The utility of the data generated depends on the quality and relevance of the assessment, the thoroughness of the associated fieldwork, as well as the expertise of those charged with the analysis, interpretation, reporting, and dissemination of results.

International assessments

These are assessments that target learners in multiple countries, with the principal aim of providing cross-national comparisons that can illuminate a variety of educational policy issues. As with national assessments, they may also include background questions for different participants (learners, teachers, administrators) to provide a meaningful context for interpreting test results. Such studies are planned and implemented by various organizations, including the IEA that conducts TIMSS and PIRLS, the OECD, which is responsible for PISA, UNESCO/UNICEF that conducts the MLA studies. For the purposes of this research project, only school based assessment and specifically CAPS shall be dealt with.

2.2.3. Assessment Formats

The wide range of targets and skills that can be addressed in classroom assessment requires the use of a variety of assessment formats. Black and William (1998, p.19) pointed that assessment should be integrated in the teaching and learning process. This requires assessment techniques that focus on assessing what students know as well as what they do not know, and the use of multiple and complex assessment tools including written, oral and demonstrations formats. Therefore, alternative assessment tools, such as rubrics, concept maps, portfolios, student Journals, self-assessments and peer/group assessments are necessary to determine what students actually know and where they are in the learning process (Anderson, 1998; Birgin, 2011). Assessment methods can be classified as traditional or alternative based on the realism and complexity of the assessment tasks and the amount of time needed for the assessment (Gronlund, 2006). Traditional assessments such as multiple choice, true-false and matching items are often lower in realism and complexities of the tasks assessed but require little time to administer and score (Gronlund, 2006). On the other hand,

alternative assessments such as portfolios, observations and other performance-based assessments are higher in both realism and complexity of the tasks assessed but require more time to use and score than traditional assessments (Gronlund, 2006). Also, the arguments in favor of alternative assessments over traditional ones are based on the notion that alternative assessments are more intrinsically motivating than traditional assessments (Shepard, 2000). Some assessment formats and the stages of assessment in which they most likely would occur, are shown in the table 1 below:-

Table 1: Classroom Assessment Techniques

ASSESSMENT FORMATS		
Format	Nature/Purpose	Stage
Baseline Assessments	Oral and written responses based on individual experience, Assess prior knowledge	Baseline
Paper and Pencil Tests	Multiple choice, short answer, essay, constructed response, written reports, Assess students acquisition of knowledge and concepts	Formative
Embedded Assessments	Assess an aspect of student learning in the context of the learning experience	Formative
Oral Reports	Require communication by the student that demonstrates mathematical understanding	Formative
Interviews	Assess individual and group performance before, during, and after a mathematics experience	Formative
Performance Tasks	Require students to create or take an action related to a problem, issue, or mathematical concept	Formative and Summative
Checklists	Monitor and record anecdotal information	Formative and Summative
Investigative Projects	Require students to explore a problem or concern stated either by the teacher or the students	Summative
Extended or Unit Projects	Require the application of knowledge and skills in an open-ended setting	Summative
Portfolios	Assist students in the process of developing and reflecting on a purposeful collection of student-generated data	Formative and Summative

Table 1: From Angelo & Cross (1993). *Classroom Assessment Techniques: A Handbook for College Teachers*. San Francisco: Jessey-Bass Eberly Center for Teaching Excellence, summer 2000.

It is clear from table 1 above that different kinds of information must be gathered about students by using different types of assessments formats. The types of assessments formats that are used will measure a variety of aspects of student learning, conceptual development and skill acquisition and application. The use of a diverse set of data collection formats will yield a deeper and more meaningful understanding of what children know and are able to do, which is, after all, the primary purpose of assessment.

2.2.4. Alternative Assessment Paradigm

Alternative assessment is based on the constructivism philosophy, Piaget' s and Vygotsky' s emphasize the importance of students constructing and supplying responses rather than selecting or choosing them (Dogan, 2001). Janisch, Liu, and Akrofi (2007, p.221) clarify the importance of using alternative assessment methods in the classrooms:

“The theoretical framework for using alternative assessment in the classroom includes considering learners as constructors of knowledge; finding authenticity in materials and activities; employing dynamic, ongoing evaluation tools; and empowering students. By putting these ideas into practice, individual attributes of initiative, choice, vision, self-discipline, compassion, trust, and spontaneity can be promoted in students.”

When still in its infancy, Murphy and Torrance brought forth the concerns and hopes of the alternative assessment paradigm that:

Our own predominant concern is not for assessments to be psychometrically pure and reliable, but for them to play a constructive role in the educational process and as a part of that role to provide valid information about educational achievement in the fullest sense of the meaning of that phrase. Such achievement is not that which is easily measurable, but that which is desirable in terms of the broad aims of those concerned with what children gain from the process of education. (Murphy & Torrance, 1988, p. 100; emphasis in original)

Their comments heralded a new emphasis on assessment procedures that provide a useful picture of what students know and can do. It was a way of saying that assessment should reward holistic learning and encourage qualitative understanding (Hildebrand, 1996). This emphasizes the individual's achievement relative to him or herself rather than to others, or in relation to defined criteria' (Gipps & Murphy, 1994, p. 261). Implied within this new understanding lies the notion that the purpose of assessment has changed from categorizing students for assignment to pre-determined curricular and instructional programmes to tailoring instructional programmes to learners' individual needs and to connecting learners and groups of learners in mutually beneficial learning experiences (LaCelle-Peterson, 2000). This necessitates a focus of attention on each student's learning, as everyone is believed to have his or her own particular requirements. Rather than unrealistically seeking equality of outcomes and the provision of identical experiences for all. Equity in assessment is thus about assessment practices and interpretation of results that are fair and just for everyone (Gipps & Murphy, 1994). The embedded emphasis on the realization of everyone's potential reflects in turn the current repositioning of assessment in relation to learning - that is, a change from being a 'measure of learning' to becoming a 'support to learning'. The classroom assessment reform vision upheld by the current drive towards assessment for learning, which Gipps captured so well in her book *'Beyond testing'* in 1994, inevitably calls for changes in the traditional assessment roles of teachers and students. Just as the teacher is no longer considered to be a transmitter of knowledge but a facilitator of student learning and the student is no longer considered to be a receiver but a constructor of knowledge. The new paradigm calls for classroom assessment to be seen as the gathering of information by both the teacher and students about their teaching-learning situation in order to help them in their decisions. This

emerges clearly from Cross's attempt to provide an indication of their new roles in the re-conceptualized classroom assessment process: Classroom assessment informs teachers how effectively they are teaching and students how effectively they are learning. Through classroom assessment, teachers get continual feedback on whether and how well students are learning what teachers hope they are teaching. And students are required, through a variety of classroom assessment exercises, to monitor their learning, to reflect on it, and to take corrective action (Cross, 1998, p.6). Apart from the emphasis on the link between assessment and learning, the other key element of the new classroom assessment scenario highlighted by Cross (1998) is the realization that students cannot rely exclusively on assessments made by teachers. Even though these assessments may provide them with good quality formative feedback, students still need to become self-monitoring learners if their learning is to improve (Sadler, 1989). The active involvement of students in their assessment process is linked to the constructivist view that 'it is essential to grasp the goals of one's work and compare them with one's present understanding if learning is to be meaningful and permanent' (Black, 1999, p. 126). The understanding is that if students are to become effective learners, they need to progress in their knowledge of themselves as thinkers and learners, in their understanding of particular tasks and in their strategic knowledge of how to go about the improvement of their own learning (Alexander et al., 1991). The recognition that students' progress depends on their understanding their strengths and weaknesses, and how they may deal with them (Harlen & James, 1997) means that, the capacity of students to judge their own work is important for good formative assessment.

Buhagiar (2007) argued that in order to provide every student with the best learning opportunity, traditional ways of assessment should be replaced by alternative forms of

assessment:

"If we truly believe in inclusion and diversity, which builds on the understanding that everyone is capable of learning and worthy of the best possible investment in his or her education, it becomes unsustainable to continue using an assessment model that has traditionally developed to focus on selection, certification and accountability" (Buhagiar, 2007, p.41).

Table 2 below provides a summary list of the alternative modes of assessment as discussed above. Key strengths and weaknesses are detailed briefly.

Table 2: Alternative Assessment Techniques and their Relative Merits

Method of assessment	Meaning and skill areas developed
Group assessment	This develops interpersonal skills and may also develop oral skills and research skills (if combined, for example, with a project).
Self-assessment	Self-assessment obliges students more actively and formally to evaluate themselves and may develop self-awareness and better understanding of learning outcomes
Peer assessment	By overseeing and evaluating other students' work, the process of peer assessment develops heightened awareness of what is expected of students in their learning.
Projects	These may develop a wide range of expertise, including research, IT and organizational skills. Marking can be difficult, so one should consider oral presentation.
Portfolio	This contains great potential for developing and demonstrating transferable skills as an ongoing process throughout the student learning.

Source: *The Handbook* for Economics Lecturers Dr Nigel Miller, University of York (Edited by John Houston and David Whigham, Glasgow Caledonian University).

2.2.5. Mathematics as a discipline

A discipline is defined as “a field of study” or “a rule or system of rules governing conduct or activity” (Merriam-Webster, 2010, n.p.). An academic discipline is, therefore, defined as the “knowledge, ways of working and perspectives of the world” (Favero, 2006, p. 1) manifested by scholars of that community. Mathematics is considered an academic discipline (Favero, 2006) like other academic disciplines such as archeology, biology, chemistry, economics, history, psychology, sociology, and others. As such, it can be described, analyzed, impersonalized, and memorized (Schiro, 2008). Inherent within its status as a discipline is the methodology for teaching and learning. A discipline such as mathematics tends to be defined by the types of problems it addresses, the methods it uses to address these problems, and the results it has achieved. To a large extent, students and many of their teachers tend to define mathematics in terms of what they learn in math courses. The instructional and assessment focus tends to be on basic skills and on solving relatively simple problems using these basic skills. It is not clear what should be emphasized in curriculum, instruction, and assessment. The issue of basic skills versus higher-order skills is particularly important in math education. How much of the math education time should be spent in helping students gain a high level of accuracy and automaticity in basic computational and procedural skills? How much time should be spent on higher-order skills such as problem posing, problem representation, solving complex problems, and transferring math knowledge and skills to problems in non-math disciplines? are important aspects to be considered which touch on classroom assessment practices by math teachers.

2.2.6 Cognitive Processes

Cognition is a mental process or representation that manifests itself in such things as problem solving, learning memory, and reasoning (Dunlosky & Metcalfe, 2009). Cognitive processes are defined as the mental processes of an individual, with particular relation to a view that argues that the mind has internal mental states (such as beliefs, desires and intentions) and can be understood in terms of information processing, especially when a lot of abstraction or concretization is involved, or processes such as involving knowledge, expertise or learning (www.scholar.google.com, 10/15/15). Without looking closely at the students' work or explanations or talking to them about their solution strategies when problem solving, it is difficult to understand how they were thinking about the task and how their thinking could have produced such a wide range of answers. It is also difficult to determine the cognitive processes they used. According to Montague (2002) at the University of Miami, cognitive processes associated with problem solving are as follows:

- comprehending linguistic and numerical information in the problem,
- translating and transforming that information into mathematical notations, algorithms and equations,
- Observing relationships among the elements of the problem,
- formulating a plan to solve the problem,
- Predicting the outcome,
- regulating the solution path as it is executed and detecting and correcting errors during problem solution.

Unless students are asked how they solved a particular problem and unless we attend to the work and explanations that accompany answers, we learn little about students'

understanding and misunderstanding of mathematical ideas (Stylianou, Kenney, Silver, & Alacaci, 2000).

Stylianou et al. (2000) conducted a study that assessed the work and responses of students to open-ended tasks and found that by writing about mathematics, students can provide a glimpse into their thinking as it related to the mathematics they were performing. In this research study, students were given problems to solve that had symbols as well as words. Considering the word problems, there is a belief on the part of some researchers and educators that problem comprehension and computational processes interact during the solving of an arithmetic word problem (Rabinowitz & Woolley, 1995). This belief is founded in the notion that the strategies involved in problem representation place a heavy load on cognitive processing capacity. Rabinowitz and Woolley (1995) contend that because cognitive resources are limited, so are the number of cognitive processes that can be performed at the same time. They conducted a study to test the belief mentioned above about problem comprehension and computational processes interacting during the solving of an arithmetic word problem. In their study they shed light on a process called automatization (automation-meaning that one has automatic operation or control of a process or system) and that researchers believe that if students do not use automatization, they will use too many cognitive processes at one time, causing them to slow down their cognitive operations that are devoted to problem solving (Sweller, 1989; Gagne, 1983; Zentall, 1990). They claim that automatized retrieval does not necessarily improve arithmetic word problem solving. These authors work from the perspective that problem size and problem type can be expected to have an effect on performance in problem solving and addresses the nature of the cognitive processes involved in solving the problems. The authors go on to suggest that either cognitive processes

performed are serial or are parallel (occur simultaneously) or occur in cascade (one process starts before the other is completed). Tarmizi and Sweller (1988) suggested that conventional problem solving activity imposes a heavy cognitive load on the working memory of the problem solver. In the case of arithmetic word problems, cognitive load would be further increased if attention is split between comprehension of the problem and the performance of the required computation, which gives way to some interaction between problem size and problem type.

2.3 Assessing Mathematical Process

It is important that students see mathematics as sensible, useful and doable. Teachers should take every opportunity during the instructional/learning process to help students develop a positive disposition towards mathematics by focusing on mathematical process skills (Ontario Prospects: 2002).

To further instruction, teachers need to gain insight into their students' thinking, a task that can be accomplished by engaging students in important mathematical processes (NCTM, 2000). Examples of this engagement include having students record their reasoning, communicate mathematically, connect to real world contexts, make connections within and between mathematical concepts, interpret and create graphics, and translate mathematical ideas between representational forms (Ontario Prospects: 2002). These are discussed below as adapted from the publication data by Manitoba Education, Training and Youth titled 'Grade 5 to 8 Mathematics: Classroom-based Assessment' (2001).

a) Mental math -Consists of a collection of strategies that enable a person to estimate, visualize, and manipulate numbers in their heads. Mental math strategies allow students to apply their knowledge of basic facts to compute problems that

involve larger numbers. In assessing mental math strategies, teachers should look for both oral and written evidence. Paper and pencil tests can be used to assess mental math. The tests need to be time-restricted to ensure that students are applying mental math strategies.

b) Estimation - Estimation is the skill of making a reasonably accurate inference based on prior knowledge or experience. Estimation experiences provide a broad practical context for continued development of children's concept of number, size, and quantity. In estimating answers to numerical questions, students apply their understanding of place value, mental math strategies, and algorithms. They can use strategies such as rounding off, compatibles, clustering, front-end and adjusting. When estimating size or quantity, students apply their understanding of length, area, capacity/volume, mass, time, money, temperature, and angles. Students need additional strategies for this type of estimation. These strategies include referents or anchors, chunking and unitizing.

c) Connections -Students should be able to identify how mathematical concepts are related to one another, to other subject areas and to everyday life. A teacher- or student-led discussion may explore concepts relative to mathematics such as measurement in industrial arts, ratio in social studies, integers in banking, transformations in art and collecting and interpreting data and estimating and recognizing patterns in science. Students also need to make connections between the concrete, pictorial, symbolic, oral and written representations of a concept.

d) Reasoning -Students need to have a real understanding of mathematics. They need to move beyond memorizing sets of rules and procedures, and into investigations that answer the "why" questions. In order to do this, students must be provided with many opportunities to explain, justify, and refine their thinking. Listening to the

explanations of their peers and being able to share their own thinking in a safe environment that fosters risk-taking. Progress related to reasoning can be assessed by having students construct, illustrate, write and present their ideas and through conceptualizations and conclusions.

e) Problem Solving -Problem solving is the process in which students apply their understanding of mathematical concepts and skills. This process involves both mathematical investigations and open problems. Teachers need to look at four main areas in problem solving and to assess students' progress within each area, namely: understanding the problem, using appropriate strategies, verifying solutions and formulating their own problems.

f) Communication -Students should be able to communicate, both orally and in written form, their mathematical understanding of a problem. The student should be able to use his or her own language to explain and clarify in such a way so that others can understand. Students should use mathematical language and concepts, explain reasoning, report evidence, state a conclusion, draw and label and reflect on what they are learning.

g) Visualization -Visualization is the construction of mental models and/or images of mathematical concepts and processes. Visualization of mathematical concepts can be demonstrated by building, drawing, and describing. Students should also be able to identify mathematical concepts in the models and images around them.

2.4. Classroom Assessments Practices

Classroom assessment embraces a broad spectrum of activities from constructing paper-pencil tests and performance measures, to grading, interpreting standardized test scores, communicating test results and using assessment results in decision-making. When using paper-pencil tests and performance measures, teachers should be

aware of the strengths and weaknesses of various assessment methods and choose appropriate formats to assess different achievement targets (Stiggins,1992).

Teachers struggle as they try to improve their assessment practices and make assessment decisions, mainly because the whole process is characterized by the tension between teachers' beliefs about assessments and the values they bring along, as well as other external forces that they have to consider along the way (McMillan, 2003).

Classroom assessment encompasses a wide range of approaches for the ongoing evaluation of student achievement and progress, including structured tests and quizzes; worksheets; homework assignments; and informal assessment of student participation, effort and behaviour.

Classroom assessment methods vary just as much as instructional methods for students (McMillan, 2004). Traditional assessment practices include summative assessments that evaluate at the close of instruction at either the end of a unit or after a set period of learning. Teachers have traditionally used objective tests that measure specific skills using unbiased questions or scenarios.

For the most part, assessment methods can be classified as traditional or alternative based on the realism and complexity of the assessment tasks and the amount of time needed for the assessment (Gronlund, 2006). Traditional assessments such as multiple choice, true-false, and matching items are often lower in realism and complexities of the tasks assessed but require little time to administer and score (Gronlund, 2006). Alternative assessments such as portfolios, observations, and other performance-based assessments are higher in both realism and complexities of the tasks assessed and require more time to use and score than traditional assessments (Gronlund, 2006). There has been a movement toward the use of more alternative assessments than

traditional assessments. The arguments in favor of alternative assessments over traditional ones are based on the notion that alternative assessments are more intrinsically motivating than traditional assessments (Shepard, 2000).

In the *Assessment Standards for School Mathematics*, the National Council of Teachers of Mathematics (NCTM, 1995) describes assessment as “the process of gathering evidence about a student’s knowledge of, ability to use, and dispositions toward, mathematics and making inferences from that evidence for a variety of purposes” (p. 3). Any method used to assess children’s mathematics learning should reflect meaningful goals and objectives (Lin, 2006) so the assessment results can be used to make appropriate instructional decisions (Romagnano, 2001) and help educators identify ways to improve mathematics teaching and learning (NCTM, 1989). Indeed, the National Research Council, in its report *Everybody Counts* (1989), asserts: “We must ensure that tests measure what is of value, not just what is easy to test” (p. 70). Thus, assessment should be a “bridge between teaching and learning, helping teachers collect evidence about student achievement in order to adjust instruction to better meet student learning needs” (Wiliam, 2007, p. 1054).

Mathematics educators have indicated that *how* students learn (i.e., the mathematical processes through which they learn) is as important as *what* they learn (i.e., the specific mathematical content) (Kilpatrick, Swafford, & Findell, 2001; Ma, 1999; NCTM, 1989, 2000, 2006). As students engage in the process of doing mathematics, they make meaning of mathematics concepts for themselves, relating conceptual and procedural understanding.

2.5. Classroom Assessment Practices in Secondary School

The system of assessment at all levels in secondary schools consists of basically classroom tests constructed by subject teachers. The tests may be given any time -

weekly, monthly, in the middle of the term or at the end of the term. The purpose is to prepare reports on student progress upon which decisions can be made on whether to pass a student to next class or not. The other purpose is to inform parents of their children's performance.

Many schools also administer continuous assessment tests (CATS). Schools with low enrolment, coupled with a wealth of teaching and learning resources, often apply CATS fairly effectively as teachers only have a small number of learners to give attention. At the same time they have requisite resources with which to carry out necessary interventions. Such schools are usually privately owned and are managed professionally. In contrast the high enrolment and scarcity of facilities in many public schools make it difficult for teachers to effectively carry out continuous assessment.

In Kenya, provision of free primary education has made the situation worse. Free primary education has resulted in high enrolment, leading to a tremendous increase in class sizes in most schools. The average class size is currently estimated at 60:1, which has made it difficult for teachers to observe learners on a one to one basis. As a consequence of these developments teachers' reporting of learner progress is less than wholesome as it is dominantly based on performance in classroom tests.

Even where teachers use written tests, many of the tests they develop are wanting in quality. The tests are usually wanting in originality of style, clarity of language and abilities tested. Some teachers do not even bother to develop their own tests. Instead they simply lift questions from past national examinations or from commercial publications. Rather than help improve the learning process, these practices seem to encourage rote learning, which both the teacher and the pupils believe would improve performance in national examinations. Thus, a combination of large class size, teacher's inability to develop suitable assessment instruments and endemic shortage of

suitable and sufficient educational resources explains why teachers are unable to effectively assess the learners and collect information that would help them improve teaching.

Apart from lack of educational resources, many teachers' inability to develop suitable assessment instrument is a result of the shortcomings of the teacher training programmes which give little emphasis on acquisition of assessment skills. There are many teachers in our schools who cannot apply the principles of assessment for diagnostic purposes because they were not given sufficient training.

A growing phenomenon in the Kenya education sector today is the stiff competition for good performance at all levels of education. The competition is not only between individual learners and schools but also between various geographical zones. The competition has led to a mushrooming of Sub-County and County examining panels formed by schools in a given County. By pooling resources together, schools in a County or Sub-County finance development of examination instruments which individual schools administer to their learners. The tests target several levels, but especially those that are near the top of the secondary education cycle (forms 3 and 4). Since most of the panel members are drawn from teachers who mark national examinations, the tests they develop bear all the characteristics of standardized tests. When the feedback from these tests is used to inform teachers' approaches to teaching the results are always positive. Also, arising from the appointment of the most competent teachers to the panels, other teachers in the Sub-County or County learn from their experience.

2.6. Use of Assessment Information

Assessment plays many roles in education and a single assessment can serve multiple, but quite distinct roles. For example, results from a selection test can sometimes be

used to guide instruction, while a portfolio of learner work culled from classroom assessments conducted can inform a decision about whether the learner should obtain a certificate of completion or a degree. The data from classroom assessment can be used to choose a program of study or a particular course within a program. Senk, Beckman, and Thompson (1997) provide an overview of the mathematics assessment practices of a group of 19 United States secondary teachers, who were selected from schools that were believed to be relatively supportive of “alternative assessment”. They noted that assessment for grading purposes featured strongly in the responses of their participants, with 58 percent of the teachers grading all their assessment tasks. In terms of grading, they note the following hierarchy of tool use: written tests, quizzes, homework, written reports; and at a lower level of use: oral reports, conferencing, and work samples. Other assessments provide information that can be used by the learner, teacher, or parents to track learner progress or diagnose strengths and weaknesses. Assessments can determine whether learners obtain certificates or other qualifications that enable them to attain their goals.

American Association for the Advancement of Science (1998) has categorized the purpose of assessment into internal and external purposes. The internal purposes for assessment include conveying to students expectations about what is important to learn, providing information to students and parents about students’ progress, helping students to judge their own learning, guiding and improving instruction, classifying and selecting students. The external purpose was to inform the education donors including parents, education departments and ministry about what happened in schools. A report on adolescent literacy for the National Association of State Boards of Education similarly stated that ongoing formative assessments are “taken frequently, even daily, to identify students’ individual needs and to design instruction

so that students can reach learning goals” (NASBE, 2006, p. 33). The NASBE (2006) report similarly described “use of formative assessments as a frequent part of teaching and learning to help guide instruction” as being among “the fundamentals of those essential components that have been consistently linked with high student achievement” (NASBE, 2006, p. 18). According to Black and Wiliam (1998b), “Feedback has been shown to improve learning when it gives each pupil specific guidance on strengths and weaknesses” (p. 144). Specifically, Black and Wiliam (1998a) cited a meta-analysis of 58 experiments that found that of the variables tracked, the quality of feedback had the largest impact on students’ performance (p. 36, citing BangertDrowns, Kulik, Kulik, & Morgan, 1991). Similarly, Marzano (2003) reported “impressive results” from a review of five synthesis studies by Bloom, 1976; Haller, Child, & Walberg, 1988; Kumar, 1991; Scheerens & Bosker, 1997; Walberg, 1999. on the importance of feedback to students (p. 37). Average effect sizes in this research ranged from 0.54 to 1.35, with corresponding percentile gains ranging from 21 to 41 points. Describing these results in more depth, Marzano identified two research-based characteristics that feedback must have in order to be effective:

“First, it must be timely. Students must receive feedback throughout the learning process—ideally multiple times throughout the school year” (p. 37, citing BangertDrowns et al., 1991).

“Second, effective feedback must be specific to the content being learned” (p. 38, citing BangertDrowns et al., 1991; Madaus, Kellaghan, Rakow, & King, 1979; Madaus, Airasian, & Kellaghan, 1980).

2.7. Mathematical competencies

Mathematical competences is the ability to understand, judge, do and use mathematics in a variety of intra- and extra-mathematical contexts and situations in which mathematics plays or could play a role (Niss, 1999). According to Niss, there are eight mathematical competencies put into two groups. The first group of competencies involves the ability to ask and answer questions in and with mathematics, namely:-

- a) Thinking/reasoning mathematically (mastering mathematical modes of thought) such as posing questions that are characteristic of mathematics, and knowing the kinds of answers that mathematics may offer; understanding and handling the scope and limitations of a given concept; extending the scope of a concept by abstracting some of its properties; generalizing results to larger classes of objects and distinguishing between different kinds of mathematical statements (including conditioned assertions ('if-then'), quantifier laden statements, assumptions, definitions, theorems, conjectures, cases).
- b) Posing and solving mathematical problems such as identifying, posing, and specifying different kinds of mathematical problems –pure or applied; open-ended or closed and solving different kinds of mathematical problems (pure or applied, open- ended or closed), whether posed by others or by oneself, and, if appropriate, in different ways.
- c) Modeling mathematically (analyzing and building models) such as analyzing foundations and properties of existing models, including assessing their range and validity; decoding existing models, i.e. translating and interpreting model elements in terms of the 'reality' modeled and performing active modeling in a given context which includes:- structuring the field; mathematising; working with(in) the model, including solving the problems it gives rise to; validating

the model, internally and externally; analyzing and criticizing the model, in itself and vis-à-vis possible alternatives; communicating about the model and its results and monitoring and controlling the entire modeling process.

- d) Reasoning mathematically/Argumentation such as following and assessing chains of arguments, put forward by others; knowing what a mathematical proof is or is not and how it differs from other kinds of mathematical reasoning; uncovering the basic ideas in a given line of argument (especially a proof), including distinguishing mainlines from details, ideas from technicalities and devising formal and informal mathematical arguments and transforming heuristic arguments to valid proofs, that is, proving statements. The other group of competencies is to do with the ability to deal with and manage mathematical language and tools.
- e) Representing mathematical entities (objects and situations) such as understanding and utilizing different sorts of representations of mathematical objects, phenomena and situations; understanding and utilizing the relations between different representations of the same entity, including knowing about their relative strengths and limitations and choosing and switching between representations.
- f) Handling mathematical symbols and formalisms such as decoding and interpreting symbolic and formal mathematical language, and understanding its relations to natural language; understanding the nature and rules of formal mathematical systems (both syntax and semantics); translating from natural language to formal/symbolic language; handling and manipulating statements and expressions containing symbols and formulae.

- g) Communicating in, with, and about mathematics such as understanding others' written, visual or oral 'texts', in a variety of linguistic registers, about matters having a mathematical content and expressing oneself, at different levels of theoretical and technical precision, in oral, visual or written form, about such matters.
- h) Making use of aids and tools (IT included) such as knowing the existence and properties of various tools and aids for mathematical activity, and their range and limitations and being able to reflectively use such aids and tools.

2.8. Examinations at Secondary school in Kenya

The Kenya National Examination Council (KNEC) is the examining body responsible for developing and assessing national exams at various levels of learning including the Kenya Certificate of Primary Education (KCPE) and Kenya Certificate of Secondary Education (KCSE) in Kenya (KNEC, 2008).

KCSE examination is a national exam and by far the most important secondary school-level examination for the majority of Kenyan students. It is an examination taken at the completion of Secondary Education. The KCSE is the entrance examination to public and private universities and the pass mark is grade C+. Students who attain a lower mark than C+ join other tertiary institutions for non-degree courses. Each year, hundreds of thousands of students take the examination after four years of the Secondary School Course and this examination is a major determinant of the individual's future career. The KNEC was established under the KNEC Act of the Laws of Kenya in 1980 ((Eshiwani, 1993). Public national examinations such as the KSCE serve three purposes, certification of the achievement level of individual students, selection of students for work, higher education and evaluation of the school system as a whole (World Bank, 2001). The evaluation system in Kenya only

recognizes academic skills and students' intelligence is measured by this standard (Mwaka et al, 2010). Non-academic skills and associated intelligence are ignored under the Kenyan examination system since such skills are not evaluated. On the other hand, the Kenyan education system includes assessment conducted by teachers within the classroom environment in the school. The assessment commonly referred to as school-based assessment or classroom assessment. The teachers design, administer, score and report results from their own assessments. School-based assessments are used by the teachers to monitor student's overall growth, ability, progress and achievement according to the objectives of the school curriculum and to adjust the classroom instruction according to the learning needs of their students. Through the end of term report forms, the parents are also informed about the student's achievement and progress. The common school based examinations in secondary schools in Kenya are weekly quizzes, mid-term exams, end-term exams, continuous assessment tests and the trial examinations.

2.9. Theoretical Review

The increasing focus on the development of conceptual understanding and the ability to apply mathematics and science process skills is closely aligned with the emerging research on the theory of constructivism. As stated earlier, this theory has significant implications for both instruction and assessment. Constructivism is the idea that learning is an active process of building meaning for oneself. Thus, students fit new ideas into their already existing conceptual frameworks. Constructivists believe that the learners' preconceptions and ideas about mathematics are critical in shaping new understanding of mathematical concepts. The constructivist view takes the position that children construct their own understanding of mathematical ideas by means of mental activities or through interaction with the physical world (Cathcart, et al., 2001).

Assessment based on constructivist theory must link the three related issues of students' prior knowledge (and misconceptions), student learning styles (and multiple abilities) and teaching for depth of understanding rather than for breadth of coverage.

According to Piagetian theory (Althouse, 1994) mental structures (schemata) change with intellectual development, and they are reconstructed continuously as children progress from one intellectual stage to another (Althouse, 1994; Cruikshank and Sheffield, 2000). Piaget identified four stages of intellectual development, which to some degree are critical to the teaching of mathematics because they suggest students' readiness to learn (Althouse, 1994; Cruikshank and Sheffield, 2000). These stages are sensorimotor (0 – 2 years), preoperational thought (2-7years), concrete operational (7 – 11 years), and formal operations (11-15 years) (Piaget, 1973). Although the ages at which individuals progress through these stages are approximate, every child passes through them in the same order. Piaget believed that meaningful learning takes place if students have the opportunity to construct their own knowledge and emphasized that such conditions must be complied with if in the future individuals have to be productive and creative and not simply repeating what others said or did. Piaget's theories fit within constructivism to some degree, guide teachers to interact with children by fully engaging them in investigations and discussions.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

The research adopted both the quantitative and qualitative research designs to investigate the common classroom assessment practices used by mathematics teachers in secondary school. Gall, Gall and Borg (2003, p.26) state that “qualitative and quantitative research can complement each other by playing the respective roles of discovery (surveys) and confirmation (interviews). Furthermore qualitative methods can be used to improve the quality of survey-based quantitative evaluations by helping generate evaluation hypothesis; strengthening the design of survey questionnaires and expanding or clarifying quantitative evaluation findings. According to Merriam (1998), qualitative research is an umbrella concept covering several forms of inquiry that help us understand and explain the meaning of social phenomena with as little disruption of the natural setting as possible (p.5).

3.2 Sample Selection

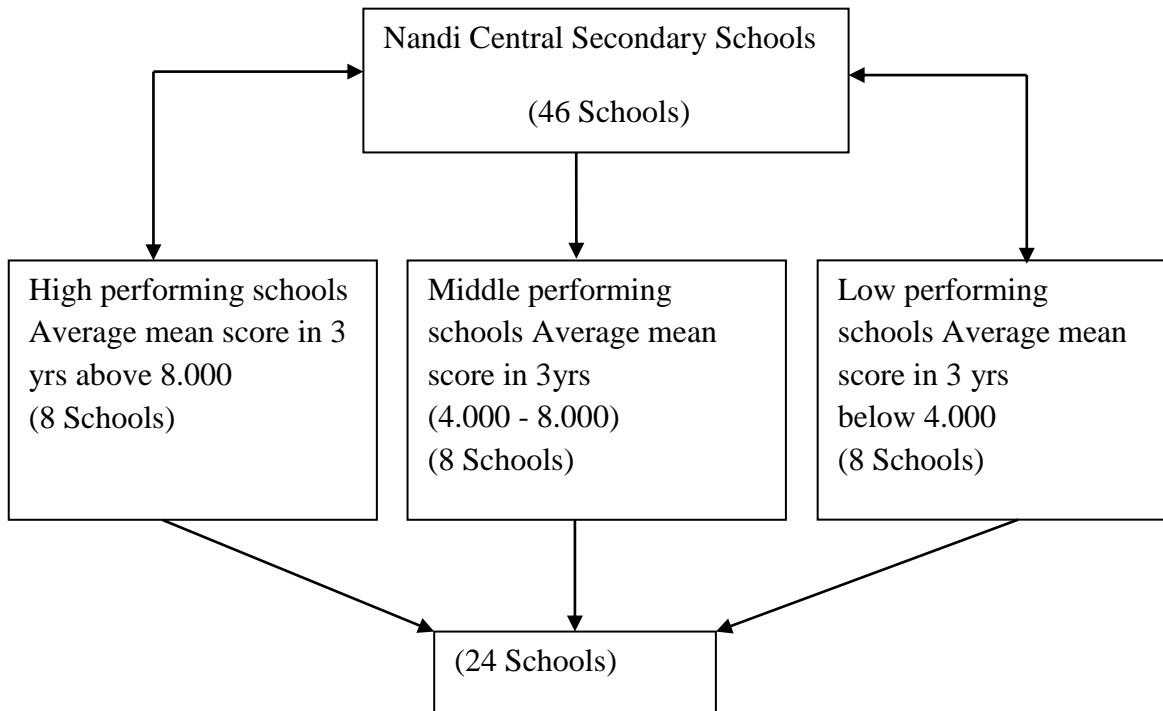
The study targeted classroom teachers of mathematics and the directors of studies in secondary schools of Nandi Central Sub-County. The directors of studies were also selected because they are responsible for all the assessment practices and strategies being used by the teachers in their schools.

3.3 Sampling Process

The sample was determined from secondary schools in Nandi Central Sub-County after categorizing the schools into three groups made up of high performing, middle and low performing schools. The KNEC mean scores of schools in Nandi Central Sub County were obtained from the Sub-County quality assurance and standards office and were used to determine school performance levels. An average of each school's

KCSE mean score in 3 years in the Sub-County was used to categorize them as low, middle and high-performing schools as shown in figure 1 below:-

Figure 1: Sampling framework



Systematic sampling technique was used to select only 24 schools (52%), eight (8) from each category of high, middle and low-performing schools that have been offering candidates for KCSE since 2009.

3.4 Population Selection

In the study, the target population was forty eight (48) mathematics teachers, two (2) math teachers from each school, and twenty four (24) directors of studies, one(1) from each school. It later turned out that fifty one (51) mathematics teachers and fifteen (15) directors of studies actually participated in the study.

3.5 Data Collection

Table 3: Summary of data collected

Objectives		Information desired	Data Collection Instrument
One	To determine the common CAPs used by mathematics teachers in secondary school	Common classroom assessment practices applied by math teachers	Math teacher Questionnaire Interview schedule
Two	To establish the common assessment formats applied by mathematics teachers in secondary school for assessment	Assessment formats/tools used by math teachers in Secondary schools of Kenya	Math teacher Questionnaire Interview schedule
Three	To establish how math teachers use assessment information collected from the classroom.	Use of assessment information	Math teacher Questionnaire Interview schedule
Four	To establish consideration of the mathematics competencies by math teachers when constructing items for classroom assessment	Mathematical competencies and classroom assessment as applied by math teachers	Math teacher Questionnaire Interview schedule

Table 3 above illustrates the summary of data collected and the respective data collection instruments according to the objectives of the study.

3.6 Data Collection approaches

Two instruments were used in the study, namely; questionnaires and structured interviews. Documentary reports or secondary data which contain examination results for the schools under the study were obtained from the Sub-County quality assurance and standards office.

Questionnaire

One questionnaire specifically designed for mathematics teachers in secondary school was administered. The questionnaire had three sections A, B and C. Section A solicited information on math teacher's bio data, qualification, training and experience and the workload and the school's average mean score in 3 yrs. Section B dealt with common CAPs used by the mathematics teachers in the Classroom and the common assessment tools/formats math teachers often employed in their day to day classroom assessment practice. Section C was used to solicit information on how the math teachers used assessment information gathered from students. In addition, information obtained included whether math teachers considered mathematical competencies while preparing classroom assessment tools. Questionnaires were preferred because they are easy to administer to the respondents and convenient for collecting information. In addition, the respondents were literate and therefore were familiar with the language in the questionnaire.

Interview Schedule

Face to face interviews were conducted to the Directors of Studies in the twenty four (24) participating secondary schools though only fifteen (15)(63%)DOS's were interviewed. Nine (9) out of the 24 schools that were sampled for the study had no appointed directors of studies. The interview schedule captured information about the CAPs used by teachers in the schools and on the existence of a school examination policy. The opinion of the DOS's on the use of alternative forms of assessment such as self- and peer assessments were sought. The results from the interview schedule was used to check whether the responses by the math teachers through the questionnaire conformed or not.

Secondary Data

Documentary reports were collected from schools and from the Nandi Central Sub-County Quality Assurance and Standards Office. The main data being list of all the schools in the Sub-County indicating the KCSE mean scores for the last three years.

3.7 Validity and Reliability

In order to ascertain the validity of instruments, expert opinion was sought from the supervisor, lecturers, and peers on face, content and format of the questionnaire and the interview schedule. Consultations with the supervisors, other lecturers, and peers helped to identify errors and offer the opportunity to modify and improve the instruments. To ensure that the items in both the questionnaire and the interview schedule fully represent the domain of CAPs in mathematics, a rational analysis of the instruments by at least 3 raters familiar with the construct of interest was sought. The raters were able to review all the items in the questionnaire for readability, clarity and comprehensiveness and came up with the items which were included in the final instrument. Also to ascertain the validity and reliability of the research instrument, a pilot study was done in two schools within the same sub-county that did not participate in the actual study. The reliability of the questionnaires responded to were further determined by the calculation of the Cronbach's alpha coefficient using the SPSS and the results are as shown in table 4 below. The value of the alpha coefficient ranges from 0 to 1 and is used to describe the reliability of factors extracted from dichotomous and/or multi-point formatted questionnaires or scales. As prescribed by Nunnally and Bernstein (1994), the general convention is to strive for reliability values of 0.7 or higher.

Table 4: Reliability Analysis of Instruments

Variable	Cronbach's alpha	No of items
To determine the common CAPS used by mathematics teachers in secondary school.	0.5623	7
To establish the common assessment formats applied by mathematics teachers in secondary school to assess the students in the classroom.	0.7193	11
To establish how secondary mathematics teachers use assessment information collected from students in the classroom.	0.6336	6
To determine the mathematics competencies math teachers do consider when developing items for classroom assessment	0.5507	8

Table 4 above indicates that, on average, the questionnaire items in the survey instrument for math teachers in secondary school were very reliable for the study since the calculated Cronbach's alpha coefficient for each of the four objectives of the study was greater than 0.5. To improve on the reliability of the survey instruments, Gulliksen (1950) states that; "the more items one has in the scale to measure the construct of interest, the more reliable one's scale will become". Caution was taken to ensure that cases of respondents being less likely to participate and answer completely when confronted with the idea of replying to lengthy questionnaires are ruled out. Validity of the interview schedule was determined by comparing the interviewee's responses with other sources of data. Drawing on the expert opinions from the

supervisors, lecturers and peers, appropriate corrections were made on the instruments. Every effort was made to reduce the effects of history on validity by administering the survey within a one month period. The instruments were administered by the researcher and collected immediately.

3.8 Methods of Data Analysis

Data Processing

The questionnaires containing the data were checked, arranged and coded. The information was entered into the computer using the SPSS program to obtain the relevant statistics and graphical representations necessary for analysis.

Data Analysis

The information from the questionnaires was presented in figures and percentages in tables while the information obtained from interviews were analyzed using qualitative techniques. A number of tables and bar graphs were used in the study to present the data findings. The data collected were analyzed according to the nature of the responses using the SPSS.

3.9 Scope of the Study

The study covered Secondary schools in Nandi Central Sub-County, Nandi County. The study revolved around CAPS being used by the mathematics teachers, the use of alternative assessment procedures and students performance in final examinations at secondary schools in Nandi Central Sub-County.

CHAPTER FOUR
DATA ANALYSIS, PRESENTATION AND INTERPRETATION
OFFINDINGS

4.0. Introduction

In this chapter, findings of this study are presented based on the objectives guided by fifty one (51) questionnaires received from mathematics teachers and fifteen (15) structured interviews by directors of studies of secondary schools in Nandi Central Sub-county.

4.1 Response Rate: Teachers Background

Table 4.1: Teacher’s Background Information

VARIABLE	CHARACTER	COUNT(N)	PERCENTAGE (%)
Gender	Male	33	65
	Female	18	35
Age	25 - 29yrs	9	18
	30 - 39yrs	25	49
	40 - 49yrs	16	31
	50 or more yrs	1	2
Academic qualification	Diploma in education	4	8
	B'ed	44	86
	M'ed	3	6
Teaching experience	1 - 5yrs	11	22
	5.1 - 10yrs	15	29
	Above 10yrs	25	49

Table 4.1 indicates that the largest percentages of teachers (65%) were male teachers compared to 35% who were female teachers. It is not clear whether this imbalance between male and female teachers has a significant influence on students’ performance. Table 4.1 also indicates that 49% of the teachers were aged between 30

and 39 years; 31% aged between 40 and 49 years; 18% aged between 25 and 29 years and 2% of the teachers were 50 years old or more. No teacher under 25 years participated in the study. The findings showed that the teachers who were Bachelor of Education degree holders dominated the teaching force in secondary schools representing 86% while diploma holders representing a mere 8% and master's degree holders only 6% of the teaching force.

4.2 School's Background

Table 4.2: School's Background Information

SCHOOL CHARACTERISTIC		NO. OF SCHOOLS(N)	PERCENTAGE OF SCHOOLS (%)
Class size	30 - 39	23	45
	40 - 49	18	35
	50 or more	10	20
Lessons per week	12 - 19	10	20
	20 - 29	40	78
	30 or more	1	2
School average mean in the last 3yrs	Below 4.000	16	31
	4.000 - 8.000	26	51
	8.001 - 12	9	18

Table 4.2 above indicates that the majority (45%) of the schools had class sizes of between 30 and 39 students. 35% of the schools had class sizes of between 40 and 49 with only 20% of the schools having 50 students or more per class but none of the schools that participated in the study had class sizes below 30. The table also shows that the workload for most teachers is between 20 and 29 lessons per week representing 78% of the teachers. 20% of the teachers had their workload below 20 lessons a week and only 2% of the teachers had workloads above 30. The table

indicates that most mathematics teachers who participated in the study came from schools that performed averagely in national public examinations, KCSE, since 51% of the teachers were from schools that had a school mean average of between 4.000 and 8.000 in the last three years, 31% below 4.000 and 18% of the teachers above 8.000. The majority of the math teachers in schools whose average in KCSE in 3 years was above 8.000 could not be found to fill in the questionnaire because they were too busy preparing the candidates for 2014 KCSE examinations.

4.3Objective1:

Common classroom assessment practices being used by secondary school mathematics teachers.

Table 4.3: Common Classroom Assessments Practices used in teaching mathematics by math teachers

Assessment Practices	Never	Seldom	Sometime	Often	Always
Discourse	0%	0%	2%	43%	55%
Observation	2%	0%	20%	65%	14%
Student Self- Assessment	0%	4%	58%	26%	12%
Peer Assessment	2%	20%	58%	14%	6%
Own Production	2%	41%	27%	14%	16%
Projects	25%	45%	22%	2%	6%
Portfolio	46%	22%	16%	14%	2%

Table 4.3 indicates that discourse (55%) and observation (14% always and 65% often) dominated the teachers' classroom assessment practices in most lessons. Student self-assessment (26%) and students' own production (14%) are often used by math teachers. Peer assessment (6%), Projects (6%) and portfolio (2%) were the least used CAPs. The researcher found out that teachers had gained very little training in the use

of these CAPs. This was more evident by the failure of most DOS's to define the terms as stated in the interview schedule.

Figure 2: Classroom Assessment Practices used by Math teachers and School Category

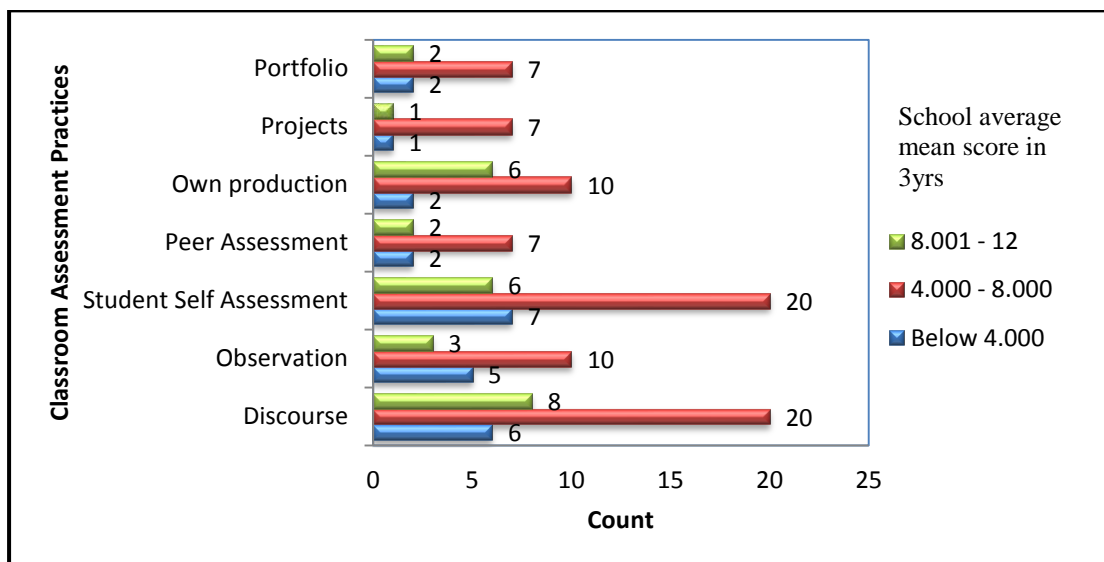


Figure 2 above indicates that the math teachers in all the schools, that is, the high, middle and low performing secondary schools in Nandi Central Sub-County often used discourse, observation and student self-assessment for classroom assessment. Own production and peer assessment were sometimes used by teachers in middle performing schools. Portfolio, projects, own production and peer assessment were rarely used by math teachers in high and low performing schools.

4.4Objective 2:

Common assessment tools/formats used by math teachers in the math classes in secondary school.

Mathematics teachers in secondary school were asked to state how often they employed stated assessment tools/formats for assessment in their math classes. Table 4.4 and figure 3 represent their responses.

Table 4.4: Common Assessment Tools/Formats used in the Mathematics Classes by Math Teachers

Attribute	Never	Seldom	Sometimes	Often	Always
Select-type items	67%	22%	6%	6%	0%
Closed-open questions	12%	33%	47%	8%	0%
Open-open questions	4%	20%	46%	18%	12%
Extended response open questions	2%	6%	69%	16%	8%
Super items	2%	37%	31%	16%	14%
Multiple-question items	8%	49%	29%	8%	6%
Essays	10%	10%	39%	37%	4%
Oral tasks and interviews	6%	24%	45%	22%	4%
Journals	8%	51%	27%	8%	6%
Concept mapping	8%	55%	20%	8%	10%
Progress-overtime tests	8%	49%	10%	16%	18%

Figure 3: Common Assessment Tools/Formats used in the Mathematics Classes by Math Teachers.

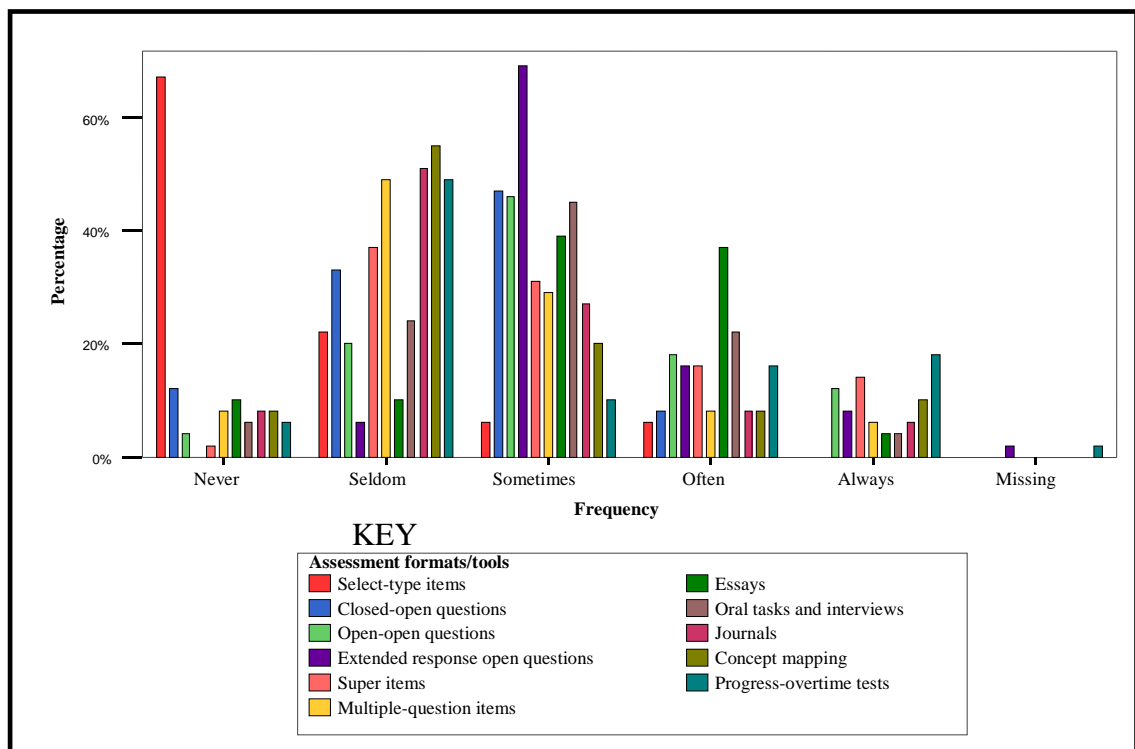


Table 4.4 and Figure 3 indicate that 67% of the math teachers who participated in the study never used select-type items while Only 6% of the teachers said they often used the same. 47% of the teachers said they sometimes used closed-open questions and only 8% claimed to have used the same often in assessing students. 12% of the math teachers said they always used open-open questions while 4% never used the same assessment tool. 8% of the teachers who participated in the study said they always used extended response open questions, a majority (69%) sometimes and 6% seldom. On super items, 14% of the teachers always used this type of tool while only 2% said they never used the same for classroom assessment. 49% of the respondents seldom used multiple question items and 8% never used this but 6% of the teachers always used the tool in their classroom assessment. 39% of those who participated in the study said they sometimes used essays as assessment tool, 37% said they often used, 4% always and 10% said they seldom or never used essays in assessment. Only 4% of the respondents said they always used oral tasks and interviews but 45% said they sometimes used and 6% of the math teachers said they never used the same as assessment tool in their math lessons. 51% of the respondents said that they seldom used journals as assessment tool and 8% said they never used journals completely. Only 6% of the math teachers said they always used journals as assessment tools. 10% of the respondents said they always used concept mapping while 55% said they seldom used the same tool. 8% said they often used concept mapping while the same percentage said they never used it. 18% of the respondents said they had always used progress-overtime tests. 49% stated to have seldom used the same tool while 16% said they often used the tool in assessment but 6% said they never used the same in assessment process.

Figure 4: Classroom Assessment Tools/Formats and School Category used by Math Teachers

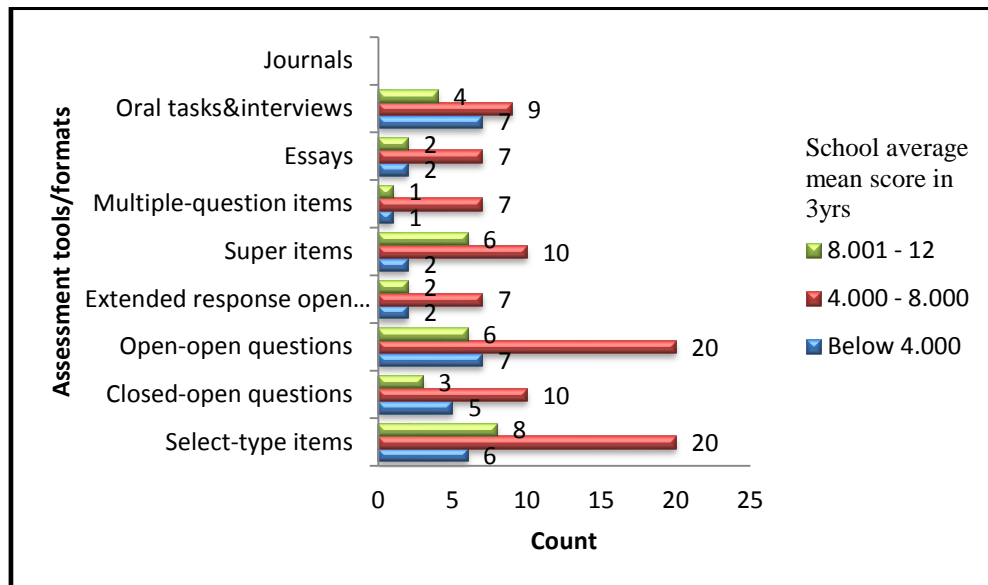


Figure 4 above illustrates that math teachers in high performing secondary schools often used extended response-open questions, open-open questions, select-type items and super items for assessment purposes in their math classes. Journals, multiple-question items, essays and oral tasks and interviews were rarely used by teachers in this category of schools. In the middle performing schools, math teachers indicated that they often used select-type items, open-open questions and super items in their day to day classroom assessment practice. They, however, indicated that rarely did they use journals, multiple-question items, extended response-open questions and essays as assessment tools. The math teachers in low performing schools said they often employed closed-open questions, select-type items, open-open questions and oral tasks and interviews in classroom assessment but rarely used journals, essays, multiple-question items, extended response-open questions and super items as assessment tools.

4.5 Objective 3:

Use of assessment information gathered from students in the classroom by mathematics teachers in secondary school.

The math teachers asked to state how often they would use assessment information gathered from students in the math classes to provide student's grades or marks, provide feedback to students, diagnose student's learning problems and report to parents, to assign students to different programs and to plan for future lessons. Their responses are illustrated in table 4.5 and figure 4.5 below.

Table 4.5: Use of Assessment information gathered from Students by Math Teachers in the Classroom

Attribute	Don't use	To some extent	Extensively	To a great extent
1. Student's grades or marks	2%	4%	57%	37%
2. Feedback to students	0%	6%	63%	31%
3. Diagnose students' learning problems	0%	25%	47%	27%
4. Report to parents	0%	57%	37%	6%
5. Assign students to different programs or tracks	0%	71%	24%	6%
6. Plan for future Lessons	2%	31%	49%	18%

Figure 5: Use of Assessment Information gathered from Students by Math Teachers in the Classrooms

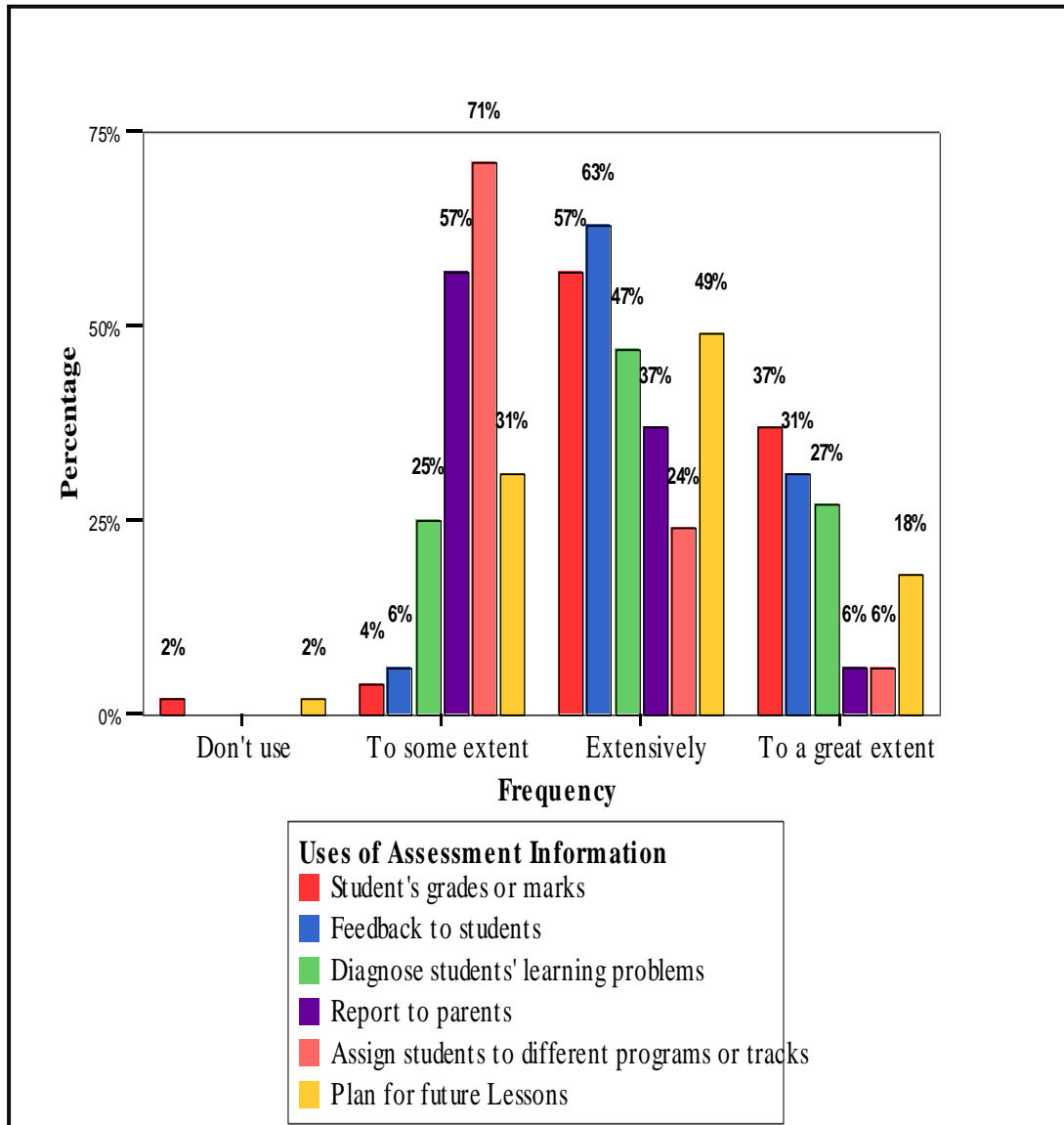


Table 4.5 and Figure 5 indicate that 37% of the math teachers used assessment information to give students grades or marks, 31% used the same to give feedback to students and 27% used the assessment information to diagnose student’s learning problems. 18% of the teachers used the assessment information collected from students to plan for future lessons. Only 6% of the math teachers said they used the information to report to parents and to assign students to different programs or tracks.

Figure 6: Use of assessment information by Math Teachers and school category

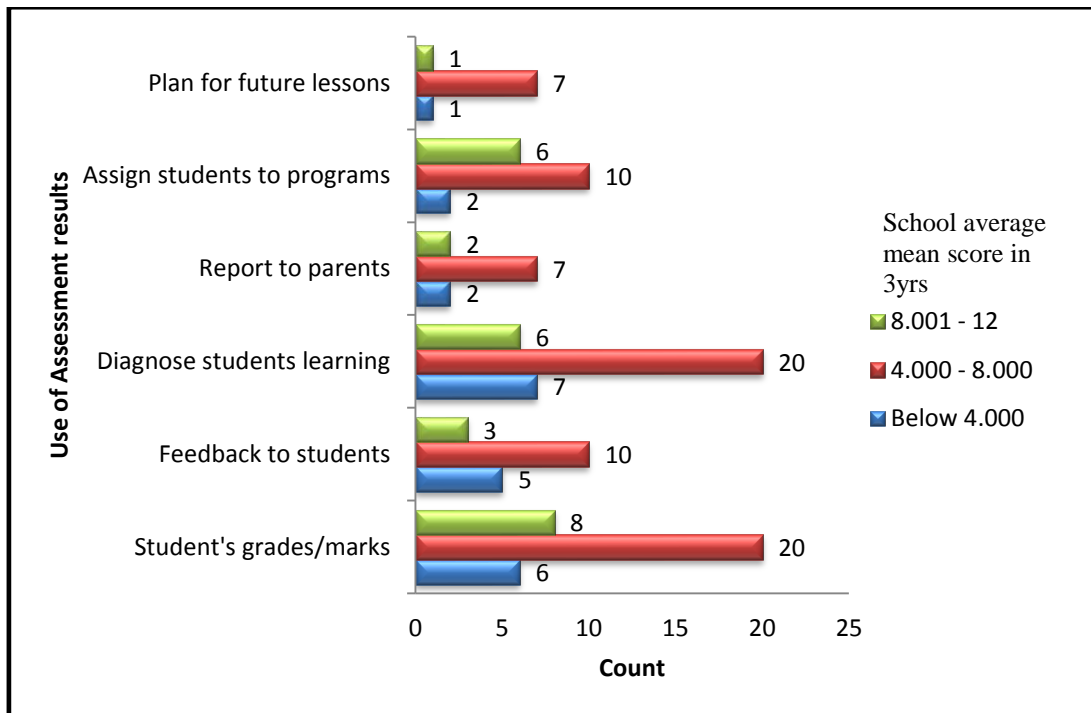


Figure 6 indicates that generally, all the math teachers across the three school categories of high, middle and low performing schools often used assessment information gathered from students to give students grades or marks, to assign students to different programs, to diagnose students learning problems and to give feedback to students. They all rarely used the same to plan for future lessons and report to parents.

4.6 Objective 4:

Mathematical competencies applied by math teachers when assessing students in the math classroom.

The math teachers were asked to respond to whether they considered items that required students to communicate mathematically, represent and analyze relationships, problem solve, use aids and tools, use symbols and formal language, model, create mathematical arguments and reason mathematically while developing assessment tools and how often they used the same in classroom assessment.

Table 4.6 and Figure 7 below illustrate the responses by the math teachers who participated in the study.

Table 4.6: Mathematics Competencies applied by Math Teachers when assessing students in the math class

Mathematical Competencies	Never or almost never	Some lessons	Most lessons	Every lesson
1. Communication	2%	31%	65%	2%
2. Representation	0%	65%	29%	6%
3. Problem solving	0%	35%	51%	14%
4. Aids and tools	0%	78%	22%	0%
5. Symbols and formal language	4%	61%	27%	8%
6. Modeling	8%	75%	16%	2%
7. Mathematical argumentation	6%	73%	20%	2%
8. Mathematical reasoning/thinking	4%	57%	29%	10%

Figure 7: Mathematics Competencies applied by Math Teachers when assessing students in the math class

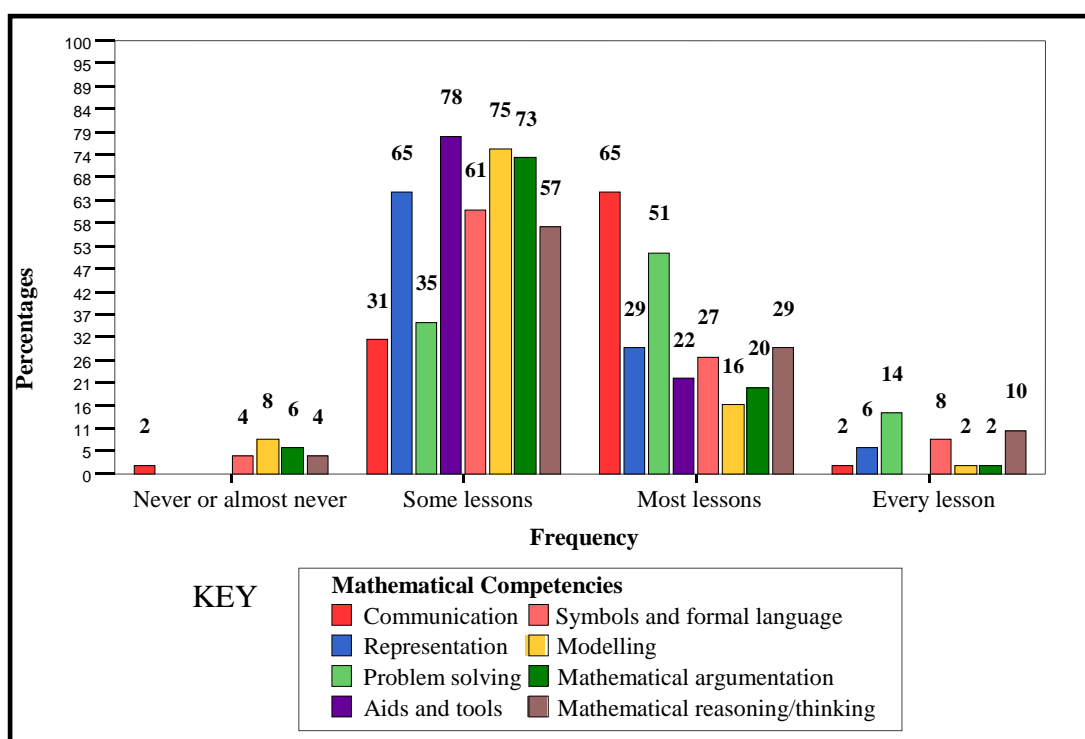


Table 4.6 and figure 7 indicate that 65% of the math teachers used items that tested on communication in most lessons and only 2% used them in every lesson. 51% of the teachers used items that tested on problem solving in most lessons while 14% used the same in every lesson. 29% of the teachers used items that tested on mathematical reasoning/thinking in most lessons but 10% used the same in every lesson. Also, 29% of the math teachers responded to the questionnaire stated that their classroom assessment tools included items that tested on representation in most lessons and 6% of the teachers used the same in every lesson. 27% of the math teachers said they used items that required students to use symbols and formal language in most lessons and only 8% used them in every lesson. 22% of the math teachers who participated in the study agreed that they used items that tested on the use of aids and tools to solve mathematical problems in most lessons but none used the same in every lesson. 20% of the teachers said they made use of items that tested on mathematical argumentation in most lessons but only 2% said they used the same in every lesson. Finally, 16% of the math teachers said they applied items that required students to model in most lessons but only 2% claimed to have used the same in every lesson.

Figure 8: Mathematical Competencies and School Category

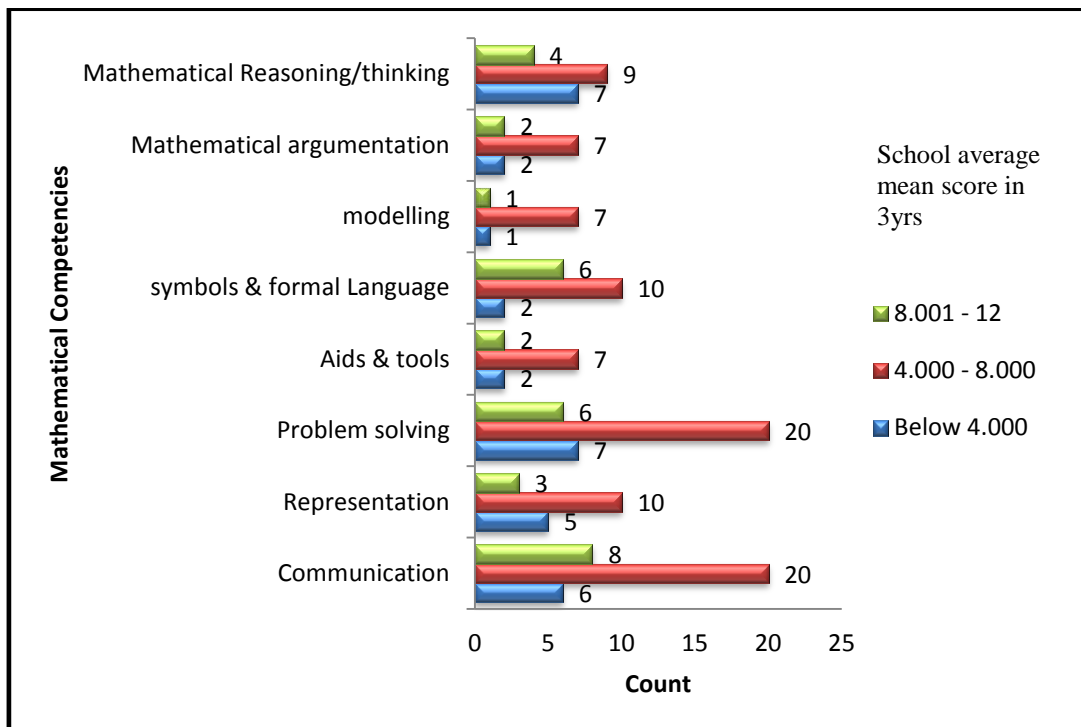


Figure 8 above indicate that math teachers in Nandi Central Sub-County secondary schools in the high, middle and low performing categories all claimed to have used items in assessing the students that tested on communication, problem solving, mathematical reasoning and use of symbols and formal language competencies more often in their day to day CAPS. The figure also indicates that items that tested on the use of aids and tools, modeling, representation and mathematical argumentation were rarely used for assessment.

CHAPTER FIVE

SUMMARY, IMPLICATIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter contains the summary of the study, implications, the conclusions from the findings based on the study results and recommendations for possible action by the relevant authorities and for further research.

5.2 Summary

According to the findings in chapter four, the study revealed that a variety of classroom assessment practices (CAPs) were being used by math teachers in secondary schools in Nandi Central Sub-County. The main CAPs being discourse, observation, students own production and projects.

Discourse which may take the forms, dialogue/conversations/talking to students, can be classified under personal communication (Stiggins and Chappius, 2002). Under this method of assessment, the teacher asks questions during instructions, listens to students as they participate in class, and gives examinations orally among others. The teacher is able to discuss, explain, illustrate and justify mathematical concepts and ideas. Observation, on the other hand, as cited by Kuls, et al. (2001) as well as Angelo and Cross (1993), is classified under performance assessment which is described as one that requires a person to observe a specific behavior or outcomes and judge the appropriate response (Oosterhof , 2003). Students own productions give students the opportunity to present their own ways or methods of tackling math problems while projects give the student the chance to perform activities over a period of time which creates a sense of responsibility and develop the necessary organizational and research skills. The study also revealed that the new alternative CAPs, namely, student self-assessment, peer assessment and use of portfolios were least used or not

used at all by math teachers in Nandi Central Sub-County secondary schools. As stated earlier, the researcher found out that, math teachers had little or no neither experience or training on the use of these types of CAPs. This was evident when the DOS's were asked to define these forms of CAPs and varied definitions for some CAPs were given. According to the DOS's interviewed, written tests/quizzes and class exercises/assignments were the common CAPs being used which are often developed by the teachers themselves. This coincides with Gaume and Naidoo (2004), Omoifo (2006) who stated that teacher-made tests are widely used in schools and in the classroom. From interviews with DOS's, it was clear that homework/takeaway assignments and projects/tasks/presentations were rarely used CAPs in most high schools in Nandi Central Sub-County.

On assessment tools/formats, the study revealed that math teachers always used extended response-open questions, essays, super items, oral tasks and interviews. Closed-open questions and progress-overtime tests were seldom used and a majority of the schools never used select-type items, open-open questions, multiple-question items, journals and concept mapping in their math CAPs.

The illustrations in chapter four indicate that math teachers in Nandi Central Sub-County secondary schools often used assessment information obtained from students in the math classes to give students grades or marks, to provide feedback to students and to diagnose student's learning problems. Feedback is used to correct students' mistakes and also to talk to them about areas they need to improve in. The study also revealed that math teachers seldom used the information from CAPs to report to parents, to assign students to different programs or tracks or to plan for future lessons. It was revealed from the study that assessment instruments/tools developed by the math teachers of Nandi Central Sub-County secondary schools for classroom

assessment purposes were dominated by items that gathered for problem solving, communication, mathematical reasoning/thinking and those items that required the use of symbols and formal language competencies were used in most lessons. Little or no items were developed that tested on mathematical argumentation, modeling and use of aids and tools competencies in math lessons.

5.3. Implications

Literature reveals that students' learning is best served when classroom assessment is guided by the principles of assessment for learning (Wiliam & Black, 1996). That the quality of classroom assessment depends on the extent to which there is a strong commitment towards the formative use of assessment practice in favor of the students in the classroom. Student self and –peer assessment, own productions and portfolio types of CAPs fall under the new assessment paradigm that calls for classroom assessment to be seen as the gathering of assessment information by both the teacher and the student. The implication being that new CAPs link assessment to help students learn as opposed to the traditional emphasis on linking assessment to classifying and grading students (Buhagiar; 2007). From the findings, the types of CAPs that were often used and those seldom used as stated above cut across the school categories as shown in figure 4.3. The explanation here being that the math teachers went through the same training in college and would very likely use similar approaches to assess and grade students. Research suggests that middle grades students learn through meaningful, hands-on experiences in the classroom that is collaborative in nature and involves students in the decision-making process (Eggen & Kauchak, 2001; Messick & Reynolds, 1992).

On assessing mathematical process and mathematical competencies, it should be noted that the complexity of mathematics and the interconnectedness of the processes

of mathematics have strong implications for assessment. An assessment program that merely uses paper and pencil tests will overlook many of the mathematical processes. An assessment program that uses a variety of strategies and tools will be more suitable to capturing the complexity of mathematics. Rich mathematical tasks allow students to develop and show their competencies in problem solving, communication skills, mathematical thinking and perseverance. Further, the timely use of self-assessment helps students foster metacognitive skills such as a positive attitude towards mathematics and responsibility towards one's own learning, that are strongly recognized as being essential to learning mathematics. Assessment that includes observation and conferencing with students allows teachers to have a window into students' mathematical thinking and strategies for solving problems. Comments and anecdotal feedback to students helps students to determine the processes that they are mastering well and those that need further development. Such an assessment program is a complex task for the teachers. However, Suurtamm (2004) recommends that in order to develop mathematical proficiency in students, the full range of content and mathematical processes must be a foundation for curriculum, instruction, and more so for assessment. Finally, Mathematics Literacy framework published by the OECD Program for International Student Assessment (PISA) (Cappo & de Lange, 1999) suggests that all levels of competencies should be present in all tests but there should be more of the lower ones because they take little time. It is advisable to make an equal distribution over the three levels in terms of time rather than in terms of the number of items. It is a good idea to keep track of the distribution of the number of items on different levels and how the student perform relative to the levels in order to be able to give quality feedback on both the classroom and the individual levels.

The general finding implies that some restructuring of undergraduate teacherpreparation measurement courses is warranted. There should be less focus onstatisticalconcepts and increased attention paid to techniques of alternative assessment, which in many measurement courses, tend to be given cursorycoverage. Although they still tend to use traditional slightly more often than alternativeassessments, the math teachers involved in this study indicated considerable use of alternativeassessment techniques at all levels of secondary education (i.e. form 1 to 4). Only whenmeasurement courses appropriately address the actual needs of classroom teachers will wehave adequately prepared our teachers to assess their students' performance.

5.4 Conclusion

Classroom assessment practices in secondary schools should be those that support the appropriate use of multiple methods of assessment that are needed to cover the “full range of achievements targeted; namely, knowledge, thinking processes, products and dispositions” (Gripps, 1994). The multiplicity and variety of assessment practices provide higher quality and fairer information. The findings from this research indicates that the teachers need to gain knowledge in using a variety of assessment options such as self and–peer assessment, observation, portfolio and performance tasks as well as gaining experience in matching the assessment tools to the purpose of assessment. These types of CAPs enable students learn to synthesize multiple perspectives; solve problems in different ways; use each other's diverse knowledge and skills as resources to advance learning and encourage them to become more responsible for their own learning. Another significant issue is the relationship between the information gathered from assessments and the teaching and learning which findings revealed as important in improving teaching, motivating students to

learn and as a basis for talking to parents. The school administration, teachers, students and parents need assessment information in equal measure for proper attainment of the set goals. On mathematical competencies, it was revealed that no single form of assessment and instrument is sufficient to validly and reliably assess the entire spectrum of mathematical competencies. Different CAPs will involve different sets of competencies. Therefore, for assessment to provide a fair and comprehensive coverage of the entire set of mathematical competencies, a broad spectrum of CAPs is used.

5.5 Recommendations

- The Ministry of Basic Education should put in place regulations, checks and balances to ensure that different CAPS are used in secondary schools in Kenya. A uniform policy on this practice should be emphasized so that all schools benefit from it.
- Higher institutions of learning should train teachers on how to use CAPs for their implementation in secondary schools. It was found out through the interviews that math teachers had little or no neither experience nor training on the use of these types of CAPs as it was evident when the DOS's were asked to define these forms of CAPs.
- Given the complexity of classroom assessment and evidence relating to teachers' skills and practice in this area, there is an obvious need for development of an infrastructure to support improvement of its quality. Therefore, regular training through seminars/workshops should be constantly organized for teachers to update their knowledge of the process involved in the implementation of CAPs to further boost the realization of learning objectives

and consider mathematical competencies when preparing assessment instruments.

5.6 Areas for Further Research

- There is a need for this research to be carried out in other Sub Counties so as to compare and test how general the research findings of this study can be made.
- In this study, there was no evidence of math teachers' frequent use of the recommended CAPs effects on student performance which could be attributed to the assumption that aspects of classroom assessment are interdependent. Future research need to independently consider each aspect of the recommended assessment practices to determine its effect on student achievement.
- Further research needs to be done on the math teachers' competency in developing assessment instruments with regard to the mathematical competencies in mathematics education. It will be interesting to follow, in the years to come, how mathematical competencies are going to be developed from research as well as from practice perspectives. At the very least, putting the competencies on the agenda of mathematics education will offer new ways of thinking about what mathematics education is all about.

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APPENDIX A: QUESTIONNAIRE FOR MATHEMATICS TEACHERS

TEACHER QUESTIONNAIRE

SCH. CODE _____

CODE _____

RESEARCH DESCRIPTION

Dear Participant,

You are invited to participate in a research study on classroom assessment practices in secondary school. I am interested in working with you to explore your perceptions of classroom assessment practices in Secondary Schools of Kenya.

Please kindly respond to the questions and statements as frankly and truth fully as you can. Your cooperation and contribution towards this research will be very much appreciated. All information given will strictly be kept confidential. (Do not write your name)

The data collected will be used for my master's project and possibly in presentations and publications.

Thank you

Eliud K. Kemboi

SECTION A: Teacher characteristics

1. Please mark the response that describe you (*Tick (✓) the box that applies*)

Teacher characteristics	Options	Tick(✓)
Gender	Male	
	Female	
Age	Under 25 yrs	
	25 – 29 yrs	
	30 – 39 yrs	
	40 – 49 yrs	
	50 or more yrs	
Academic qualification	Diploma in Education	
	Post Graduate Diploma	
	Bachelor of Education degree	
	Masters' in Education degree	
	PhD in Education	
	Other degree Specify.....	
Teaching experience	Less than 1 year	
	1 – 5 yrs	
	5.1 – 10 yrs	
	Above 10 yrs	
Class size	Below 20	
	20 – 29	
	30 – 39	
	40 – 49	
	50 or more	
Lessons per week	Below 12	
	12 – 19	
	20 – 29	
	30 or more	
School mean average in Public National Exams in the last 3 years	Below 4.000	
	4.000 – 8.000	
	8.001 – 12.	

SECTION B: Classroom assessment practices

Please grade the following on a 5-point scale format where 1-*Never*, 2-*Seldom*, 3-*Sometimes*, 4-*Often*, 5-*Always*. Put 1,2,3,4 or 5 in the Ratings column.

Consider the following aspects of the daily classroom practice.

Item	Classroom assessment	Ratings
1. State how often you employ the following for assessment purposes in the daily classroom practice:-	Discourse -Discussing, explaining, justifying, illustrating and analogizing.(features of reasoning in a mathematics classroom)	
	Observation - used to identify individual and group performance, how organized student(s) are and determines confidences levels of students as they engage in argumentation.	
	Student self-assessment -Students reflect on their own understanding and help them take more responsibility for their own learning	
	Peer assessment - comment on oral presentation of another student, grade traditional tests, construct test items,, etc.	
	Own productions - allowing students to present own ways of tackling math problems	
	Projects -(work done individually or in groups over a period of time)	
	Portfolio -(Collection of separate pieces of work done usually on one topic or theme for an overall assessment purpose)	
2. State how often you employ the following assessment tools/formats for assessment in your mathematics class:-	Select-type items -Multiple-choice, true-false, blank filling and matching items	
	Closed-open questions -Student required to give answer by a number, a yes or no, a definition, simple graph or formula	
	Open-open questions -Student required to give answer by number or formula but process to get there involves higher order activities	
	Extended response-open questions -student expected to explain his/her reasoning process as part of the answer.	
	Super items -Tasks that give students the opportunity to get involved with a context or problem situation by asking a series of open questions of increasing complexity.	

	<p>Multiple-question items- A set of items formed from one context or problem situation with the structure of range of questions being arranged in no strict order</p>	
	<p>Essays- efficient in measuring complex outcomes such as ability to create, to organize, to integrate, to express and more that require production and synthesis of ideas</p>	
	<p>Oral Tasks and Interviews An oral discussion on certain mathematical subjects that are known to the students, an oral discussion on a subject—covering a take-home task—that is given to the students for 20 minutes prior to the discussion or an oral discussion on a take-home task after the task has been completed by the students.</p>	
	<p>Journals- drawing schemata and graphs, writing mathematically—shaping, clarifying, and discovering ideas.</p>	
	<p>Concept mapping- used to show how students see relationships between key concepts or terms within a body of knowledge.</p>	
	<p>Progress- overtime tests- Use of almost similar items/problems in tests given at different times where new tasks are supposed to be more difficult than the previous ones.</p>	

SECTION C: Use of Classroom Assessment information.

2. How often do you use the assessment information you gather from students to... *Check one box in each row.*

Item	<i>None</i>	<i>Little</i>	<i>Quite a lot</i>	<i>A great deal</i>
a) Provide students' grades or marks?				
b) Provide feedback to students?				
c) Diagnose students' learning problems?				
d) Report to parents?				
e) Assign students to different programs or tracks?				
f) plan for future lessons?				

3. In your mathematics lessons, how often do you ask students to:-
Check one box in each row.

Mathematical competencies	Indicators	<i>Never or almost never</i>	<i>Some lessons</i>	<i>Most lessons</i>	<i>Every lesson</i>
Communication	Express oneself in a variety of ways on matters with mathematical components(numbers, shapes, objects, patterns, data etc) in oral and/or in written form				
	Understand others' written or oral statements on mathematical components.				

Representation	Decode, interpret and distinguish between different forms of presentations of mathematical objects and situations. \\\				
	Represent and analyze relationships using tables, charts, or graphs				
Problem solving	Pose, formulate and make precise different kinds of mathematical problems (e.g., pure, applied, open-ended, closed)				
	Solve different kinds of mathematical problems in a variety of ways.				
Aids and tools	Know about and be able to make use of various aids and tools (including information technology tools) that may assist mathematical activity				
	Understand the limitations of such aids and tools.				
Symbols and formal language	Decode and interpret symbolic and formal language and understand its relations to natural language.				
	Handle statements and expressions that contain symbols and formulas; use variables, solve equations, and perform calculations.				
Modelling	Interpret mathematical models in terms of “reality” and reflect, analyze, offer critique of models and model results.				
Mathematical argumentation	Know what mathematical proof is and how it differs from other kinds of mathematical reasoning and				

	be able to create mathematical arguments.				
Mathematical reasoning/ thinking	Pose questions characteristic of mathematics-Does there exist...? If so, how many? How do we find...?				
	Distinguish between different kinds of statements (e.g., definitions, theorems, conjectures, hypotheses, examples, conditioned assertions).				

The End: THANK YOU for the thought, time, and effort you have put into completing this questionnaire.

APPENDIX B: STRUCTURED INTERVIEW FOR DIRECTOR OF STUDIES

1) What classroom assessment practices do the teachers in your school apply?

.....
.....

2) What examination policy is applied in assessing student performance in your school?

.....
.....

3) How are they carried out?

.....
.....

4) What is your view on the contribution of Classroom Assessment practices to students performance in final examinations especially KCSE?

.....
.....

5) a) What do you understand by the following forms of classroom assessment?

Student self assessment.....
Peer assessment.....
Student's own productions.....
Projects.....
Portfolio.....

b) To what extent do the teachers in your school use the classroom assessment practices mentioned in (a) above?

6) What is the best Classroom Assessment strategy that you would recommend to teachers and why?.....

.....

7) What suggestions would you make so that teachers can improve on the use of Classroom Assessment strategies?

.....

End

APPENDIX C: LETTER OF INTRODUCTION TO THE RESPONDENTS

Dear Respondent;

I am a post graduate student at the University of Nairobi pursuing a master of education degree in measurement and evaluation. I am interested in working with you to explore the commonly used classroom assessment practices in Secondary Schools in Kenya.

Please kindly respond to the questions and statements as frankly and truthfully as you can. Your cooperation and contribution towards this research will be very much appreciated. All information given will strictly be kept confidential. (Do not write your name)

The data collected will be used for my master's project and possibly in presentations and publications.

Thank you

Eliud K. Kemboi

Cell Phone: 0722456741

Email: ekemboi33@yahoo.com

APPENDIX D: LETTER OF OBTAINING PERMIT

KEMBOI ELIUD K.

UNIVERSITY OF NAIROBI

DEPARTMENT OF PSYCHOLOGY

P.O. BOX 30197,

NAIROBI

THE DISTRICT EDUCATION OFFICER,

NANDI CENTRAL SUB-COUNTY

**RE: REQUEST FOR A RESEARCH PERMIT BEFORE COMMENCEMENT
OF RESEARCH WORK**

I am a post graduate student at the University of Nairobi pursuing a master of education degree in measurement and evaluation. I do hereby report to your office as required by the Ministry of higher Education before starting to collect research data within the Sub-County.

Kindly allow me to conduct this research in your Sub-County. Thank you.

Yours Faithfully

Eliud K. Kemboi

Cell phone: 0722456741

Email: ekemboi33@yahoo.com

APPENDIX E: LETTER OF OBTAINING PERMISSION FROM SCHOOLS

KEMBOI ELIUD K.

UNIVERSITY OF NAIROBI

DEPARTMENT OF PSYCHOLOGY

P.O. BOX 30197,NAIROBI

TO THE PRINCIPAL

.....**HIGH SCHOOL**

Dear Sir/Madam;

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH AT THE SCHOOL

I am a post graduate student at the University of Nairobi pursuing a master of education degree in measurement and evaluation.

I am requesting your permission to allow me collect research data using a questionnaire and an interview schedule in your school. At least two mathematics teachers and the director of studies are to participate in the study. The data collected from the school shall be held in full confidentiality and no name of the respondent or of the school shall be revealed in the study.

Kindly allow me to conduct the research in your school.

Yours Faithfully

Eliud .K. Kemboi

Cell phone: 0722456741

Email: ekemboi33@yahoo.com