

**TEACHERS' READINESS FOR CRITICAL THINKING AND PROBLEM  
SOLVING SKILLS DEVELOPMENT IN THE COMPETENCY  
BASED MATHEMATICS CURRICULUM IN PRIMARY SCHOOLS IN  
NANDI COUNTY, KENYA**

**BY**

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**DECLARATION**

**Declaration by the Candidate**

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**DEDICATION**

I dedicate this work to God Almighty for being my source of inspiration, wisdom,

knowledge and understanding. He has been the source of my strength throughout this program and on His wings only have I soared. I also dedicate this work to my parents; Peter Kosgei and Grace Kosgei and all my siblings; Brian, Alphine, Alca and Adelaide who have encouraged me all the way and whose encouragements have made sure that I give it all it takes to finish this work.

Thank you all. God bless you

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## ABSTRACT

Critical thinking and problem-solving skills are important aspects of mathematics education in the newly implemented competency-based curriculum (CBC) in Kenya. According to the literature, a curriculum change not only requires the teachers to acquire new content knowledge, but also new skills in teaching methods that support the aims of the new curriculum and a positive attitude towards the effected curriculum change. Given the recent curriculum change in primary schools in Kenya, the purpose of the study was to investigate the teachers' readiness for developing the skills of critical thinking and problem solving in grade 1-3 learners. The following objectives guided the study: (i) to determine the teachers' own level of competence in critical thinking and problem-solving using questions from a validated critical thinking test, (ii) to explore the teachers' perceptions of critical thinking and problem-solving skills and their incorporation in mathematics education and (iii) to establish teaching practices employed by the teachers to promote critical thinking and problem-solving skills in mathematics education. The Visible Learning Theory by John Hattie provides the theoretical framework of the study and a pragmatic paradigm was chosen where quantitative (critical thinking test and questionnaire) and qualitative (semi-structured interviews) data were generated from grades 1-3 teachers in a concurrent triangulation design. The target population comprised of 75 schools and 210 grades 1-3 teachers. Simple random and purposive sampling were used to select the research participants from Nandi County primary schools, comprising of 20 schools and 55 grades 1-3 teachers. The quantitative data was analysed and summarized into frequency tables, percentages and bar graphs. The qualitative data was analysed using thematic analysis. This study adhered to ethical issues. The findings for the first objective revealed that only approx. 52% of the teachers answered the critical thinking test questions correctly. The findings for the second objective on a Likert scale of 1-5, showed that the overall mean of teachers' perceptions was 4.245, which means that teachers perceived it as important to develop learners critical thinking and problem-solving skills. Qualitative findings revealed that the teachers perceived the change as very positive and were open to use the new teaching methods but found them difficult to put in practice in overcrowded and under-resourced classrooms. Findings for the third objective on a 5- point Likert scale gave a high overall mean of 4.14, pointing out that the teachers applied learner-centered methods, which was confirmed by the qualitative results. However, the findings highlighted a certain level of uncertainty about which teaching methods serve to promote critical thinking and problem-solving skills and which do not. In conclusion, the study found that the teachers' readiness in developing critical thinking and problem solving in the classroom was only partially achieved. Hence, the study recommends that it would be useful to expose teachers to more and indepth training that not only equips them with the skills to apply learner-centered methods, but also with more knowledge about how critical thinking and problemsolving skills develops in children.

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## ABBREVIATIONS AND ACRONYMS

**CBC:** Competency Based Curriculum

**CBE:** Competency based Education

**CEMASTEА:** Centre for Mathematics, Science and Technology Education in Africa

**EFA:** Education for All

**KICD:** Kenya Institute of Curriculum Development

**KNEC:** Kenya National Examination Council

**KNUT:** Kenya National Union of Teachers



**MDG:** Millennium Development Goals

**MOE:** Ministry of Education

**REB:** Rwanda Education Board

**SPSS:** Statistical Package for Social Sciences

**TIE:** Tanzania Institute of Education

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## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Overview**

This chapter presents the study background, problem statement, the purpose of the study and its objectives, the research questions and significance of the study as well as its scope and limitations. It also sketches the theoretical and conceptual framework and has information on how the key terms of the study have been operationalized.

#### **1.2 Background of the Study**

School curricula and their changes are usually contested and discussed widely among education specialist, policy makers and the public. It is believed that learners' class results are attributed to faults in the system, when the defect should be actually in the teaching learning process (Isyaka, 2019). According to Hameyer (2003), the quality of the curriculum can be of the same level with the curriculum process depending on the self-renewing ability of the institution. Similarly, the learners' academic performance can be improved when the kind of the needed pedagogy is objective and actualized with rigor and with assessment for results that is tuned with the whole process (Smith & Lovat, 2003).

In the past years, issues pertaining to the quality of education delivered to learners have been the main bone of contention in all education sectors (Milligan, 2017).

While the focus of the Millennium Development Goals (MDG) had been mainly on the access to basic education, it has been established that this focus tended to neglect what learners were really learning at school (Alexander, 2008, Barrett, 2011, Cunningham, 2012). A different class of literature has considered the level at which the system goes hand in hand with the learners' needs and development issues in the society. Moreover, studies

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have found out that there exists a significant correlation between an over-ambitious education system and poor learning outcomes (Pretchet & Beaty, 2015).

Hence, in the past years, many countries in the world have changed their school curricula towards competence-based-curricula (CBC). In Mexico, the actualization of the competency-based curriculum began in 2009. A series of attempts to revolutionize the basic and national educational policies have made competencies to be perceived as the application of skills and values (Secretaria de Education Publica, 2011). According to a publication by the Mexican Ministry of Education (2011), classroom teaching has been a policy priority in Mexico with reforms majorly on teacher training, teacher career, progression and evaluation.

In England, the introduction of the competency-based curriculum aimed to focus on learner's competencies rather than content knowledge overloads in the curriculum. According to the report, teachers encountered external pressure from stakeholders to make sure that learners acquire the right techniques to face different obstacles in life and help enhance their societies (Bryne, 2013).

In Spain, the Spanish education Act 2006 incorporated certain core competencies as one of the elements of the curriculum and evaluation. The mathematics competence

was among the integrated competencies. It involved the use of basic operations and logical reasoning to think critically and solve problems (Pamies, Blanco, Sanchez & Villanueva, 2015). The Spanish reforms on education incorporated these key competencies in the system for both primary and lower secondary learners. Consequently, there was the urge for different teachers to cooperate and work together as a team to make sure that learners acquire the desired skills that can be applied throughout their lives (Tiana, Moya & Luengo, 2011).

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In 2005, the Republic of Tanzania reintroduced the competency-based curriculum. The philosophy had been in existence in the Tanzanian primary education system (Mosha, 2012). It revealed that the primary school system was changed from 'traditional content based' to a 'competency-based' curriculum (Tanzania Institute of Education, 2007). The education scholars from Tanzania Institute of Education pointed out that competencies, as a variety of techniques, include: critical thinking, communication skills, technological skills and self-reliant learning skills. Teachers in Tanzanian schools considered writing, reading and counting to be all encompassed in these competencies. Concerning the realization of the competency-based curriculum in the classroom, it was revealed that a good number of teachers still utilize traditional teaching techniques, which were not considered conducive to development of competencies, focusing on the delivery of content. A good number of teacher implementing the curriculum, from lesson planning, different guides to learner's assessment, had not adopted the new curriculum.

The Republic of Rwanda came up with curriculum reforms to enhance the quality of education. This was a vital milestone in Rwanda's journey to come up with competencies, that could promote the growth of regional and global competition in the

job market (Rwanda Educational Board, 2015). The important shift was a move away from a knowledge-based curriculum to a competency-based curriculum. The proposed competencies, which were incorporated in Rwanda's new curriculum, included critical thinking and problem-solving techniques, innovation, and creativity, mastering the official languages, co-operation and inter-personal techniques (Ngedahayo & Williams, 2016). This scenario demonstrates the movement to acknowledge the growing potential of competency-based education, which sought to develop the learners' competencies

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and are perceived to be vital for success in both academia and the current society (Hammond, 2012).

The change of the curriculum in Kenya came along with a change of the 8-4-4 (meaning eight years in primary, followed by four years in secondary school and finally another four years in tertiary education) system of education, which had been implemented in 1984 and was founded on the philosophy of education for selfreliance. However, this guiding philosophy was soon lost due to implementation challenges and consequently, the 8-4-4 system of education did not sufficiently look into factors that may change the community by improving usefulness and productivity of each member of the society to boost the economic growth rate (KICD, 2017). As such, it was heavily criticized concerning issues such as the curriculum content, overloaded subject fields, unnecessary overlaps and inadequacies in addressing certain emerging issues. Initially, this system was tailored to enhance self-reliance and increase employment potential for qualified graduates (Bogonko, 1992). Since its inception, the 8-4-4 system has been among the key issues in the national debate for being practically oriented only on paper, broad, expensive and burdensome to pupils

and parents (Amutabi, 2003). Amutabi (2003) in her study maintains that recent years since then there is a shift towards a system, which produces graduates with relevant skills in the job market.

Increasingly, several countries worldwide have initiated extensive curriculum reforms putting more emphasis on skills and competencies believed to be central for the 21st century, as compared to academic knowledge. It is against this background, that in 2017 the Kenyan Government - through the major educational stakeholders, that is the Ministry of Education (MoE) and the Kenya Institute of Curriculum Development (KICD), - sought to implement a revised curriculum blue print that is competency based and that reflects these dynamic universal trends. This included a major shift from the

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previous 8-4-4 system to the implemented system of 2-6-3-3-3 (two years in preprimary, six years in primary, three years in lower secondary, three years in upper secondary and three years tertiary education). It is anticipated that the new system, which is competency based, should emphasize on the learner's development techniques and competencies to acquire the desired results at every phase from preschool to tertiary level (Kenya Institute of Curriculum Development, 2017).

The Kenyan Government through a Sessional paper number 2 of 2015, which recommended educational reforms on Kenya's educational system, opted to adopt a competency-based curriculum (Kenya Institute of Curriculum Development, 2016). The framework sought to develop specific competencies so as to enable Kenyan learners to thrive in the 21st century. The newly designed competency-based curriculum requires that at the end of the learning period, every learner should be competent in the seven core competency areas. These core competencies include:

communication and collaboration, critical thinking and problem solving, imagination and creativity, citizenship, learning to learn, self-efficacy and digital literacy (Bourn 2018) he Kenya Institute of Curriculum

Development (KICD) has incorporated critical thinking and problem-solving skills as key components also of mathematics education. Piloting these has indicated that developing these competencies is an essential part in mathematics instruction.

Under the guidance of the Ministry of Education (MOE) and the Kenya Institute of Curriculum Development (KICD), a new competency-based curriculum (CBC) has been implemented starting with pre-primary and lower primary schools. The national rollout of the competency-based curriculum in Kenya started in January 2019. It is not a new curriculum in the education sector as such, but any change in curriculum holds

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its new challenges. The biggest impediment of launching such a model is not technology, content or standards mapping, but how the teachers are trained and prepared (Sagan, 2017).

A report by the (KICD, 2018) pointed out that more than half of teachers in primary schools were ready for the adoption and implementation of the new curriculum. According to the report dubbed ‘monitoring reporting on the national pilot of the competency curriculum’, teachers are still using the old syllabus and some classes are congested. It also adds that teachers have difficulties in interpreting curriculum designs and subsequent preparation of schemes of works and lesson plans. The report recommends that KICD should plan for teachers to have more training sessions to bridge capacity gaps highlighted on pedagogy, assessment and the preparation of teaching documents.

On the other hand, the Kenya National Union of Teachers (KNUT) through the media have requested the Kenyan Government to halt rolling out the implementation of the competency-based curriculum in March 2019. The teacher's union (KNUT) felt that the implementation was hurriedly done without proper teacher training or involvement and teachers had been pushed to implement it.

### **1.3 Statement of the Problem**

Critical thinking and problem solving skills are essential competencies for learners to develop in school in order to be able to judge the credibility of a source, make correct inferences and deductions, as well as to recognize assumptions and evaluate arguments in our complex 21st century world. In Kenya, like in other parts of the world, many secondary school graduates and university students do not possess sufficient critical thinking and problem-solving skills (Githui et al 2017), which is why the newly adopted

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curriculum emphasizes teaching methods that foster these competencies. Teacher education and professional development are crucial in this regard, as they prepare the teachers to develop the skills of interest in their learners. At the time this study was carried out, most teachers had received training on the new curriculum and its preferred teaching and assessment methods. However, little is known about whether teachers are competent, willing and able to develop critical thinking and problem-solving skills in their learners after the new curriculum has been implemented. Hence, the research gap that this study set out to address is to look into the teachers' readiness, conceptualized as their own competence, their attitudes and perceptions and their practices in terms of teaching and assessment methods with regard to critical thinking and problem-solving skills. As mathematics education is a

subject where critical thinking and problem solving is explicitly put forward, and because primary schools had implemented the CBC at the time the study was carried out, this study focuses on grade 1-2 mathematics teachers.

#### **1.4 Purpose of the Study**

This study sought to investigate teachers' readiness in developing critical thinking and problem-solving skills in mathematics education in the competency-based curriculum in Nandi County, Kenya.

#### **1.5 Objectives of the Study**

More specifically, the study sought to,

- i. Determine the level of the teachers' own competence in the field of critical thinking and problem-solving in Nandi County.
- ii. Explore teachers' perceptions on the incorporation of critical thinking and problem-solving skills in mathematics education in primary schools in Nandi County.
- iii. County
- iv. Establish teaching practices used by teachers to promote critical thinking and problem-solving skills in mathematics education in Nandi County.

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#### **1.6 Research Questions**

The following research questions guided the study,

- i. What are the critical thinking and problem-solving competencies of the mathematics teachers in primary schools in Nandi County?
- ii. How do teachers perceive the incorporation of critical thinking and problem-solving skills through mathematics education in primary schools in Nandi County?



- iii. Which teaching practices do mathematics teachers employ to promote critical thinking and problem-solving skills in primary schools in Nandi County?

### **1.7 Justification of the Study**

Kenyan education has come under criticism for many years and educators through research have shifted towards many reforms to improve teaching, learning and curriculum (CEMASTEPA, 2019). The literature expounds that many have argued that the separation of content and application has adversely affected education in Kenya.

KICD (2016) highlights the incorporation of critical thinking and problem-solving skills as key components in the mathematics curriculum and points at its positive impact on the learners' ability to think critically and solve problems, also in other fields. The need for learners to become critical thinkers and problem solvers has become a prevailing theme in many countries that have shifted towards the competency-based curriculum. Jordan (2018) suggests that critical thinking and problem solving are

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typically an intrinsic part of mathematics instructions at all levels of education. The study alludes that without entrenching critical thinking and problem-solving skills systematically into instruction, learning will be transitory and superficial.

Hence, one can say that the acquisition of critical thinking and problem-solving techniques in mathematics instructions is very crucial for the 21st century teacher. It is important in preparing students for a global society defined by intricate and rapid changes. With scientific facts being discovered each year, it becomes vital for learners to acquire high end thinking techniques. Skills such as critical thinking and problem solving competencies require learners to use knowledge and information in various

domains, perform critical analysis and judgements, and solve problems (Kirkley, 2003). As educators call for integrated instruction, critical thinking and problem solving often serves as the main competency strand that combines various disciplines, concepts and techniques. This is mainly because these competencies are important in solving real life problems and in helping the learners reach their potentials, which is a vision for the basic education curriculum. It is also believed to contribute to addressing the unemployment challenge in Kenya. By carrying out this study, it is envisaged that the knowledge gained would stimulate further discussion and studies on critical thinking and problem-solving skills, as the country rolls out the Competency Based Curriculum.

### **1.8 Significance of the Study**

The findings of the study are helpful to different stakeholders in the education sector such as teachers, administrators, curriculum developers and students. It provides insights into the question; how primary teachers actually include critical thinking and problem-solving skills during mathematics instruction and what they might need in terms of training or resources in order to fully embrace these skills in their lessons.

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The findings add knowledge that provides a better understanding of mathematics teachers' readiness to develop learners' skills in the field of critical thinking and problem solving, which is a required by the competency-based curriculum. The research findings add to the scientific knowledge since few studies have been done on promotion of critical thinking and problem solving by teachers in Kenyan primary schools. By looking at the specific local conditions for implementing this aspect of the CBC, the situation of teachers will be better understood and the gap between theory and practice addressed. Hence, it is hoped that the findings of this study will help

curriculum developers and planners to improve the systematic training of mathematics teachers based on the 21st century competencies.

Hence, it is believed that the findings of the study might be useful to the MOE and KICD in organizing in-service trainings, workshops and seminars to adequately prepare teachers to include the relevant skills of critical thinking and problem solving in their mathematics instruction and therefore, for an effective implementation of the competency-based curriculum.

### **1.9 Scope of the Study**

This study encompasses primary teachers in their readiness to develop critical thinking and problem solving in mathematical education under the competency-based curriculum in Kenya. The study investigates the 'readiness' from mathematics teachers' perspective and include their own competencies, understandings or perceptions and their teaching strategies. The population participants included mathematics teachers of grades one and two. The study was conducted in selected public primary schools in Nandi County, Kenya, both in rural and urban settings. The teacher characteristic on which the selection of research participants is based, is: training on the new curriculum,

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male and female teachers and preferably they should have some years of teaching experience in mathematics.

### **1.10 Limitations of the Study**

The study was limited to a specific time and local context within Kenya. Given the situation that the competency-based curriculum (CBC) has been newly introduced, that it is politically contested and that the teachers have had different exposure through

trainings, the process in which this study is carried out is a very dynamic one. It might be that a year later and after more training sessions for the teachers, the results would be different. Carrying out the research during a longer period of time or replicating it at a later stage would probably help refine the results but was not possible in the scope of this study.

The weakness of the competence test could be, that while the test questions have been verified to be suitable to measure critical thinking and problem-solving skills in various contexts, the questions and arguments are posed in English. English being the second or third language for most of the teachers, it was expected that the questions and argumentation are barely sufficiently understood. However, the exact and detailed wording is crucial to judge the arguments and respond to the questions correctly.

Another limitation concerning the questionnaires is that they rely on the information provided by the teachers, for example about their teaching strategies and this self-reported information cannot be completely verified. Interpreting inconsistencies in the findings, for example with regard to the application of teaching methods, will be difficult. However, through triangulation, the envisaged weaknesses were minimized.

The research findings may not reflect the status of the whole country and therefore findings need to be generalized with caution; the literature review was drawn from

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developed and developing countries with different types of education systems. However, the researcher made use of studies conducted in different contexts as they were of great use and relevance to the present study.

### **1.11 Assumptions of the Study**

The study started with the following assumptions: the participants (teachers) of the

study were honest in their responses and they provided a true picture of what they practice within the new curriculum. All mathematics teachers have received training on the new curriculum and on the methods of incorporation the skills when teaching mathematics before the national rollout of CBC. Finally, it is assumed that the data generation and analysis tools employed in the study were appropriate.

### **1.12 Theoretical Framework**

This study was done under the guidance of the visible learning theory, which was put forth by John Hattie in 2012. The visible learning theory seemed particularly suitable for this research, as it focuses on the teachers and their impact on student learning especially in the context of curricula and curriculum change. The teacher is viewed as having the strongest positive impact on student learning and the teachers' beliefs, perceptions and commitment substantially affect student cognitive development. The theory observes that globally, fundamental changes in education systems have important implications for curriculum reforms. According to this theory, learners need to think critically and solve problems, work in teams, communicate through discussions, take initiatives and bring diverse perspectives to their learning. In addition, students need to learn more in less time.

Visible learning is seen as an improvised duty for teachers because they become auditors (evaluators) of their own work. According to the proponents of this theory,

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visible learning happens when teachers witness learning in the eyes of the students, assisting them to be their own learners. Visible learning entails making students' learning visible to teachers so that they can know whether they have an impact on the learning. This is an important component of becoming a life-long learner. Teaching and learning become visible when learning is not only challenging but also explicit.

Furthermore, both the teacher and the student work together to attain the goal, provide feedback, and ascertain the attained goal. Evidence shows that the greatest effects on student learning emerge when not only the students become their own teachers (through self-monitoring, and self-assessment), but also the teachers become learners of their own teaching. In successful classrooms, both teaching and learning are visible. This way of learning is essential for criterion referenced assessment, which sought to make assessment part of learning, which is also an essential component of the competence based curriculum.

The theory (Hattie, 2012) asserts that the greatest effects on student learning is attained when students become their own teachers and teachers become learners of their own teaching. Teachers are critical evaluators of students' development. They develop a mind frame and evaluate their students' commitment, progress and achievement.

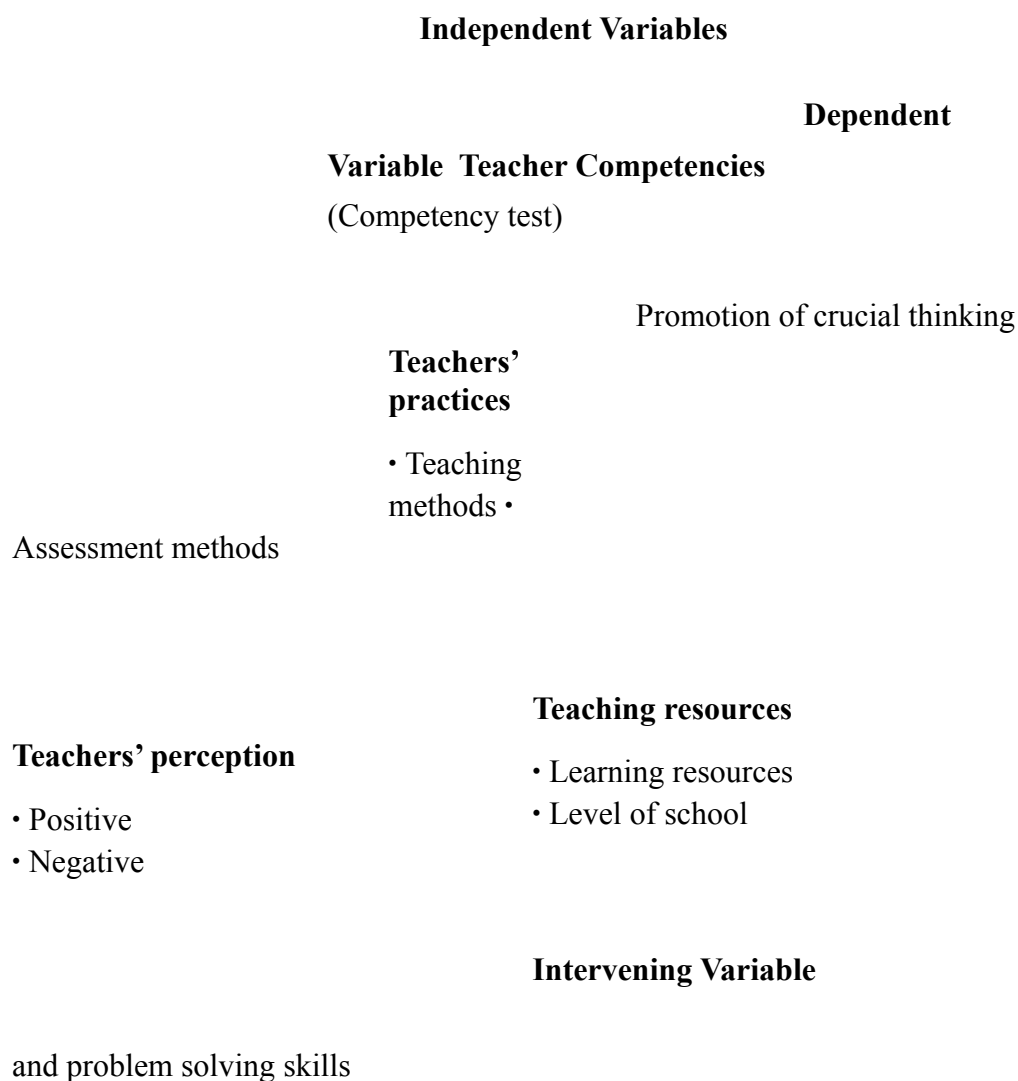
The overarching idea, according to this theory, is, that the teacher should point out and comprehend where the pupils are with regard to their level of thinking and also, the kind of problems they face on a regular basis, then challenge them to face these challenges through a process described as cognitive acceleration. Teachers need to instruct their students using teaching techniques that make students to perceive more explicitly.

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The importance of this theory in the implementation of the CBC is that it provides direction of the learning process to both the teacher and the student and provides a theoretical framework for understanding how critical thinking and problem-solving skills are developed in students.

### **1.13 Conceptual Framework**

The conceptual framework is derived from the study's paradigmatic stance as well as its theoretical framework. As such, it provides a description of the relationships of the main variables used in the study and how these describe the research interest, namely the teachers' perceptions, practices and competencies in the promotion of critical thinking and problem-solving skills.



**Figure 1.1 Conceptual Framework**

### 1.14 Operational Definitions of Terms

**Competency based curriculum-** This is a new curriculum in Kenya that involves learner centered pedagogy and incorporation of 21st century skills.

**Critical thinking and problem-solving skills-** These are 21st century skills that are developed for example during mathematics lessons.

**Mathematics education-** This is the practice of teaching and learning of mathematics.

**Public primary schools** – These are state schools funded and operated by the government.

**Teacher competency-** This is the knowledge and skills of teachers in the specific field of interest (as a prerequisite to teach the field of interest to their students).

**Teacher perceptions-** Teacher’s feelings, understandings and opinions about critical thinking and problem solving and their incorporation into teaching.

**Teacher practice-** Teachers’ activities including teaching methods and classroom management that take place within the competence-based curriculum classroom.

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## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.0 Overview**

The second chapter entails information about the conceptual underpinnings of the competency-based curriculum and the specific skills of critical thinking and problem solving. Furthermore, it looks at definitions of teacher competencies, practices and perceptions and at teaching methods that particularly enhance critical thinking and problem-solving skills, before a summary of the literature is presented.



## **2.1 The Concept of Competency-Based Curriculum (CBC)**

The Ministry of Education in Kenya enacted a curriculum reform in 1985, introducing the 8-4-4 system and replacing the previous system of 7-4-2-3. The main reason for this shift was to impart practical skills and competence to students that would help them be independent after school. This was different from what was offered in school before, where learners were mainly prepared for jobs that are in most cases not available when they complete their education, leading to high rate of youth unemployment. Schools emphasized on practical subjects for example home science, music, art and craft, wood work and agriculture (KICD, 2016).

The Sessional Paper Order No. 2 of 2015 on the “Reformation of education and training in the Republic of Kenya”, recommended a more practical approach based on competencies. This included the request to establish a countrywide learning assessment system, which would be able to identify and nurture talents easily and introduce national values such as cohesion and integration in the curriculum. It also called for bringing in ICT education to ensure every learner - after completing schooling - is competent and can exploit and use their potential fully (Ministry of Education Science and Technology, 2015). Through this, the curriculum reforms advocated for a complete

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change of curriculum from being a subject-based curriculum to a competence-based curriculum. This would be suitable for the identification of skills that are to be mastered and put in practice by a pupil and would be assessed based on standards put in place to measure the effectiveness of teaching. (Farrant, 2004)

According to Ross (2000), competencies should be both amenable and demonstrable.

Bravalaski (2001) argued that the concept of competency-based curriculum has taken a vital role in curriculum changes undertaken worldwide. The curriculum prescribes the competence as its organizing rules, since programs use situations as their point of departure (Jonnaet, Masciota, Barrette, Morel & Mane, 2007). A curriculum is broader in scope when compared to study programs and usually involves many different programs. The study programs provide information used in doing evaluation of learning and teaching activities, which are continuously used with the provided curriculum (Jonnaet & Eyettayebi, 2007)

According to Njegere and Ji (2017), the curriculum is a tool which enables a nation to empower its citizens with basic knowledge, skills, attitudes and values, which are important both at national and personal level for development. Curriculum should entail both the needs of the citizens and the nation. Nations globally arrange education along curriculum frameworks. This explains the boundaries within which the curriculum must be developed. The curriculum outlines components, like rules, core values, general outcomes, expected learning achievements, procedures concerning the teaching and learning process and examination (UNESCO, 2013). Further, UNESCO (2013) argued that a curriculum, which insists on the complex results of the learning process, for instance knowledge, skills, and attitudes to be used by students, specifically targeting on students' expectations is a learner centered. It further states, that learning activities and environments are chosen in a way, that the learner can acquire and apply the

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knowledge, skills and attitudes towards situations they come across in daily life. A competency-based curriculum is normally designed to revolve around a set of key competencies that can be cross-curricular or subject bound.

Sullivan (2005) argued that for choosing the competencies for the curriculum, a good cooperation between the subject matter experts (SMEs), curriculum developers, the learners, and the community is needed. This will ensure right decision making of competencies required by the student for a brighter future. A curriculum that is competency based should therefore include specifications of results and the competencies to be achieved. The result statement should contain learner objectives and goals, and should be measurable. Learners in a competency-based curriculum will learn until they demonstrate a level of competency in results and mastery (Mosha, 2012). Competence- based curricula aim to mold students to be more productive by the acquisition of new skills and further development of the already mastered techniques (Mbarushimana & Kuboja, 2016)

According to Wesselink et al. (2007), there exists claims behind the idea of competence concerning the curriculum on different theoretical and empirical studies done. Rules on comprehensive competence-based curriculum started to strengthen local education teams in terms of the provision of interactive processes of curriculum deliberation. These principles are included in a matrix that was meant to be a guideline for programed teams.

Using these set principles, a comprehensive approach to competence-based education promises outcomes that are more effective. Competence-based curricula insist on the use of instruments such as core-competence models and competence assessments (Mulder, Gulikers, Biemans & Wesselink, 2009). Another setback on the

competencybased curriculum is that competence can replace knowledge. A study by Mulder et al. (2009) appeared that the respondents were of different opinion on the

question whether the competency-based curriculum was based on knowledge acquisition.

According to Andronache, Bocoş and Neculau (2015) a competence-based curriculum aimed to take into account change in the society in order to prepare learners to cope and fit into the society. The curriculum objectives were designed in a way that they aid in developing students' abilities to put in practice the knowledge they have acquired. Teaching activities have positive impact on learners socially in that it helps them take part in activities that require cooperation, communication and handling problems.

Moon (2007) argued, that in this 21st century, what should be focused on is how to cultivate and nurture talents, skills and abilities of learners and develop their potentiality as opposed to leadership and power, which are not of great importance. To attain this, a competency-based curriculum must be implemented as an independent education model. He argued that learning institutions must change to teach not just knowledge based on subjects but competencies to impact the intended strength necessary to fulfill lives that have a great quality in general.

Kouwenhoven (2010) pointed out, that competence-based curricula have a great impact on students through the acquisition of competencies, great development of the recently acquired skills and improvement in already held competencies. Kouwenhoven (2010) gives simplified meaning of competency that can be explained through a model which explains what happens in the mind when an assigned task is realized. The model at hand, therefore, outlines competency as the ability to come up with various inputs in an intended way. Schilling and Koetting (2010) say that the purpose of competency-based

curricula was to create an education experience that will prepare students for specialization of occupations by constructing an educational process based on specific competencies, assessment strategies, determining appropriate learning and creating quality results.

The main purpose for well-known of the competence was the outcome realized by many stakeholders in the field that has led to a rift between labor and education to be bridged through competence-based education (Biemans, Niewenhuis, Poell, Mulder & Wesselink, 2014). Competency based curriculum can therefore be regarded as the leading paradigm for innovation both at the system and at the learning environment levels (Merrenboer, 2002) and hence, the competence-based curriculum has increasingly gained popularity in education globally. Its attractiveness can be explained through the positive impact it can make on education and learning. The revision done towards a competence- based curriculum in Tanzania, in comparison with other Black nations for instance South Africa, Rwanda and Botswana, insisted on the adoption of a learner-centered pedagogy, formative and authentic assessment approaches putting emphasis on the development of competencies and their application of knowledge in daily activities in life.

## **2.2 Critical Thinking and Problem-Solving Skills**

Based on Scriven and Paul (2007), critical thinking is a way of conceptualizing, putting in practice, analyzing, synthesizing and evaluating information brought out as a guide to belief and action. Shikirova (2007) argued that critical thinking is of great significance for enabling students to deal with social, scientific and practical problems. He adds that being in possession of knowledge is little to make one productive in the work place and in individual lives. A learner should handle challenges, come up with

good decisions and reason well. He says that learners who are capable to reason well are able to find solutions to problems they encounter.

There is a struggle with teachers trying to engage students to critically think and be able to handle real world problems (Bartlet, 2002, Rippin, Booth, Bowie & Jordan, 2002). Synder and Synder (2011) put that critical thinking and problem solving are learned skills which should be developed and put in practice by involving students in active learning. They argue that instructions that support critical thinking uses techniques of asking questions that require students to analyze, synthesize, and evaluate information to come up with solutions and reasonable decisions. Classroom lessons can be alternated to traditional curriculum for effectiveness in motivating teachers and students to create a fun and engaging environment for both teaching and learning (Wang & Zheng, 2016). Thompson (2011) asserts that teachers taking all subjects and across should impart knowledge with attention towards reasoning and problem solving.

### **2.3 Teacher Competencies**

According to Katane et al. (2006) competencies are defined as skills, knowledge and experience which are manifested in activities. Varvel (2014) says that competencies are appropriate knowledge, skills, attitudes, and abilities that provide context which is flexible, develops with time, needs to complete a given objective and examined against a low standard. Like Weddel (2006), other scholars consider competence as an enhancement of skills, knowledge, attitude and behaviors needed for effective performance. Competence goes hand in hand with a person's ability to understand the information received and the ability to decide. A word that means individuals' ability to get, keep and come up with meaningful information (Drew, Hardman & Hosp,

2008). Competence as claimed by Niss (2002) means that one is able to master aspects in personal, professional or social life domains.

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Insights from TIMSS on curriculum analysis point at the important role that teachers have with respect to differences in learners' achievement (Schmidt et al. 2001). Given the important role teachers play in the selection of topics meant for classroom instruction, organizing and leading classroom learning opportunities, providing for a wide range of student achievement and development, a critical concern arises: how are teachers prepared in terms of competencies and content to teach (Jamil et al., 2011).

Niss (2002) postulates that competencies in mathematics means the ability to understand, judge, and apply mathematics in a variety of mathematical contexts and situations in which mathematics play a role. Mathematic competencies deal with mental or physical processes, activities, and behaviors. The focus is on personal ability and therefore, competencies are behavioral.

Possessing a mathematical competency consists of individual preparedness and ability to act mathematically based on knowledge and insights. Teachers should improve their skills and knowledge to advance, improve and explore their teaching practices as postulated by (Selvi, 2010). He also points out that many studies done on competencies of teachers focus on the teaching roles of teachers in the classroom rather than on the teachers' competencies. According to Selvi (2010), competencies of teachers should be discussed from a different angle. In this situation, the literature about teachers' competencies was analyzed, pointing at three types of competencies: field competencies, curriculum competencies and communication competencies.

Field competencies. We question "what should schools teach?" This competence

highlights what to be taught. For instance, the knowhow of mathematics teachers is the key competency for teachers who will teach mathematics in class. Field competencies are the main area of teacher competencies that include academic studies about content.

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Field competencies are necessary in the teaching profession. They are the subjects that teachers teach and students learn as offered by the ministry. For a long time, field competencies seemed the key competency, assuming that teachers are only responsible for transmitting the content.

Curriculum competencies include two sub-sections for example, curriculum development and curriculum implementation competencies. The focus is on teacher curriculum implementation competencies since the main implementers of the curriculum are teachers in the classroom setting. Curriculum competencies go hand in hand with an understanding of the planned curriculum for learning activities and teaching. Curriculum competencies are the competencies that are teacher oriented. They direct teachers towards carrying out their teaching role more effectively. These competencies are intertwined in both classwork and practical competencies. Without them it is hardly possible to come up with an effective education service in learning institutions.

Communication competencies entail communication models referring to the socialization among students, teachers, the environment and learning areas at different levels. Teachers also need skills for using oral, body language competencies in their profession. Communication mastery involves the use of voice, body language and words through speaking, singing and sometimes the tone of voice variations, sign language, paralanguage, touch, eye contact, or the use of writing. Communication skills are to be seen on two levels for example intrapersonal and interpersonal. This



works through processing, listening, observing, speaking, questioning, analyzing, and evaluating.

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The change towards a competence-based system in primary schools requires different instructional approaches through imparting of knowledge, acquiring of knowledge and the assessment processes. Finally, this must bring differences in teacher education programs to equip teachers with mastering of skills that aid to effectively deal with problems that are associated with the implementation of competence-based curriculum in primary schools (Woods, 2008; Kitta & Tilya, 2010).

In Tanzania, Mosha (2012) posited that teachers are required to have the basic competencies to develop and use appropriate learner-centered teaching methods. Teachers need to be aware of rifts in their knowledge and skills, their flaws and specialization in putting in place a competence-based system. For an enhancement of those abilities, regular training of teachers is needed. Even pre-service training of teachers must be suitable concerning the development of skills for implementing a CBC. The pre- service training programs should lead to the production of teachers who are not only good at academically, but also professional in a number of ways.

Okanlawon (2014) pointed out on his studies on the teaching competencies got by science teacher after exposure to attachment in Nigeria discovered that teachers considered themselves to be incompetent regarding instructions through planning, putting in use, weighing and integrating technology into instruction. Conclusions indicated that teacher training Programs should be checked once more and insist on competencies not acquired.

## **2.4 Teacher Practices**

Different scholars (for example Landman and Gortsky, 2007, Sandholtz, Ogawa, & Scribner, 2004, Wong, 2007) have pointed out that present education tends to standardize education systems and concentrate on 'teaching to test' scores. This would

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demoralize the teachers' ability to put in place critical thinking and problem-solving skills in the learning environment. Concentration on tests interferes with the learning process from the student-centered instruction and insists on the content. If the target is on the learning, student should have the freedom to go through the content.

Critical thinking needs more involvement concerning students' invention of ideas. A study of student learning by Nokes et al. (2007) showed that learners involving a heuristic approach in handling issues performed better on a content-based assessment than those who learned through books and lecture means. Heuristic teaching methods encouraged learners to acquire knowledge, invent, understand and handle issues personally.

A study done by Gurses et al. (2007) also proposes that problem-based learning activities encouraged problem handling and reasoning through lively participation in the studying process including the finding of learning needs, working together, and creative discussion, copying from peers, integration and coming up with a variety of information.

Kumar and Natarajan (2007) also identified problem-based learning as increasing students reasoning skills and knowledge acquisition. Problem solving and reasoning is acquired through learning and needs guidelines and action. Mathematics teachers can increase learners' reasoning and problem handling through guidelines, which require learners to take part in the learning (Ebosele, 2012)

Haynes and Bailey (2003) encourage the teaching method of questioning to stimulate learners reasoning and problem-solving skills. Similarly, brown and Kelley (1996) as well as Hemming (2000) also stressed the importance of questioning techniques, for

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example in group discussions in class to aid in learning institutions in which learners can practice and put in use reasoning and problem-solving competencies.

What kind of services teachers offer to learners depend greatly upon the methods they use in the class, trying to ensure that teaching is effective as propounded by Effandi and Iksan (2007). The CBC advocates for a learner centered approaches (KICD report, 2017). Osakwe (2009) examines that students centered approaches where the teacher sought to cause difference in behavior of students by imparting skills and knowledge in a friendly way, are most useful.

#### **2.4.1 Teaching Methods**

The school curriculum is designed to offer skills and knowledge to students by developing critical thinking and aiding in problem solving in real life situations. The mathematics curriculum, for instance, ensures that the students are provided with the mathematical knowledge and skills to develop their problem solving and decision making competencies (Ministry of Education, 2016).

The current education aims to enable students to handle problems and to meet the needs of the job environments and of real life. Students do not only need knowledge but also skills like communication skills, problem handling, creative and reasoning skills (Effandi & Iksan, 2007).

Mathews (2003) identified teaching methods that specifically promote problem handling and critical thinking skills. He stated that students and teachers should handle

together tasks for learning and promoting cooperative learning, class discussion and project-based learning. He adds that the teachers' task is to develop learners' reasoning skills by coming up with strategies that include questioning and encouraging respect for various ideas. Instead of only helping students fulfill expected tasks, students should

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be also encouraged to reason by themselves and the teachers concentrate on getting learners to reason and think and motivate them to search for solutions and arguments and communicate them. He further adds that the arrangement of the classroom should allow students to work in unity. The main focus should be on the students, not the teacher.

Synder (2005) identified the following teaching strategies to be effective in promoting critical thinking and problem-solving skills: group and whole class discussions on specific topics and raising students' urge to find solutions and the use of visual aids.

Walker (2003) identifies three methods that promote critical thoughts in his article 'Active learning strategies to promote critical thinking'. The three methods include questioning, classroom discussions and classroom assignments and he says in and out of class assignments can serve as inspiration in terms of allowing students to expand on their thinking.

Critical thinking is beyond memorizing, it is meant for giving morale to learners to put different ideas together, handle arising issues, think creatively, and put in practice what they learned in different contexts. Walden University (2012) provides ways how to teach critical thinking:

### **Ask Questions**

Open-ended questions provide learners with an opportunity to use what they have acquired in school and develop their thinking on prior knowledge. These questions aid in problem handling and the learners' reasoning by themselves, and increases morale through giving chances to learners to communicate before others.

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### **Encouraging decision-making**

In order to pass high level knowledge on reasoning that aims at putting in use knowledge to get answers, elementary teachers should put emphasis on discovering solutions for problems. This encourages learners to put in use what they have acquired to various contexts, and to measure advantages and disadvantages of different outcomes, and put in use ideas that work best.

### **Working in groups**

Assignments for groups of learners are among the best means in elementary schools to develop reasoning skills. This kind of acquiring knowledge familiarizes learners with the reasoning means of other class peers and enlarges their reasoning capacity by experiencing that there is not only one right way to approach a given problem that one may encounter.

### **Incorporate different points of view**

Good critical reasoning for elementary learners means to look at understanding an idea from different angles. The criteria do not bring out ideas which are to be looked into from different points of view before views are given, but also give students chances to share their own viewpoints while learning from fellows.

### **Connect different ideas**

Linking unique arguments is a very important aspect of critical thinking. In this case,

elementary school teachers pose questions to learners, for example if they are aware of anybody who travels to work by matatu and if so, discuss the reasons for the individual while also looking at alternatives like a taxi program. Such information assists students to look for other means for example delayed matatus, and the alternative of using taxi, apart from aiding them use skill acquired to emerging contexts.

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### **Inspire creativity**

Creativity is another important aspect to develop and enhance in elementary school. Teachers should seek current means for learners to use knowledge to come up with unique ideas. Projects from art are very good for this purpose.

### **Brainstorming**

Brainstorming is an old time-valued way in elementary education, particularly as a reasoning activity. Often, it is linked to visual elements that bring original thinking and classroom discussions to real life situations.

According to Effandi et al. (2007) two pedagogical disadvantages have been highlighted as the main setbacks of teacher centered instruction, for example the lecture method. The lecture-based method focused on a passive acquisition of knowledge and therefore, he claims that in such an environment, students become dormant recipients of knowledge and resort to rote learning.

A major challenge in mathematics education - as in education in general -is to effectively teach students of various capabilities and diverse backgrounds. According to Iksan et al. (2007) teaching should be done in such a manner that it helps the learners tackle mathematical concepts while adopting handling skills, attitudes and

values. In order to achieve this, a combination of a variety of teaching methods has been advocated for in mathematical instruction.

Emphasis is also being placed on three classroom practices: individualization, collaboration, and authentic assessment. Individualization means that teachers instruct each student by drawing upon the knowledge and experience that this particular student already has. Collaboration means that teachers allow students to work in groups. Lastly, authentic assessment is where assessment occurs as an artifact of learning activities. It

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is accomplished through individual and group projects that take place on an ongoing basis, rather than once in a while (Golub, 1988; Graves & Sunstein, 1992; McLaughlin & Talbert, 1993).

There is also a lot of research being done in the field of cooperative learning methods in mathematical instruction. Research conducted by Iksan and Effandi (2007) show that cooperative learning is mostly effective when students actively participate in sharing ideas and work cooperatively to complete academic tasks. It has been used as an instructional method and as a learning tool on different levels of education and in various subject areas.

The key objective of cooperative learning in science and mathematics education is to enhance problem-solving skills, attitudes and inculcate values. An experimental study conducted by Effandi (2003) on cooperative learning and problem-solving skills showed that the development of critical thinking and problem-solving skills was significantly higher in the cooperative learning group.

Rosenshire (2012) posited that the most skillful teachers did not overwhelm their

students by giving them too many materials at once, but presented only a small amount of information at a time, which ensured that each point was mastered before moving to the next point. Teachers also assessed students understanding at each point and taught again where necessary, this strategy has been found essential in promoting mathematical skills. He goes ahead and argues that teachers should check for students understanding by asking questions. Responding to questions helps the students to explain on the content that has been learned and alerting the teacher where there is weakness.

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Explicit and systematic instruction is the most successful strategy to be affected when a child has a problem with a specific skill (Kroesbergen & Van Luit, 2003). This kind of strategy constructs interaction between students and the teachers. The teachers' role is to state a teaching objective, follow a defined instructional sequence and monitor students' progress. Students go through the curriculum as individuals or in groups repeatedly practicing skills taught by their teachers (Swanson, 2011).

Systematic instruction focuses on teaching students how to learn by giving them tools and techniques required to understand new skills in mathematics (Steadly, Dragoo, Arafe and Luke, 2008). Systematic instruction is thus, helpful in developing mathematical skills such as critical thinking and problem-solving.

Appropriate  
pacing

Frequent student  
response

Provide feedback  
Instructional delivery



**Figure 2.1; Hall 2002**

Adequate  
processing time

Monitor

Self-instruction is a mathematical strategy that students can apply to control themselves, handle their own behavior and their own attention as stated by (Graham, Reid & Harris, 1992). When pupil's discuss the nature of learning they get to develop a detailed picture of themselves as learners. This is known as meta cognitive awareness. Teaching students to talk and reflect when learning new information, solving a math

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problem or completing a task, will be helpful in enabling them develop skills in problem solving and critical thinking (Steedly et al., 2008).

Mathematical instruction is a process that makes abstract concepts and hard ideas understandable. It also helps to make multifaceted problems solvable. Visual representation and other tools to meet a desired result by the instruction can aid the process (Gersten et al., 2008). Visual representation means the use of pictures, number lines, graphs, drawings, and shapes. Research exploration articulates those visual representations are appropriate in learning key mathematical skills such as addition, subtraction, division and multiplication (Manalo, Bunnell & Stilman, 2000). The use of visual representation can be explicitly very appropriate in developing skills in learners during mathematics instruction.

Effective asking of questions is the most useful strategy that a teacher can use in promoting critical thinking and problem solving. Questions that guide thinking and encourage students to interpret, analyze, synthesize, critique, and reflect are said to be useful (Thompson, 2011). Asking of questions is an open-ended process of inquiry and a function of critical thinking (Ikuenobe, 2001). Teachers should therefore develop the skills to spontaneously raise and respond to good questions.

A study by Mosha (2012) showed that teachers' programs need a total transformation from training teacher-centered methods to the introduction of trainees on an authentic learner-centered approach. This would in turn aid in the development of pedagogical skills necessary for the teaching and learning professions that would improve students' intellect as stated by (Shaunessy, 2005).

For an improvement in academic performance to be realized by all students, regardless of their background, studies suggest that a set of classroom practices need to be

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changed. The literature review on effective teaching insists on paying more attention on critical thinking skills (McLaughlin & Talbert, 1993). According to Wenglisky (2001) teaching critical thinking skills entails conveying of information as well as understanding the same. Students learn the concepts, attempt to apply them on various problems, solve the problem and then learn the concepts that underlie the solution.

#### **2.4.2 Assessment**

Teachers should change the learning process to thinking by picking both formal and informal assessment. This will help students in problem solving and critical thinking.

Different types of assessments exist that learning institutions and teachers have at their disposal when they come up with the curricular plan for addressing mathematics

success (Baldwin & Yun, 2011). Assessments in educational context, is a process of determining whether students have received the curricular objectives (KICD, 2017). The report by KICD (2017) maintains that assessment is important in teaching and in learning processes. Assessment needs to be considered when planning an effective implementation of the curriculum.

The analysis of the assessment system conducted by Mugo and Asiago (2015) shows intake in KCSE/KCPE which is over 1.3 million children yearly compromise the role of formative assessment. KCSE/KCPE are the national examinations in Kenya and as such, they are used for purposes of certification and the movement to higher levels - contrary to it being meant to improve learning. The curriculum framework (2017) underscores the focus of the competency-based curriculum on formative assessment, stating that cross- curricular competencies, literacy and numeracy in student learning should be targeted instead of summative assessments.

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The current curriculum reform includes competency-based assessment as a key reformation, which, if adopted, will facilitate formative assessment practices that will promote diagnostic approaches. This will in turn enhance learning and improve its outcome (KICD framework, 2017). According to the National Mathematics Advisory panel (2008), formative assessment is defined as the ongoing monitoring of student learning to inform instruction. It is considered as a hallmark for effective instruction in any discipline. According to Girnsburg (2009), formative assessment reveals information about students' performance, thinking, knowledge, learning potential and motivation.

According to KICD (2017), the aim of formative assessment is to observe students' learning and to provide ongoing feedback that can be used by teachers to improve

pedagogical practices and improve students' learning. The revised competency-based curriculum insists on formative assessment focusing attention on prescribed competencies. Teachers are required to assess students often by use of authentic assessment methods such as checklists, rating scales, rubric, portfolios, observations, projects, oral presentations, self-assessment, interviews and peer-assessment (Kitta & Tilya, 2010, KICD 2017). Kite and Tilya (2010) and KICD (2017) explain some of the instruments in formative assessment as follows:

### **Observation**

Teachers are expected to make observations on behavior changes of learners as a daily routine. The teacher should identify the competencies the learner may have acquired and those that are yet to be acquired. Teachers, parents, peers and other persons who interact with the learner should mark the competency observed in individuals within the observation grid. This will show the level of competency development in each learner.

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### **Checklist**

This outlines student's behavior. It also requires a teacher to carefully make observations, write a summary and draw conclusions at the end.

### **Rating scales**

This allows for an indication of behavior, skills and strategies of a learner as rated by the teacher. Rating scales explain the criteria used and provide three to four responses to describe the quality or frequency of student work.

### **Rubrics**

Rubrics is a set of criteria used to evaluate a student's performance. It involves a fixed

measuring scale and a detailed description of the features in each level of performance. Rubrics is effective in examining students' performance with a purpose of results' inclusion in the reports and for accountability purposes by the teacher. They may also be used in individual and group assessment due to its rating scales.

### **Questionnaires**

This can be defined as a list of questions on different aspects of a person's situation or issue. It requires a respondent to give honest opinion. Questionnaires helps the teacher to have an insight into the situation at hand and prepare appropriate programs and materials.

### **Portfolio**

Portfolio can be defined as a purposeful collection of student work samples, self assessments and goal statements that reflect on their progress. It is also a collection of evidence assembled to demonstrate competency. The portfolio file contains all the main learning activities, assessment projects and documents that students choose from. A

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teacher may also recommend that specific work samples be included. The teacher from time-to-time reviews how learners are organizing and maintaining their portfolios.

### **Project method**

This can be defined as a set of activities implemented within a set time frame. Students may select a need in their community where they can offer services based on what they have learned. There are two assessment methods namely authentic assessment and summative assessment.

Authentic assessment methods are much more important in the competence-based

curriculum than any other form of assessment, since they provide chances for students to demonstrate the competencies, they have mastered in real life situations. Teachers are thus required to change from a norm-referenced to a criterion-referenced judgment of learners' capabilities or competencies to determine their progress (Kouwenhoven, 2003).

Summative Assessments are outlined periodicals used to determine at a particular point in time a student's ability to recall what has been learned (Garrison & Ehringhaus, 2011). Garrison and Ehringhaus (2011) argue that summative assessment is being linked with set tests such as state assessments. Summative assessment in a classroom setup can be used as an accountability measure and as part of a grading process. Summative assessment is used to determine student learning ability, skill acquisition, and academic progress. It can also be used at the conclusion of a defined instructional period, typically at the end of a learning cycle, by comparing it against some standard. In Kenya, summative assessment is introduced at the end of upper primary education, lower secondary education and senior school (KICD, 2017).

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A study conducted in Tanzania by Paulo (2014) showed that trainee teachers were not aware of the set assessment methods for the implementation of the competence-based curriculum. The teachers in this study used paper and pencil assessment methods to examine learning contrary to the demands of the revised competence-based curriculum for primary and secondary schools.

In other national contexts, the dominance of summative assessment methods is also prevalent. Curriculum assessment in Rwanda, for instance, has shown that it is still fundamentally summative, including the end of term/year examinations, national examinations at the end of primary, lower secondary and finally at the end of upper

secondary school. (Ngedahayo & Williams, 2016)

In their study they recommend that for the success of Rwandese CBE, much more focus should be placed on classroom assessments, which would require both the teacher and student involvement in the development of assessment goals and criteria, and in using those criteria to monitor learning processes in self-assessment and peer assessment (Darling-Hammond & Pecheone, 2009). Teachers' practices should encompass assessment methods that promote higher order learning such as portfolios, projects, solving problems and performances to collect timely information on students' learning.

A study conducted by Pepper (2011) in France posits that assessment policy in mandatory education has shifted its common cores of competences into seven domains. The curriculum is organized by subjects, with each expected to contribute to the development of the competences in the common core. Pepper (2011) argues that assessments' intentions should focus on these competences by means of a booklet for which students and teachers compile information. Assessing fewer familiar

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competences such as humanist culture, social and civic competences, autonomy and initiative would be important in including in teacher training (Pepper, 2011).

In order to have effective and efficient ways of assessing students, it is important to develop the skills of teachers in both formative and summative assessment (KICD, 2017). According to Kelagan and Greanery (2001), regular, reliable and timely assessment is important for improving learning achievements and should be a fundamental component of an effective teaching and learning process.

## **2.5 Teacher Perceptions on the 21st Century Skills**

Perception is defined as attitudes, beliefs, and emotions associated with the subject (Daskalogian & Simpson, 2000). Teaching mathematics in school is associated with teachers' attitudes and perceptions, which can result in problems that frustrate their efforts to teach effectively and efficiently (Wekesa, 2013).

Teachers' attitudes affect the teaching process and the entire classroom practices (Goulding, 2002). According to Hill (2004) teachers' content delivery is influenced by the experience gained over years of teaching and curriculum content. Teachers' understanding on student learning and effective instructions delivery is linked to their content, knowledge and perceptions (Barnet & Hodson, 2001).

Konokman, Yelken, Karasolak and Cesur, (2017) in their study on 'Teacher perception: competent or not in curriculum development' indicates that there is the perception both by experienced and novice female and male teachers of their incompetency levels. They argue that teachers should be equipped with the competencies and skills essential for curriculum development in order to increase their perception level on the curriculum competencies.

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According to a study conducted by Duman (2006), teachers are often good at teaching strategies, methods and techniques as well as assessment and evaluation methods of competencies, but incompetent concerning the theoretical basis of social, historical and philosophical foundations of the curriculum (development).

Spielman and Lloyd (2004) found out that belief of prospective mathematics teachers in the curriculum material section differed. This difference supported the general educational objectives of the teacher educational programs. Findings from this study outlined the significant role mathematics courses play in shaping prospective teachers'



conceptions and practices.

In the study by Nadelson (2010) it is highlighted that beliefs and perceptions can have a significant impact on reforms and modifications on science education standards to involve educational contents. In the study the attitude and perceptions of a group of educators shows that level of education attained is not a reflective index on how learning concepts are delivered.

According to Amato (2001), the development of a positive attitude to mathematics depends on the type of teaching. Negative attitudes can be generated when a teacher teaches instrumentally, and the student tries to understand relationally. Teachers' attitudes affect their approach to teaching and to their classroom practices (Goulding, 2002). According to Aaronson (2003), students taught by teachers with positive attitudes towards their work excel in their studies.

Connelly and Zheng (2003) view perceptions of the teachers as including their schools, the subjects they teach their students as well as the overall work they do. McGrath and King (2011) found that teachers with negative perceptions and attitudes differed from those with positive attitudes and perceptions on four factors: attitudes toward what they

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teach in class, attitudes towards the learning environment, goal assessment and motivation.

## **2.6 Summary of the Literature Review**

The present study sought to investigate teachers' competencies, perceptions and practices in promoting critical thinking and problem-solving skills. The research location is Nandi County, Kenya. The literature has focused on the Competency Based

Curriculum, and concepts of teachers' competencies, perceptions and practices.

According to a research by Paulo (2014) Tanzania's trainee teachers have opted not to adopt teaching and assessment methods as set in the competence-based curricula despite them having awareness on the same. A study by Mosha (2012) on learning materials used to deliver knowledge and skills in the Competency Based Curriculum recommended the use of basic competences in developing learner centered methods.

A Kenyan based study by Waweru (2018) with a title 'influence of teacher's preparedness in the implementation of Competency-Based Curriculum' found out that teachers needed support in infusing the core competencies where 59.5% needed support in promoting critical thinking and problem-solving skills. A similar study by Ondimu (2018) recommended that teachers should be included in the Curriculum reform processes to enable the creation of positive perceptions and an effective implementation of the study.

A well-designed competency-based curriculum assures there is a connection between the challenges of postmodern society and the school programs (CEMASTE, 2019). The curriculum should therefore be responsive, relevant and flexible to both the teachers and students for the diverse needs of the students to be met. More focus is directed to competencies and less on content (KICD, 2017). Competency based

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instruction measures what learners have learned as opposed to what teachers have taught. There should also be a change of curriculum from being teacher centered to learner centered pedagogies. Learning is measured by how well the learner performs in relations to competencies (learning outcomes) (KICD, 2017).

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### **CHAPTER THREE**

## **RESEARCH DESIGN AND METHODOLOGY**

### **3.1 Introduction**

This chapter outlines and rationalizes the philosophical and methodological underpinnings of the study. The methodology, including the techniques of data generation and analysis in relation to the philosophical positions are also discussed. The pragmatic paradigm has been identified as the most suitable and hence, insights into the researcher's philosophical stance put forward on how best it informed the research. Furthermore, the rationale of using a mixed method approach was outlined. The research design, including the sampling and data generation instruments and the data analysis processes are explained. Finally, reliability and validity issues as well as ethical considerations for this study are discussed.

### **3.2 Research Paradigm**

A review of literature on different research paradigms advises that the research should get a deep understanding of what it means to design a research project under a specific paradigm. According to Guba and Lincoln (1994), a research paradigm is a set of beliefs or a worldview, which leads research action and investigation. Denzin and Lincoln (2000) also defined paradigms as human constructions, that handle rules or ultimate's truth showing areas in which the study was carried out to come up with meaning embedded in the data. It has significance in that a research paradigm provides beliefs and directs researchers in a particular direction in terms of what should be studied, the way it is studied and the way the outcomes of the research was presented.

The present study was guided by the pragmatic approach, since the researcher's beliefs concur with scholars who have debated it was impossible to get the truth about the real world solely by a virtue of a lone scientific means, advocated by the positivist

on the one hand and the interpretivist paradigm on the other hand. Rather, philosophers like Alise and Teddler (2010), Biesta (2010), Tashakori and Teddler (2003) and Patton (1990) brought out whatever was needed was a worldview that would give meaning to a study that is highly appropriate for studying the phenomena. Hence, they favor a combination of approaches of methods that could in conjunction shed light on the actual behavior to the respondents.

### **3.3 Research Design**

This study employed a mixed-method approach that the pragmatic paradigm suggests as appropriate. The mixed-method approach involves methods from both qualitative and quantitative approaches to shed light on the key variables under study (Bryne, 2006). Teddlie and Tashakori (2003) also state that using mixed-methods involves the generation and analysis of both quantitative and qualitative data in lone research. The data is collected either concurrently or sequentially and the data is integrated in singular or more phases during the research process (Creswell & Poth, 2016).

According to Kothari and Garg (2014), a research design is the setting and condition for data generation and analysis. Similarly, Denzin and Lincoln (2011) argue that a research design is a plan that guides the researcher to carry out the study. The present study used a concurrent triangulation design, which is a mixed-method design where the experts use double unique ways in an attempt to confirm, cross-validate and corroborate findings within a single study (Greene et al., 1989). In this kind of design, it is common to use quantitative and qualitative methods separately as ways to offset the challenges inherent within one method with the strengths of the other (Creswell, 2016).

In the concurrent triangulation design that was used, both the quantitative and the qualitative phases took place at the same time and are measured equally. Creswell (2016) posits that it is more manageable to generate both quantitative and qualitative data at roughly the same time, rather than to revisit the field multiple times for data collection.

The purpose of concurrent procedures is that the researcher converged quantitative data and qualitative data to give a clear analysis of the study problem. The rationale for this type of design is that it enables triangulation of the data instruments.

### **3.4 Research Locale**

The study area covered primary schools in Nandi County. Nandi County is one of the 47 counties created under new constitution of Kenya (2010). It is located in the North rift region in Kenya. Occupying an area of 2884.4 km<sup>2</sup>. It borders Kakamega County to the west, Uasin Gishu County to the North East, Kericho County to the South East, Kisumu County to the South and Vihiga County to the South East. Nandi County is divided into five educational Sub Counties namely Emgwen, Mosop, Nandi hills, Aldai and Tinderet. Geographically, the unique jug-shaped structure of Nandi County is bound by the Equator to the south and extends northwards to latitude 0034°N. The Western boundary extends to Longitude 34045°E, while the Eastern boundary reaches Longitude 35025°E.

Among the 47 counties in Kenya, Nandi County was chosen based on the consideration that the researcher would be able to communicate with the teachers and support them using the local language in case questions arose regarding the questionnaire (which was administered in English) or during the interviews. No other

factors that could have influenced the selection of the study area, like the state of implementation of the CBC

in primary schools or the amount of teacher training provided, seemed relevant, because they did not differ between the counties.

### 3.5 Study Population

According to Mugenda and Mugenda (2003), the study population is defined as a group of individuals, events or objects having common observable characteristics. Table 3.1 shows the framework of all primary schools in Nandi County both public and private schools. Also, an outline of the number of teachers per Sub County is shown.

**Table 3.1 Study Population**

Sub County	Type of school	Staffing Primary schools'			Teachers Head teachers									
		Male	Female	Total	Total									
Emgwen Public		169	725	789	1518	507	169	Mosop Public	164	600	640	1240	492	164
Aldai Public		131	691	435	1126	393	131	Chesumei Public	127	418	510	918	381	127
Nandi hills Public		75	375	410	762	330	80	Tinderet Public	127	441	225	666	381	127
								Private	8	45	16	61		
Grand total									832	4165	3686	7851	2484	798

*Source: Nandi integrated plan (2018-2023)*

The County has about 832 primary schools with 651 being public. The target population for this study comprised grade one, two and three teachers from public schools in Nandi County. The overall number of schools within the target population was 651 publicly owned schools in the county. The schools were further grouped into rural and urban categories. The reason for including schools from both categories was to get a multifaceted picture of teachers' perceptions, practices and competencies in

promoting critical thinking and problem-solving skills in rural and urban contexts.

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### **3.6 Sampling Techniques**

Sampling refers to the process of selecting a subset of the population (Singh, 2018). The number of elements in the sample is the sample size. In this study, both probability and non-probability sampling procedures were employed in selecting the target schools and research participants.

Stratified random sampling divides the elements of the study into small sub groups (strata) based on the similarity in such a way that the elements within the groups are homogenous among other subgroups. In order to concentrate on a certain degree of homogeneity in the structure of the schools, one educational sub county within Nandi County was identified as study region, which is Nandi hills Sub County.

Simple random sampling was used to select schools in Nandi Hills Sub County where schools from rural and urban areas were selected randomly for the purpose of the study. Nandi Hills Sub County has a total of 75 public primary schools, from which 20 primary schools were selected for the research study. The schools were selected from both urban and rural areas. Purposive sampling was used to select grade 1, 2 and 3 primary mathematics teachers in the selected schools in Nandi Hills Sub County. The purposive sampling technique entails that only those elements selected from the population best suits the purpose of the study (Oso & Onen, 2005). In this case, these entailed teachers who teach mathematics as a subject in grade 1, 2 & 3 and who had received training on the CBC.

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**Table 3.2 Sampling Frame**

#### **Population Sample Sampling**

## **Rural Urban**

Schools 75 15 5 Simple Random Grade one teachers 75 15 5 Purposive Grade two teachers 75 15 5 Purposive Grade three teachers 60 10 5 Purposive

**Totals 210 63**

### **3.7 Data Generation**

As elaborated above, probability and non-probability data generation techniques were employed for the purpose of the study. Through triangulation in the blending of both approaches' corroboration and validation of the findings was ensured.

#### **3.7.1 Questionnaires**

According to Kombo and Tromp (2006), questionnaires can be used to gather data over a large sample. It is efficient when applied and can get individual ideas from a respondent (Orodho, 2003). A questionnaire was opted for this research to elicit information from a large number of teachers. The questionnaire included a competency test for testing the level of the teachers' own competencies concerning critical thinking and problem-solving skills. This test was based on the validated Watson Glaser critical thinking test that assesses a person's reasoning ability in five areas: inferences, assumptions, deductions, interpretations and evaluation of arguments. Each of these areas is tested separately and therefore, the test used in this study included five different types of questions. The study explores each of them in chapter 4.

Besides the critical thinking test, the questionnaire included questions about the teachers' perceptions on critical thinking and problem-solving skills as well as on their

own teaching practices in the competency-based curriculum to develop critical



thinking skills in their learners.

### **3.7.2 Interview Schedule**

An interview is mostly a qualitative research instrument that coordinates a conversation aimed at obtaining desired information. The researcher makes first contact, schedules the event, designates its location, sets out the ground rule and then begins to question the participant (Gubrium & Holstein, 2001). Depending on the type of data targeted, interviews can contain many specific and structured questions or open and unstructured. In the more structured versions, questions elicit answers in an anticipatable format until the researcher is satisfied.

For this study, it seemed useful to interview some mathematics teachers to gain additional insights and information on the context factors in which the teachers work, their perceptions of critical thinking and the CBC in general. Hence, grade 1, 2 & 3 mathematics teachers were interviewed in a semi-structured way. The interview started with an introduction of the researcher, with providing the research participant with information about the background and the scope of the research project and subsequently, the signing of the consent form. The interview participants comprised of grade 1, 2 and 3 teachers in selected primary schools in Nandi Hills Sub County. The teachers were asked to respond to interview questions from a semi-structured interview guide which include open ended and closed ended questions. Gubrium et al. (2001) posited that the researcher can get an understanding through interviewing, what people perceive and how they interpret their experiences. Similarly, they argue that interviews give access to the individual practice. Hence, the interviews aim to provide deeper insights into the teachers' perceptions on the incorporation of critical thinking and problem-solving skills in mathematics. Furthermore, the teachers' practices will also be

solicited through the interviews by asking for examples and the opportunity to go into detail. In order to validate what the teachers say during the interviews, observation will be used to validate the teachers' practices.

### **3.8 Validity and Reliability of the Research Instruments**

In order for the findings of the study to be reliable, it is important to ascertain the reliability and validity of the instruments. A pilot study enabled to ascertain the reliability of the instruments and also enable familiarity with the administration of the research tools.

#### **3.8.1 Reliability of the Instrument**

Reliability is a measure of the degree to which a research instrument yields consistent results of data after repeated trials, thus providing information about its accuracy and precision. The reliability of the instrument was ensured through the pilot study that was done in four primary schools in Uasin Gishu County.

A pilot study was conducted among four selected primary schools in Kesses Sub County in Uasin Gishu County. The questionnaire was tested for appropriateness of question items in terms of language, content, clarity, time taken to administer as well as general administration logistics. In addition, the pilot study was conducted to determine whether the instruments would generate the type of data anticipated and the type of data desired could be meaningfully analyzed in relation to the stated objectives. After the analysis of the data collected from the pilot study, ambiguities and unnecessary content in the questionnaires were addressed. The piloting exercise ensured a common understanding and facilitated the identification of challenges that would likely occur when the tools were administered to large number of similar participants.

The researcher used test-retest reliability technique where the same instrument was administered twice to the respondents to determine the reliability of the instrument. The collected scores were computed using Pearson moment correlation formulae. A reliability correlation coefficient of 0.68 was obtained for the study. According to Kothari (2011), a reliability coefficient of 0.5 and above is considered adequate for research results computed from the administration of research instruments.

### **3.8.2 Validity of the Instruments**

The research must lead to the generation of valid data. How valid will depend on the instrument used and the information elicited. According to Orodho (2009), validity is the accuracy and meaningfulness of inference through an instrument measuring what it is supposed to measure.

Content validity was employed to ensure the validity of the instruments. Content validity refers to the extent to which the instrument covers the complete content of the particular construct that is set to measure. To ensure the content validity of the instrument, the researcher presented a provisional version of the questionnaires and competency test to experts in the field for their comments before finalizing the instrument. These experts include the supervisors, lecturers and colleagues. I only focused on content validity because of the nature of the study.

The suggestions and clarifications from the experts were used for making necessary changes to advance the quality of the questionnaire and the competency. In order to evaluate the content validity of the questionnaire, the researcher came up with dimensions and elements that constitute adequate coverage as per the studies objectives.

### **3.9 Data Analysis**

Approaches of data analysis need to be sensitive to the design employed for the study (Creswell et al., 2003). Different analysis approaches have been suggested for integrating quantitative and qualitative data that explore how the information might be transformed or analyzed for outlier cases (Caracelli & Greene, 1993). Data analysis was achieved through the use of two approaches; the quantitative data was analyzed through descriptive statistics and the qualitative data was analyzed through thematic analysis.

#### **3.9.1 Quantitative Data Analysis**

The Statistical Package for Social Sciences (SPSS) software was used to analyze the data from the questionnaires. The quantitative data was coded and analyzed using descriptive statistics.

#### **3.9.2 Qualitative Data Analysis**

The process of qualitative data analysis involved six steps (Creswell, 2003). The first step involved transcribing of all the generated data. After the data generation from the field, the data seemed largely unstructured and it was required to make sense out of it when beginning with the transcription. This was the first step of analyzing the data.

Transcription means converting all spoken and recorded data into textual form. The second step involved organizing the data. After transcribing the data, the organization of the generated data according to the research questions and objectives followed to avoid working with unorganized data.

The third and the most crucial step was the coding of the data and preparing the themes. Coding is the best way to compress the data into easily understandable concepts for a more efficient data analysis process. Coding in qualitative analysis

involves categorizing the data into concepts, properties and patterns (Creswell, 2012).

The

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coding process is a vital step in any qualitative data analysis and included giving meaning to data generated in the field. The next step after coding the data was to build on the themes or patterns to gain deeper insight into the meaning of the data. Representing, reporting and validation of the findings were the last stages of the qualitative analysis.

The integration and comparison were done directly by comparing the results from the qualitative and the quantitative data. The researcher looked at statistical trends and tried to search for support or contradiction from the qualitative themes. The consolidation of both data was done by combining quantitative and qualitative data to form of a new data set that best answered the objectives.

### **3.10 Ethical Considerations**

Respecting the research participants throughout the research and using the agreed standards guided the research process (Alderson & Morrow, 2011). Researchers are expected to be sensitive to the potential harm that participants may experience because of the research (Creswell, 2013). Recently, social researchers have been expected to observe ethical standards more formally in most institutions in the world.

Since mixed method research combines quantitative and qualitative research, ethical consideration needs to attend to typical ethical issues that surface in both forms of enquiry. Ethics in research commence with obtaining permission to the research site. The study approval for conducting the research was obtained from the NACOSTI and the Nandi Sub County Educational Office. A letter of introduction was given to the

selected school principals to gain access to conduct the research in the schools. The letter stated the purpose of the study and potential risks for the research participants.

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Informed consent forms developed were signed by the respondents before commencing with the research. The consent form ensured voluntary participation, confidentiality through anonymity, privacy, protection of sensitive information and avoidance of deceptive practices.

Respect of rights is vital in ethical research, especially when research participants are vulnerable and less powerful. Privacy is a complex right, at one extreme end, it can protect participants to an extent of excluding them from the research (Alderson et al., 2011). Privacy was ensured through avoiding undue intrusion into participant's personal affairs and keeping their identity confidential at all stages of the research process.

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## **CHAPTER FOUR**

### **DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION**

#### **4.1 Introduction**

This chapter presents the empirical findings of the questionnaires and the interviews administered during the study, and discusses the teachers' readiness in developing critical thinking and problem-solving skills in the competency-based mathematics curriculum in primary schools in Nandi County, Kenya.

#### **4.2 Response Rate**

Response rate, is the number of people who answered the survey divided by the

number of people in the sample. The study response rate for this study is presented in Table 4.1.

**Table 4.1 Response Rate**

**Respondents Frequency Percentage** Responded 55 87.3

Non-responded 8 12.7

**Total 63 100.0**

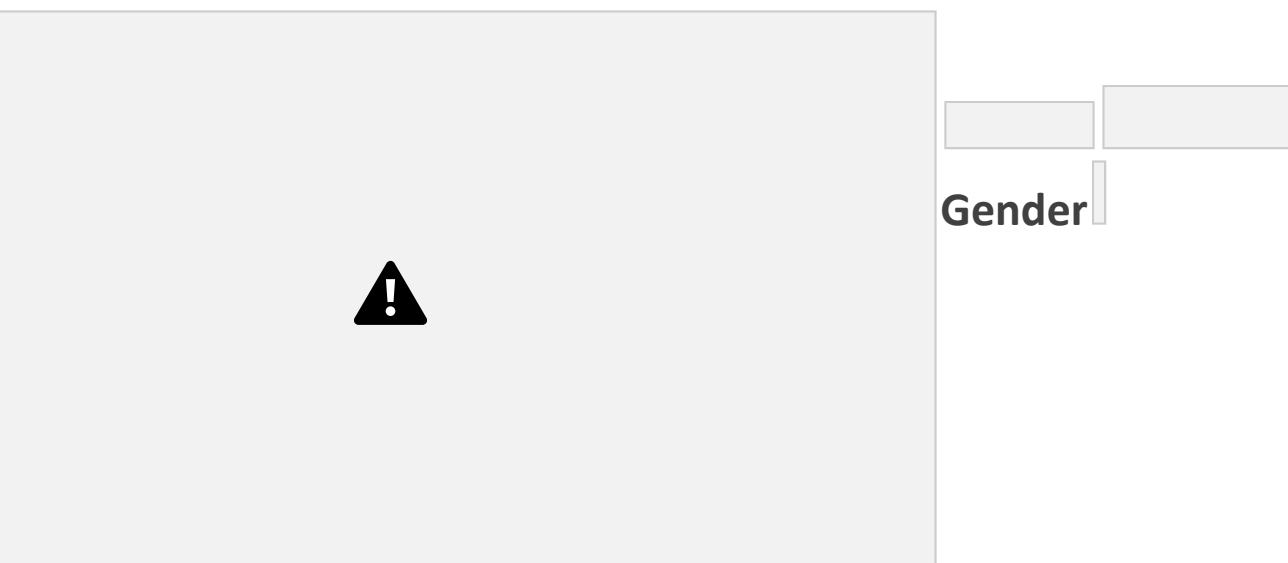
Out of a total of sample 63 respondents targeted, 55 respondents successfully filled the questionnaires, which translate to a response rate of 87.3%. The response was appropriate for the study to continue and provide reliable results. According to Mugenda and Mugenda (2003) a fifty percent response rate is adequate, sixty percent good and above seventy percent rated very well.

**4.3 Demographic Information of the Teachers**

The respondents were asked to fill in some demographic information that included information regarding their gender, level of education, the grade they teach, number of years they have taught, and whether they have received training or not.

Figure 4.1. Displays the gender of the research participants and shows that approx.

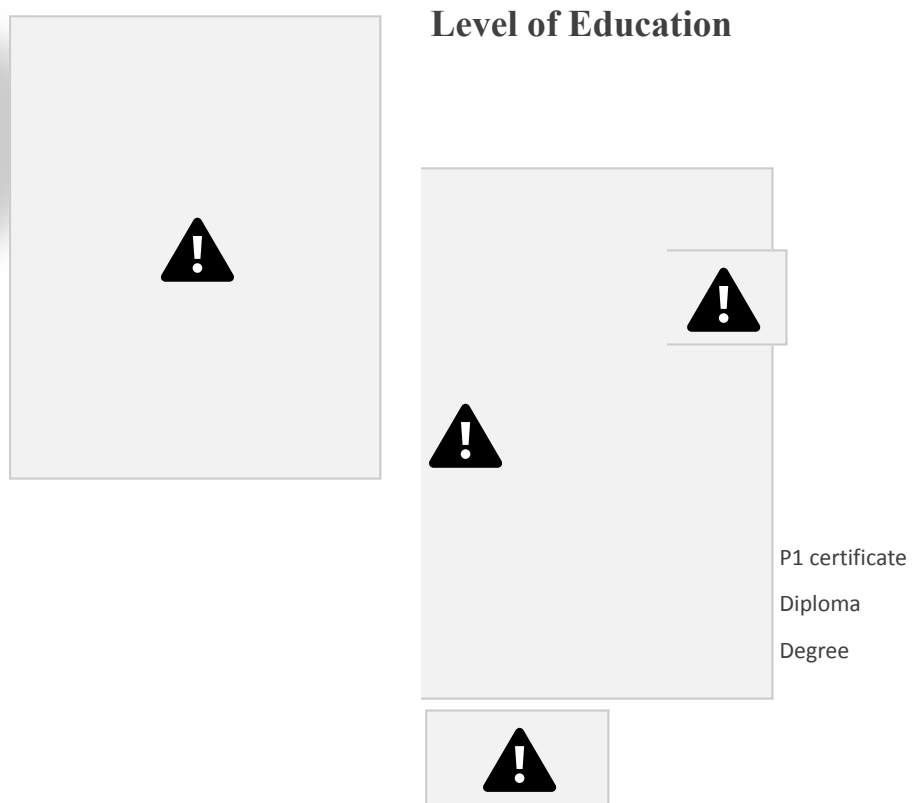
Two thirds of the teachers were female (39) and one third male (16).





**Figure 4.1: Demographic Characteristics of Teachers-gender.**

In order to identify the years of teacher training that the research participants had, they were asked to state their highest level of education the results are presented in Figure 4.2.

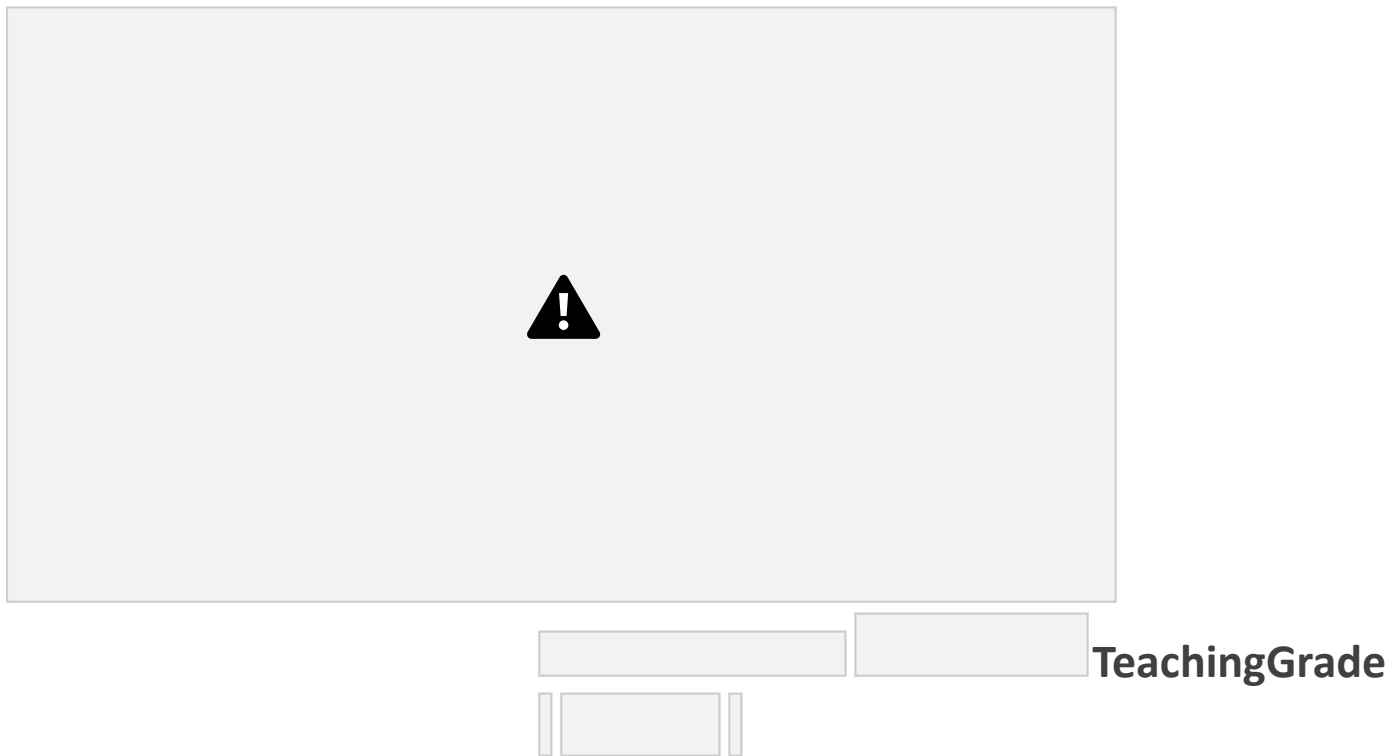


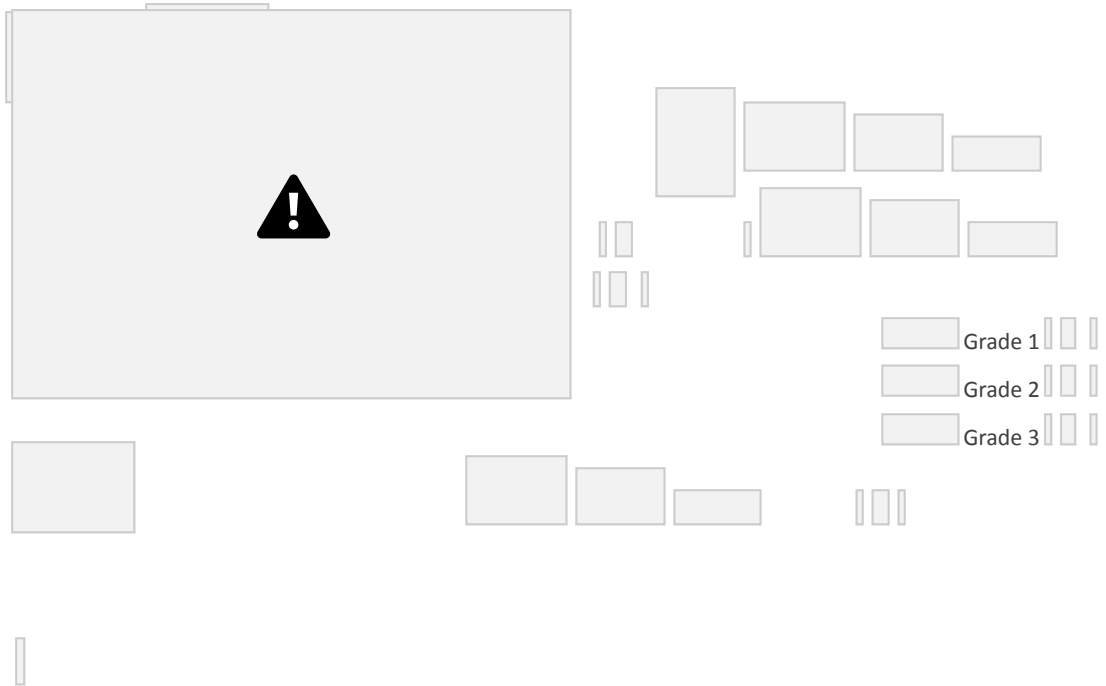


**Figure 4.2: Teachers level of education**

The study findings from Figure 4.2 established that of those teachers who participated in the study, the majority (54.5%) had a diploma. A diploma in Kenyan context means 2 years in college education. Just above 30 % had a degree (30.9%) meaning the teachers had completed a four-year teacher education course offered by universities. 14.5% had a P1 certificate, which is a bridge courses to pursue higher courses such as diploma and master’s education. This implies that the sample of this study had majorly a diploma certificate, meaning approximately 2 years of higher teacher education.

Since the study included primary school teachers of grades 1-3, the research participants were asked to state which grade they mainly teach in and how many years of teaching experience they had. Figure 4.3 points out that the majority of the research respondents mainly taught in grade 2.

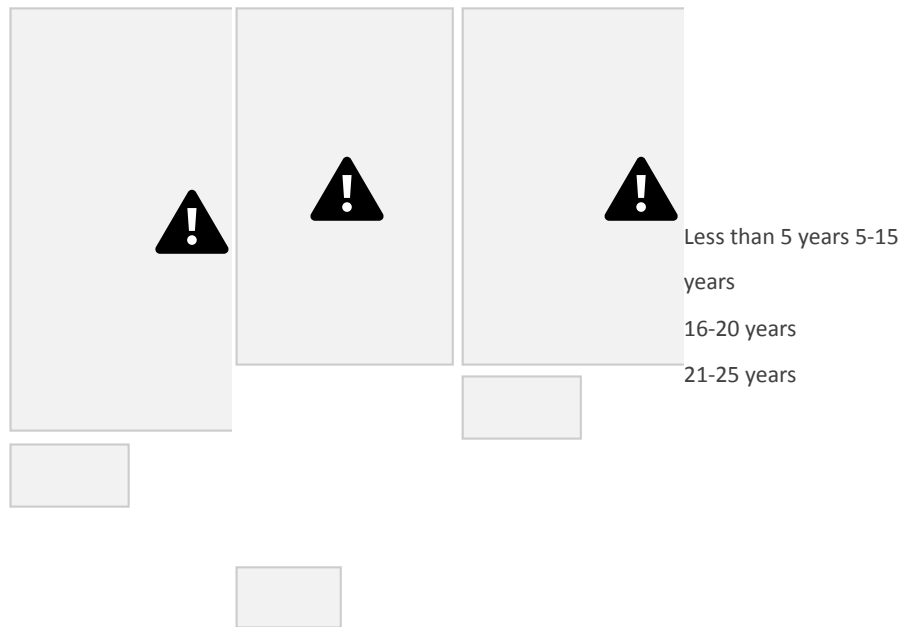




**Figure 4.3 Teaching Grade of The Respondents**

Figure 4.4 shows that most of the teachers in the study's sample had between 5 and

### Teaching Experience





**Figure 4.4 Teaching Experience**

The study findings from Figure 4.4 indicated that 12 (21.8%) had taught for less than 5 years, 26 (47.3%) for 5-15 years, 13 (23.6%) for 16-20 years and 4 (7.3%) for 21-25 years. This implies that most of the respondents had taught for between 5 and 15 years and that the majority of approx. 80% had quite extensive teaching experiences of more than five years.

Since this study was carried out at a time when the Competence Based Curriculum (CBC) had been newly introduced in Kenya, the research participants were asked whether they had already taken part in teacher professional development programs especially for the CBC. The study findings are shown in Figure 4.5.





#### **Figure 4.5 Training on the Competency Based Curriculum.**

The study findings show that the vast majority of 52 (94.5%) of the respondents had been trained on the CBC while only 3 (5.5%) had not received training on the CBC. This implies that - with few exceptions - the teachers participating in this study had taken part in courses on the CBC and hence, were familiar with the new curricular focus on competences prior to this study.

The study sought to find out if the teachers themselves regarded the training on the new competence-based curriculum as effective, meaning useful to their teaching practice. The study findings are shown in the Table 4.2.

#### **Table 4.2 Effectiveness of CBC Training**

<b>Opinion</b>	<b>Frequency</b>	<b>Percent</b>	<b>Agreed</b>	<b>Disagreed</b>	<b>Total</b>
	15	28	40	72	55
	100				

The study revealed that 15 (28%) of the respondents stated that in their view, the training was effective, while the majority of 40 (72%) stated that they did not think it was effective. This implies that from the point of view of the majority of the

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participating teachers, the trainings or workshops they participated in were not insufficient, meaning that they did not feel well prepared for the CBC after participating in the training.

#### **4.4 Teachers' Competency Test on Critical Thinking and Problem Solving** As

explained in the methodology chapter, the teachers' competence test aimed to assess

the teachers' own abilities to recognize assumptions, evaluate arguments and draw conclusions rather than accepting arguments and conclusions presented to them. The ability to think logically, evaluate information and deduct conclusions rationally can be regarded as the core of critical thinking (see chapter 2). However, the purpose of this section was not to reveal what could be seen as incompetence of the participating teachers, but rather to get a better understanding of the teachers' needs when preparing them for the competence-based curriculum and specifically critical thinking and problem-solving competencies.

The critical thinking test confronts the research participants with statements and they have to interpret the information given to them in these statements. It is not about the statements themselves, but about understanding the text and what can be deduced from it, and the ability to judge whether an argument is strong or weak.

The first of the test questions circles on reasoning and evidence. The participants were asked to evaluate a statement in terms of identifying information that can be deduced from the statement as true, probably true or false.

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#### **4.4.1 Statement 1**

*Studies have shown that people who live in England are more likely to own their own homes than people living in Scotland, although there is little difference in the rate of home ownership amongst people who have the same level of educational achievement. The average level of educational achievement is significantly higher in England than Scotland.*

The first statement given to teachers was:

Teachers were given the three following assumptions and were asked to evaluate

whether these assumptions are either true, probably true or false when deduced from the statement.

Assumption 1. People with high educational achievements are in a better position to buy their own homes than people with low educational achievements.

Assumption 2. There is a lower rate of home ownership in Scotland among people with relatively high educational achievements than among people in England with much lower educational achievements.

Assumption 3. People with higher levels of educational achievement are more likely to own their own homes, since they earn more money than those with lower educational achievement levels.

**Table 4.3 Teachers' Responses to Statement 1: (Correct Answers are highlighted)**  
**Statement True Probably true False**

People with education have better homes	F	36	11	8	%	65.5	20.0	14.5
Lower rate of home ownership among educated people in Scotland than England	houses.	F	27.3	19			41.8	21
	High levels of education achievement are likely to own their own	%	34.5	19	F			38.2
		%	34.5	23				23.6

**Valid N 55**

*Source: Watson Glaser critical thinking test, updated 2021*

The study findings from Table 4.3 revealed that 36 (65.5%) said true, 11 (20%) said probably true and 8 (14.5%) said false to the first assumption. This means that only 65.5% of teachers answered the first assumption correctly. The study findings further revealed that 15 (27.3%) said true, 19 (34.5%) said probably true and 21 (38.2%) said false to the second assumption. This means that only 38.2% of the teachers answered

the second assumption correctly. Also, the study findings finally showed that 19 (34.5%) said true, 23 (41.8%) said probably true and 13 (23.6%) said false to the third assumption. This means that 41.8% of the teachers answered the third assumption correctly. Generally, the findings reveal that 48.5% of the teachers gave correct inferences on the assumptions deduced from the first statement. This means almost 50 % of the teachers were able to understand and think critically hence giving correct deductions concerning the aspects of reasoning and evidence.

#### 4.4.2 Statement 2.

The second statement given to teachers was;

*“We need to save money, so we’d better take a holiday in our own country.”*

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Teachers were given the three following assumptions and were asked to evaluate whether the assumptions are either true, probably true or false when deduced from the statement.

The first assumption was “Holidays in one’s own country are cheaper than holidays elsewhere”.

The second assumption was “Transport costs make international holidays more expensive than those in one’s home country.”

The third assumption was “It is possible to take a holiday in one’s home country”

The results are shown in Table 4.4. The descriptive statistics used were frequencies, percentages, means, standard deviation, skewness and kurtosis

**Table 4.4 Teachers’ Responses to Statement 2 (correct answers are highlighted)**

Statement	True	Probably true	False
Own country holiday is cheap	F 31	12	12 % 56.4
Transport cost expensive	F 12	18	25 % 21.8 32.7 45.5

Holidays outside possible F 25 14 16 % 45.5 25.5 29.1

**Valid N 55**

*Source: Watson Glaser critical thinking test, updated 2021*

The findings from Table 4.4 showed that 31(56.4%) said true, 12(21.8%) said probably true and false respectively to the first assumption. This means that only 56.4% of teachers answered the first assumption correctly. Also, the findings further revealed that 12(21.8%) said true, 18(32.7%) said probably true and 25(45.5%) said false to the second assumption. This means that only 45.5% of teachers answered the second

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assumption correctly. It was further established that 25(45.5%) said true, 14(25.5%) said probably true and 16(29.1%) said false to the third assumption.). This means that only 45.5% of teachers answered the third assumption correctly. In general, 49.1% of the teachers gave correct deductions in the assumptions on statement two.

#### **4.4.3 Statement 3**

The third statement given to teachers was;

*“It snows in January. Schools are always closed when it snows.”*

Teachers were given the three following assumptions and were asked to evaluate whether the assumptions are either true, probably true or false when deduced from the statement.

The first assumption was “Schools are never closed on days when it is not snowing”

The second assumption was “Schools are sometimes closed in January” The third

assumption was “Sometimes schools are open in January”

The results are shown in Table 4.5. The descriptive statistics used were frequencies,



percentages, means, standard deviation, skewness and kurtosis.

**Table 4.5 Teachers' Responses to Statement 3 (correct answers are highlighted)**  
Statement **True** **Probably true** **False**

Schools closed in snowing F 17 3 35 % 30.9 5.5 63.6

Closed in January F 22 12 21 % 40.0 21.8 38.2

Open in January F 12 12 31 % 21.8 21.8 56.4

**Valid N** 55

*Source: Watson Glaser critical thinking test, updated 2021*

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The study findings from Table 4.5 revealed that 17(30.9%) said true, 3(5.5%) said probably true and 35(63.6%) said false to the first assumption. This means that 63.6% of teachers answered the first assumption correctly. Also, it showed that 22(40.0%) said true, 12(21.8%) said probably true and 21(38.2%) said false to the second assumption. This means that only 40.0% of teachers answered the second assumption correctly. Lastly the findings further indicated that 12(21.8%) said true and probably true respectively and 31(56.4%) said false to the third assumption. This means that slightly above half of the teachers (56.4%) answered the third assumption correctly. The overall percentage on the correct deductions on statement 3 is 53.3%. This shows slightly above

50 % of the teachers were able to give correct deductions.

#### **4.4.4 Statement 4**

The fourth statement given to teachers was:

*“. A study of carbon dioxide (CO<sub>2</sub>) emissions from 1990 to 2010 shows that the volume of CO<sub>2</sub> emissions fell consistently, from 24bn tones per year in 1990 to 16bn tones per year in 2010”*

Teachers were given the three following assumptions and were asked to evaluate

whether the assumptions are either true or false when deduced from the statement.

Assumption 1: The reductions in CO<sub>2</sub> emissions demonstrate that energy efficiency initiatives have been successful

Assumption 2: The amount of CO<sub>2</sub> emitted within the EU in 1992 was less than 24bn tons

Assumption 3: CO<sub>2</sub> emissions in 2011 were lower than in 1990

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The results are shown in Table 4.6. The descriptive statistics used were frequencies, percentages, means, standard deviation, skewness and kurtosis.

**Table 4.6 Teachers' Responses to Statement 4 (correct answers are highlighted)**

	<u>Statements True</u>	<u>False</u>					
CO <sub>2</sub> reduction is efficient	F 21	34	% 38.2	61.8			
CO <sub>2</sub> emission is less than 24bn	F 31	24	% 56.4	43.6			
CO <sub>2</sub> emission less in 2011	F 28	27	% 50.9	49.1			

**Valid N 55**

*Source: Watson Glaser critical thinking test, updated 2021*

The study findings revealed that 21(38.2%) said true and 34 (61.8%) false to the first assumption. This means that only 61.8% of teachers answered the first assumption correctly. It furthermore also established that 21(56.4%) said true and 24 (43.6%) to the second assumption. This means that only 56.4% of teachers answered the second assumption correctly. The findings revealed showed that 28 (50.9%) said true and 27 (49.1%) said false to the third assumption. This means that only 49.1% of the teachers answered the third assumption correctly. In general, 55.7% of the teachers were able to give correct inferences on the fourth statement

#### **4.4.5 Statement 5**

The fourth statement given to teachers was:

*“Should the voting age should be lowered to 16?”*

Teachers were given the three following statements and were asked to evaluate whether the arguments made in these statements were strong or weak when deduced from the statement.

The first statement is “Yes, voting provides an opportunity for young people to feel like adults.”

The second statement is “Yes, young people will be affected in the future by decisions made today”

The third statement is “No, 16-year-olds are unduly influenced by celebrities “

Table 4.7 shows the results of statement 5. The descriptive statistics used were frequencies, percentages, means, standard deviation, skewness and kurtosis.

**Table 4.7 Teachers’ Responses to Statement 5. (correct answers are highlighted)**

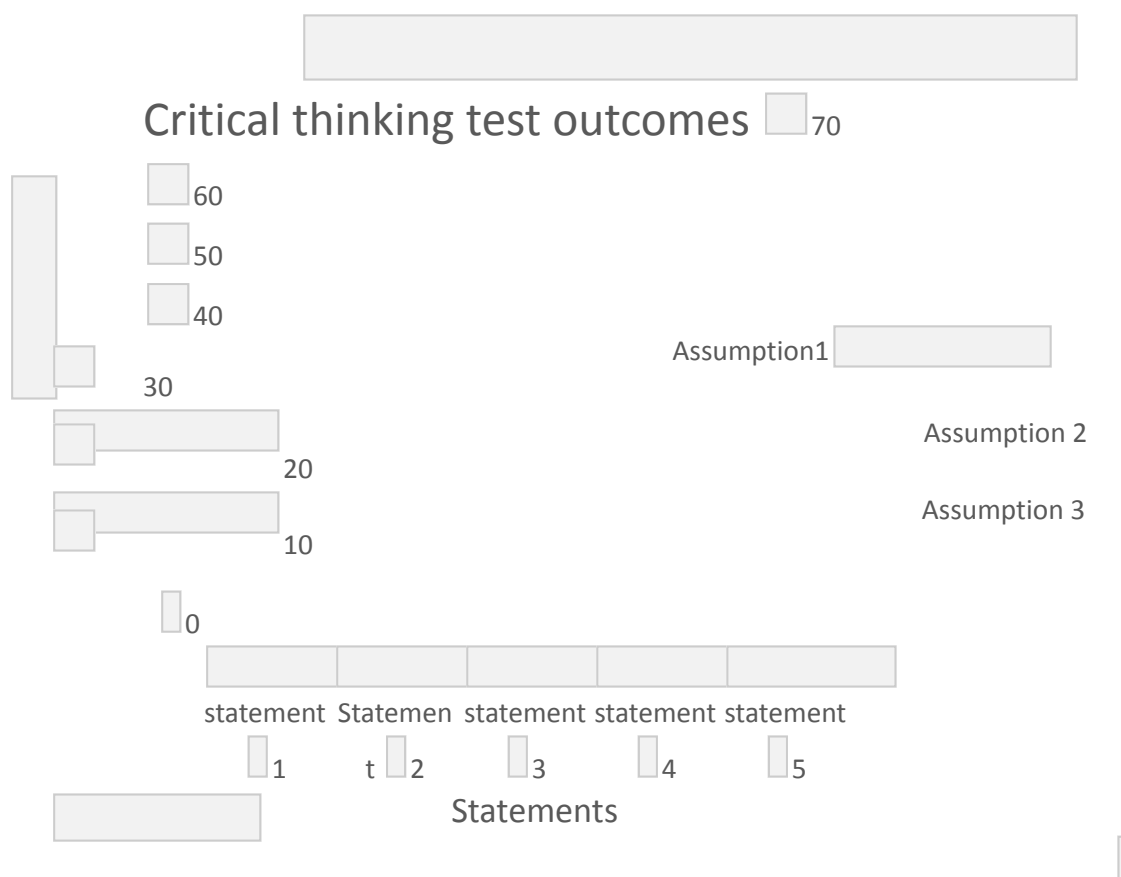
		Statement Strong	Weak
Yes, voting provides an opportunity for young people		29	
		52.7	30
F	F	54.5	
to feel like adults	decisions made today	26	
		47.3	25
%		45.5	
Yes; young people will be affected in the future by %			
No; 16-year-olds are unduly influenced by celebrities	F 19 36 % 34.5	65.5	

**Valid N 55**

*Source: Watson Glaser critical thinking test, updated 2021*

The study findings revealed that 29 (52.7%) rated the first argument as strong and 26

(47.3%) as weak. This means that only 47.3% of teachers answered the first assumption correctly. The findings further revealed that 30 (54.5%) teachers rated the second argument as being strong and 25 (45.5%) as weak. This means that 56.5% of teachers answered the second assumption correctly. Regarding the third argument, 19 (34.5%) teachers regarded it as strong against 36 (65.5%) who rated the argument as weak. This means that 65.5% of the teachers answered the third assumption correctly. Generally, 55.7% of the teachers were in a position to read, understand and rate arguments correctly in the fifth statement.



**Figure 4.6: Graph Showing the Overall Percentage of Correct Deductions from Teachers**

**4.5 Teachers’ Perceptions and Methods: Developing Critical Thinking and Problem-Solving Skills When Teaching Mathematics**

The study sought to find out the teachers' perceptions of critical thinking and problem solving skills by asking them what they find important when teaching mathematics. In order to get a deeper understanding of the teachers' situation in the classroom, their understandings, perceptions and practices concerning the two skills, semi-structured interviews were carried out with mathematics teachers participating in the study. The purpose of complementing the questionnaire with qualitative insights was to particularly find out and contextualize, which of the teaching methods suggested in the CBC would help enhance critical thinking and problem-solving skills from the perspectives and in the experiences of the teachers. At the same time, the interviews aimed to provide insights into aspects that might have not been covered in the

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questionnaire and that could help to understand the teachers' situations, perceptions and practices in more differentiated ways.

Looking more closely into the teachers' perceptions of various teaching methods and what they think these methods offer in terms of helping the learners develop the skills of critical thinking and problem solving, the questionnaire offers some interesting insights. As such, Table 4.12 and 4.13 (perceptions of teaching methods) and correspondingly 4.14 (most useful teaching method), where the research participants were asked to assess and rank the suggested teaching methods in terms of their ability to develop critical thinking and problem-solving skills in the learners, are discussed below. The descriptive statistics used were frequencies, percentages, means, standard deviation, skewness and kurtosis. The perceptions as well as the corresponding teaching methods were divided into two sections for ease of analysis and to decongest the items. The first section comprised of seven items and the second comprised of six items. All the items tested the perceptions of the teachers concerning specific teaching

methods related to the development of critical thinking and problem-solving skills in the new competency-based curriculum.

**Table 4.8: Teachers' Perceptions I: Importance of Various Teaching Methods**

Teaching method	$\mu$	$\Delta$	Skew	Kur
To consider different points of view from your pupils when teaching	4.0	1.8	1.8	56.4
To use different sources of information	4.15	0.59	-0.60	2.49
To let pupils, work in small groups	4.23	1.8	5.5	69.1
To take enough time for pupils' questions.	4.31	0.81	-1.70	4.53
To consider your pupils levels of understanding when teaching	4.5	5.5	45.5	45.5
To help your pupils identify and correct their mistakes	4.22	0.81	-1.51	3.97
To demonstrate the correct way to solve a problem.	4.09	0.80	-1.52	4.11
F 1 - 2 19 33 4.51 0.74 -2.29 8.09 % 1.8 - 3.6	4.51	0.74	-2.29	8.09
F 1 - 7 27 20 4.18 0.80 -1.26 3.29 % 1.8 - 12.7	4.18	0.80	-1.26	3.29
F 1 1 31 22 4.35 0.62 -0.86 2.32	4.35	0.62	-0.86	2.32

The results presented in Table 4.8 for the items of teacher perceptions indicate that the means were in the range 4.09 to 4.51. This gave an overall mean of 4.3. On a 5-point Likert scale. The scores were above average and the results showed that the teachers pointed out that it was important to use the different methods when teaching mathematics. The standard deviations were in the range of 0.59 and 0.81, the overall

standard deviation was 0.7. The relatively low standard deviation value indicates that