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Effective use of Abacus in the Teaching and Learning of Mathematics among class three Teachers in Public Primary Schools in Kasipul Division Rachuonyo South Sub County, Kenya

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ABSTRACT

Abacus has been considered as one of the most significant tools used for teaching and learning of mathematics among primary school mathematics teachers since it helps in spurring better performance in mathematics. However, most of the teachers who use it have reported poor and perennial ineffective use of Abacus in Rachuonyo South Sub County. It is a simple mathematics tool used for calculation and easy to use when solving problems in mathematics. The study objectives were to; find out how the effective use of Abacus can be achieved; to determine age and gender differences in the effective use of Abacus, to explore the challenges faced by mathematics teachers in using Abacus and finally to establish the strategies that could ensure the effective use of Abacus in the teaching and learning of mathematics in public primary schools. Using descriptive survey design, this study was framed from Vygotsky's constructivism theoretical perspective. This study targeted 170 public primary schools with 1,069 mathematics teachers of which568 were males and 501 were females. Purposive random sampling technique was used to select a sample size of 30% which was 51 public primary schools and 321 class three mathematics teachers. Questionnaires were used for quantitative data collection. Interviews were conducted among 51 heads of mathematics department while observation was done throughout the process. The validity of the instruments for data collection was ensured by expert judgment of the University lecturers. The reliability was determined by the Split Half method and a reliability coefficient of r=0.791was reported. Trustworthiness of the study ensured the validity and reliability of the data from the study. The quantitative data was analysed using descriptive statistics with the aid of Statistical Package for Social Sciences SPSS version 22 while qualitative data was analysed based on the construct items relating to important components on the use of Abacus. The study established that, Abacus improves performance in mathematics among pupils in primary schools in Kasipul Division. The findings of the study also revealed that, teachers had positive attitude towards Abacus. Abacus is good and effective in spurring new skills for teaching and learning of mathematics, however, most of the mathematics teachers lack the skills to use abacus effectively and need to be trained on the use of abacus. Age differences did not significantly affect the effectiveness in the use of Abacus in teaching mathematics; however, there was gender difference on the effective use of Abacus for teaching mathematics where effectiveness for male teachers was higher than that of their female counterparts. The study also established several challenges faced by mathematics teachers in the use of Abacus simply due to lack of skills. The study findings established that, mathematics teachers adopted several strategies to ensure effective use of Abacus in the teaching and learning of mathematics. The study recommended that, the Kenyan Ministry of Education should train the mathematics teachers on the effective use of abacus. Moreover, the Kenya Institute for Curriculum Development should infuse the use of Abacus into the mathematics syllabus. The significance of this study therefore is that, it is believed the findings of this study will be used by mathematics teachers to improve in teaching mathematics, provide curriculum planners with an insight to infuse effective use of abacus in mathematics curriculum development and finally it is hoped that this study will generate knew knowledge in this field of study and further research.

1.0 INTRODUCTION

1.1: Background of the Study

Abacus is a mathematical tool that has been used in the Middle East for ages (Stigler, Chalip and Miller, 1986). Kaput (2007) described Abacus as a wood frame mathematical tool is composed of columns of movable beads has been used for arithmetic calculations throughout Asia.

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In the Middle East Abacus is described as an "abax", a Greek word for tray or table that originated from the Semitic word "abq", meaning "dust" or sand or "earth" (Jenni and Pumfrey, 2007).

Stigler, Chalip and Miller (2006) described Abacus as a simple device for performing arithmetic function. A method used by Chinese, Japanese, and Koreans to improve mathematical skills.

It is defined it to be having ten parallel wires stung between two boards on a frame with nine beads on each wire used for counting. Beads on the upper part of the central bar represent the value of "fives" in base ten and those below the horizontal bar represent "ones". The beads are counted in terms of ones, tens, and hundred (Stigler *et al*, 1986).

In America (Hooser, 2013) defined Abacus as a wood frame with sliding counters that represent numbers. Abacus is an accounting frame with movable beads either two or one bead on top of the horizontal bar in the middle representing "fives" and five or four beads on the lower part of the bar representing "ones". However many mathematics teachers have ignored the use of this important magic tool.

Several authors have acknowledged the importance of Abacus in the teaching and learning of mathematics (Hooser, 2013) in US, (Gissoni, 2011) in Malaysia, (Kumar and Ramanujam, 2006) in India and (Dhaval, 20012) in Asia; all observed that Abacus is regarded as the oldest computer that has survived for over 2,000 years as a favourite mathematical tool in the era of digital age.

Similarly, (Waqui, 2010) in Asia, McClore (2011) in Europe and (Davidow, 2007) in America agreed that, Abacus can be adopted or use the combination of many approaches despite of the existence of traditional methods.

Jenni and Pumfrey, (2007) reported that, several countries have realized tremendous success using Abacus in teaching mathematics i.e. Taiwan, US, India, Malaysia, Tornado, Bahrain, Iran, Saudi Arabia, Egypt, Nepal, New Zealand, Australia, UAE, UK, Oman, Qatar, Syria, North Sudan, China, Sri Lanka, Korea, Thailand, Japan, Nigeria, South Africa, Canada, Brunei, Kuwait, Lebanon, Jordan, Mauritius, Japan and Thailand, Japan, Mauritius, and Hungary.

Since then Abacus has been called by different names such as abax or Vedic (Greek), Saunpan (Chinese), Soroban (Japanese), Sampoa or Kongak (Malaysian), Kumon (Korean), Cranmer (German), and the UK Software Abacus (McClure, 2012).

Despite of all the efforts, performance in mathematics is still very poor in Kenya Primary certificate (KCPE) in Rachuonyo South Sub County as indicated by the data below; due to limited use of Abacus by mathematics teachers.

Table 1.1. RachuonyoSouthSubCounty KCPE Mathematics Mean Scores for 2009-2013.

	2009			2010			2011			2012		2013			
Entry	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total	Boys	Girls	Total
Number of Pupils	3352	2555	5907	3068	2455	5523	2783	2436	5219	3069	2488	5557	2929	2502	5431
Mean Scores	53.74			53.01			53.01			51.75		49.82			
Mean Deviation	+1.066			+0.92			+0.92			+1.93		-1.200			

1.2. Statement of the Problem

Research has shown that abacus should be used to enhance the teaching and learning of mathematics in Kenya. Interestingly, no studies have been conducted on the effective use of Abacus by teachers in teaching primary mathematics curriculum Kenya.

1.3. The Purpose of the Study

The purpose of this study was to examine how class three primary school teachers effectively use of Abacus in the teaching and learning of primary mathematics curriculum in Kasipul Division Rachuonyo South Sub County.

1.4. Objectives of the Study

The study sought to achieve the following objectives:

(i) To investigate the impact of using Abacus for effective teaching and learning of primary mathematics curriculum among class three mathematics teachers in Kasipul Division Rachuonyo South Sub County.

(ii) To examine the effective use of Abacus on the basis of the age and gender of teachers in the teaching and learning of mathematics in the primary school curriculum in Kasipul Division Rachuonyo South Sub-County.

(iii) To explore the challenges faced by mathematics teachers in using Abacus in the teaching and learning mathematics in the primary schools curriculum in Kasipul Division Rachuonyo South Sub County.

(iv) To establish the strategies that could ensure the effective use of Abacus in the teaching and learning mathematics in the primary school curriculum in Kasipul Division Rachuonyo South Sub County.

1.5. Research Questions of the Study

The research was guided by the following research questions:

(i) How effective is the use Abacus in the teaching and learning of mathematics among class three pupils in primary schools in Kasipul Division Rachuonyo South Sub County?

(ii) Which age group and gender of teachers used Abacus more effectively in the teaching and learning of mathematics in primary schools' curriculum in Kasipul Division Rachuonyo South Sub County?

(iii) What challenges do mathematics teachers face in using Abacus in the teaching and learning of mathematics in primary schools' curriculum in Kasipul Division Rachuonyo South Sub County?

(iv) What strategies could ensure the effective use of Abacus in the teaching and learning of mathematics in primary schools' curriculum in Kasipul Division Rachuonyo South Sub County?

1.6. Significance of the Study

The study has potential contributions. First, the findings might help the Ministry of Education (MOE) in organizing in-service training for mathematics teachers on the use of Abacus in the teaching of mathematics. Furthermore, these study findings might help Kenya Institute of Curriculum Development (KICD) to modify the curriculum to accommodate the use of Abacus in mathematics curriculum.

1.7. The Scope of the Study

The study was restrictedto public primary schools in Kasipul Division Rachuonyo

South Sub County and the study focused on the use of Abacus by class three mathematics teachers in public primary schools. The study involved 321 class three mathematics teachers from 51 public primary schools in the Sub County. The teachers were categorized as those who are using Abacus and those who do not use Abacus in the teaching and learning of mathematics.

1.8. Theoretical Framework

The study adopted the social constructivism theory of (Vygotsky and Wood, 1998) explained how the zone of proximal development (ZPD). This can be achieved using Abacus in the teaching and learning of mathematics. The theory is useful for this study because it is a motivational social approach that develops cognitive skills. Barner, *et al.* (2014) corroborated the theory that, the use of Abacus for teaching and learning of mathematics in the zone of proximal development helps the children in cognitive development as the children work in the zone of a range of tasks which the children could perform independently and accomplish with the help of a more competent person. The children understand, develop knowledge and explain each concept when solving mathematical problems (Stigler, Chalip and Miller, 2006).

On the basis of this theory, children are helped to identify problems and appreciated approaches in retention to characters, ideologies, behaviours, hopes, cultures and languages. The learning approach further enabled the learners to build their knowledge based on their background, experiences, and the role the environment play in acquiring new methods, relate the past to present experience in the immediate environment which can motivate the learners according to (Barner*et al*., 2014).

According to Vygotsky and wood (1998) when children are tested on the tasks they do on their own, they rarely did as well as when they are working with an adult (McClure, 2012 and Sewannee, 2013). Hence emphasis should be made about the induction of learners by the experienced instructors.

In addition, the development of language, mathematics, articulation and formation of ideas becomes central to learning and development and problem solving. It acknowledges the uniqueness of children as individuals, with unique needs and backgrounds which is multidimensionality complex. It encourages, utilizes, and rewards, as it becomes an integral part of a learning process (Stigler *et al*., 2006). Through this theory children learn to become competent when using Abacus and also become proficient (Barner*et al*., 2014).

1.9. Operational Definition of Terms

The following terms have been operationally defined as:

Abacus:A tool for calculating mathematics with movable beads on a vertical wire strung between the horizontal bars.

Effective:refers to achieving the desired effect,the production of good result or impressive, to have the result intended or hoped to be achieved.

Learning: For the purpose of this study, it refers to a process of constructing meaning. It is how people make sense out of their experiences.

Mathematics:This is a Greek word "Mathema" – "Tics" which means to explain, to know or to understand. "Tics" is the techne which is rooted in art, skill or technique.

Public:(Pablik) an attribute of or concerning people in general or opinion or known to people in general. Well known or often seen.

Teaching: It is an attempt to help someone acquire or change some skill, attitude, knowledge, idea or appreciation.

2.0 LITERATURE REVIEW

2.1. Introduction

This chapter presents the review on the aspects of the effective use of Abacus; age and gender of teachers; challenges of using Abacus by mathematics teachers, and the strategies.

2.2. The impact of using Abacus for effective teaching and learning of primary mathematics curriculum

A study conducted by (Barner, *et al.*, 2014) shows that use of Abacus improves on Learning of Mathematics in Visuospatial Format. The study population was 2100 learners aged between 5-7 years old. Random sampling was used for a sample size of 204 students in second grade and above. Control group of 104 students. Woodcock Johnson Test of Achievement (WJ-III) and the Math Fluency Sub-test of Wechsler Individual Achievement Test (WIAT-III), two in house assessments of mathematics skills, adaptive test of Spatial Working Memory (SWM) and test of Verbal Working Memory (VWM) were also used to collect data. The analysis was done on Weber fractions (a measure of approximate number acuity). The findings were that, children learned to use an Abacus with high performance and that performance on the Abacus arithmetic task rose substantially over the years. Therefore, Abacus arithmetic significantly correlated with performance on other math measures. However, study did not investigate the consequences of improved arithmetic influence on (MA) users.

Stigler, Chalip and Miller (2006), found that learners do not have critical mass of talents and quality in the faculty of mathematics and teachers also had limited skill for teaching and learning of science that could expose pupils to mathematic tasks. They used 120 classrooms in three cities of Taipei, Taiwan, Sendai, Japan, and the metropolis-metropolitan in USA by selecting the fifth grader classes from the three locations and another one hundred (100) first graders, and another 100 graders in the fifth giving a total of 200 graders. The study focused on 40 first graders and in Cook County 40 fifth graders in Chicago city totalling to 80 graders. The study used 22 classes, alongside 22 fifth graders in Beijing China. Comparative analysis was used from all countries.

Shwalb, Sugie and Yang (2013) on the motivation for Abacus studies and school mathematics among Japanese using "Juku" found that, Abacus Juku exerts a positive influence on school mathematics education.

In New York (Rockoff, Thomas & Douglas, 2008) on varied non-traditional predictors on effectiveness in teaching specific content knowledge, cognitive ability, personality traits feeling of self-efficiency and scores concluded that, there is no single factor that could predict success in teaching, using a broad set of measures to help schools improve the quality of their teachers.

The same has been observed by (Wong and Lai, 2006) on factors affecting mathematics teaching effectiveness among Pre-Service Primary Mathematics Student-Teachers in Malaysia and by (Zhang, 2008) at Utah University (2006-2007).

Bearden (2012) also examined the relationship between high schools mathematics teachers' dispositional and their metaphors and found that, there was a strong link between the professional dispositions and teaching metaphors among mathematics teachers who use Abacus at Kennsaw State University. Anthony and Walshaw (2009) in New Zealand examined the characteristics of effective teaching of mathematics using Abacus and reported that, effective teaching of mathematics depends on what kinds of pedagogical practices desirable to students' outcomes.

Nye, Kotsiopoulos and Hedges (2004) in Nigeria studied the teacher effects on students' achievement using Abacus

and found out that, the effects on achievement gains were similar in magnitude to those of previous studies but with larger effects on mathematics achievement than on reading achievement when Abacus is used significantly for 2nd grade reading and 3rd grade mathematics.

Others scholars like (Onyekuru and Ibegbunam, 2013), (Bakke and Igharo, 2013),

Alao (2014), (Amoo and Disu, 2012) concluded that, mathematics teachers believe that Abacus contribute to the effectiveness teaching of mathematics.

Githua and Mwangi (2013) who studied the effects of using Loci-Kit Model on secondary School Students' Achievement in the mathematics on the topic of "LOCI" in Kibwezi District, Kenya revealed that LOCI-KIT Model just like Abacus could benefit school teachers understand the effects of using models in teaching mathematics and to improve mathematics performance.

This was corroborated in (Odhiambo and Toili, 2013) who studied the implication of electronic calculator on pupils' performance in mathematics in secondary schools in Butere/Mumias Kenya, but noted drawbacks experienced using Abacus especially when manipulating it following the slide rule and its management for mathematical operations.

The same was highlighted by (Jannis, 2013) in a study conducted in Nkuene Division Meru County, Kenya to establish the contributions of SMASSE In-service Project on Pupils' Performance in Mathematics in Kenya Certificate of Secondary Examinations (KCSE) examinations and found that, the teaching methods improve performance in mathematics and sciences and recommended the use of SMASSE as an incorporated curriculum in teacher training to the teachers.

2.3. Age and gender difference in the use of Abacus in Teaching and Learning of Mathematics

Several researchers like (Tweed, 2013) in America investigated technological implementations on teaching and learning of mathematics using Abacus based on gender and reported that, age, years of experience, quality of professional development and efficacy in classroom did not play a significant role but use of resources.

In Germany (Blomeke, Suhl, and Kaiser, 2011) studied the effect of gender and language on mathematics content knowledge and mathematics pedagogical content knowledge were examined and the findings revealed significant cultural differences in the effectiveness of teacher education. Gender and language effects could be decomposed into direct and indirect effects.

Similarly, (Wu, Cheen, Huang, Lui, Hsieh and Lee, 2008) in China determined the impact of Abacus in the function of neural base for exceptional mental calculation ability possessed by the Chinese and revealed that, there was activation of brain regions among young experts associated with (inferior frontal network) and visuospatial processing (left parietal/frontal network).

Jamil, Razak, Raju and Mohammed (2012) stated that young generation of teachers face the challenge of professional development in Malaysia. Anouchie (2013) conducted a study in Ashanti region of Adonsi north district in Ghana on the use of multi-base block in teaching place value by Akrokerri College of education among pupils taught by young teachers below twenty-five years and reported lack of understanding of the basic concepts of place value by failing to explain the concepts to the pupils. Consequently, more experienced teachers used teaching and learning materials better than new entrants to the teaching career.

Similarly other researchers such as (Antencol, Eren and Ozbeklik, 2012) in the study of the impact of academic dynamics in the classroom based on gender and the effects of having a female teacher on the math test scores of students in the primary schools in Born Germany and found out that, female students assigned to female teacher without a strong mathematics background suffered from lower mathematics test scores at the end of the academic year.

Alao (2014) who also studied the teacher effectiveness, rating in selected Nigerian primary and secondary schools had results showing that, a high percentage (78-3%) of teachers were effective. The difference in the effectiveness was found to be statistically significant ($t=4.93$, $p<0.05$). The study recommended that there should be improvement made on the effectiveness of female teachers by assigning light teaching periods.

Udousoro (2012) conducted a study about factors that promote gender imbalance in the teaching of science/mathematics among practicing teachers at the University of Uyo, Uyo in AkwaIbom State, Nigeria revealed that, there was significant difference between male and female teachers in their view concerning factors promoting gender imbalance in the teaching of science and mathematics in favour of male teachers. It recommended that the government should provide good working environment to teachers and equip the laboratories for effective teaching of science/mathematics.

Wright (2013) in South Africa investigated Significance, Trends, Nomenclature, Context, Key Topics, Learning Framework and Assessment Tasks on early numeracy and recommended that, teachers should develop children's verbal knowledge of number words (in the sense of spoken and heard rather than written) and the learners' knowledge of numerals extending beyond 20 and 100 as soon as in the early year since teachers have both capacity to learn teaching of numbers and basic arithmetic.

In Nigeria, Chinyere and Angela (2014) who studied secondary school pupils' assessment of innovative teaching strategies in enhancing achievement in physics and mathematics in Uundike, Umuhia, Abia State reported that, peer tutoring, simulation; team teaching, brain storming, experimental learning, co-operative learning, inquiry, and role-play are innovative teaching strategies that enhance achievement in physics and mathematics when using Abacus. It recommended that, the innovative teachings should be reflected in the curriculum to fully equip new graduate teachers.

Bunyi, *et al.* (2013) reported that, teacher professional development in Kenya among New Qualified Teachers (NQT) and Old Qualified Teachers (OQT), who used Abacus, reflected a difference on more experienced teachers who used Abacus more often than (NQT) who eventually gave up the practice of using teaching/learning materials. The study recommended for teacher quality, training and educational policy and comprehensive research among new qualified teachers.

2.4. The Challenges Facing Mathematics Teachers in the Teaching and Learning of Mathematics.

A study on Professional Teacher Development (PTD) and Continuous Professional Development (CPD) in Malaysia revealed that there are many challenges facing the use of Abacus in teaching and learning of mathematics because of low quality of teacher education (Jamil, Razak, Raju, and Mohammed, 2012).

The same was reflected in the (Stigler, Chalip and Miller, 2006) research conducted on the use of Abacus for teaching children in three cities of Taipei Taiwan, Sendai Japan, and the metropolis-metropolitans (USA), and Beijing China that found major challenges facing math teachers using materials in teaching mathematics.

The same case was with (Jayeoba and Atanda, 2013) who conducted a research on school quality factors and secondary school students' achievement in mathematics in south western and north central Nigeria which found out that materials and conveniences are contributing significantly to students' achievement in mathematics.

A study by (Sofewe, 2012) at Yala, Nigeria on the impacts of co-operative learning approach on senior secondary schools pupils' performance in mathematics revealed that, experimental tasks yielded higher mean score than controlled tasks. The study recommended that training and workshops should be organized for teachers to equip them with basic skills.

Sewannee (2013) used chip Abacus as another way of making sense in teaching and learning mathematics at Kasese Primary School in Uganda and Namable Magnet School in Kenya. The study revealed that, motivation was prominent and introduced lunch programme by replacing traditional teaching method with workshops and discussions in training leadership among students and more teachers joined the professional training.

Makewa, Elizabeth, Too, and Kiplagat (2013) conducted a study on teacher related factors associated with performance in mathematics in public primary schools, in Nandi central district, Kenya and found that, majority of the teachers were trained with teaching experience ranging between 11-20 years on average but lacked effective skills in using teaching and learning resources including teaching methodology.

2.5: The Strategies for effective use of Abacus in the Teaching and Learning of Mathematics.

Stigler et al., 2006) conducted a study in America, Japan, Taiwan, China and England Canada, Australia and Dalain to examined hand waving or fingering as a strategy for effective teaching using Abacus. The study revealed that the best strategy is train the learners the proper articulation in mathematics, language, mental skills and memory, construction, personality and self-motivation using Abacus in the early years of elementary education.

Hamsa and Mellony (2011) in Natal South Africa reported that, hand waving leads to mediation of learning which only occur when a teacher treated the content as a science using number bonds of Vygotskian Lens of scientific concept. The researchers recommended that the mediation method should be reviewed regularly in order to accommodate different teaching circumstances.

Jamil, Rhazak, Raju and Mohammed (2012) in Malaysian study stated that, the increased use of technology in education encourage the revision of curriculum to make it a student centered pedagogical.

Chinyere and Angela (2014) in Nigeria conducted a study on secondary school pupils' assessment of innovative teaching strategies in enhancing achievement in physics and mathematics in Umundike, Umuhia, Abia State Nigeria at the Michael Opera University of Agriculture and confirmed that, innovative teaching strategies enhance achievement in learning of physics and mathematics.

Makewa, Elizabeth, Too and Kiplagat (2012) examined the teacher commitment on pupils' performance in mathematics in primary schools in Nandi central district, Kenya found that, mathematics teachers were just average on using teaching and learning resources and prepare, plan, organize and be committed by considering learners' experiences, abilities, interests, motivation and skills for better achievements.

3.0 RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents research methodology as used to determine the effective use of Abacus in teaching and learning of mathematics.

3.2. Research Design

The descriptive survey design was adopted for the study. It refers to a self-report study used for data collection of quantifiable information from the sampled 30% of the members of a given population as recommended by (Odundo, 2005; Kerlinger, 2012 and Kothari, 2006).

3.3. Area of Study

The study area was Kasipul Division Rachuonyo South Sub County Kenya as recommended by (Jannis, 2013). The area covers Central and East Karachuonyo, in the North, Rangwe on the West, Mosocho in the South, Nyamira and Kabondo on the East. The area is about 1000 kilometre square. Rainfall is between 250mm to 700mm per year with long rains in March to July and short rains from September to December. Temperature is between 17 degrees centigrade (170^{c}) to thirty-four degrees centigrade (340^{c}). Soil texture is bimodal suitable for agriculture. A tarmac road crosses it from Kisumu to Kisii about 80 km and other gravelled or earth surfaced feeder roads covering about 300 km used for transport.

3.4. Population of the Study

According to (Mugenda and Mugenda, 2009) this comprised of all public primary schools' mathematics teachers in Kasipul Division. The target population was 170 public primary schools with 1,069 teachers (568) males and (501) females. Sample size was 30% from 51 public primary schools consisting of 321 class three mathematics teachers using Abacus from public primary schools.

3.5.1. Questionnaire for Mathematics Teachers.

Questionnaires were used because they save time and uphold confidentiality of participants (Lovell and Lawson, 2013; Best and Khan, 2008).

3.5.2. Interview schedule for Heads of Mathematics Departments:

Interview was conducted for the head teachers and heads of department on the effective use of Abacus to obtain direct and accurate information. Prior arrangements were made between the researcher and the respondents (Cohen and Marion, 2008).

3.6. Data Collection Procedures

Permission was secured from Jaramogi Oginga Odinga University of Science and Technology (JOOUST) Board of Post Graduate Studies, the National Commission for Science, Technology and Innovation (NACOSTI), Sub County Director of education officer Rachuonyo South Sub County, heads of schools and teachers from public primary schools in Kasipul Division Rachuonyo South Sub County before the distribution of the questionnaires.

3.7. Quantitative Data analysis

The data was analyzed using descriptive statistics including percentages (%), tables and graphs (Raburu, 2011; Odundo, 2005; Orodho, 2005; Kothari, 2006; Mugenda and Mugenda, 2003).

3.8. Ethical Considerations

The consent and interest of the respondents was considered after the authorization (Powell, Fitzgerald, Tylor and Graham, 2012).

4.0 FINDINGS, INTERPRETATION AND DISCUSSION

4.1. Introduction

This chapter reflects the findings, interpretations and discussions of the results of the study as presented by data from public primary schools in Kasipul Division Rachuonyo South Sub-County using the statistical package for social sciences (SSPS) version 22.

4.2. Teachers' Respondents

Table 4.1. Teachers' demographic information on age and gender (n=321).

	Total	20-29 Yrs	30-39 Yrs	40-49 Yrs	50-59 Yrs
Male	114 38.24%	9 60%	28 43.08%	30 30.93%	24 48.98%
Female	195 56.72%	6 40%	37 56.92%	67 69.07%	25 51.02%
Undeclared	12 5.04%	-	-	-	-
Total	321 100%	15 6.64%	65 28.76%	97 42.92%	49 21.68%

Source: Data (2014)

From the information presented in table 4.1, the research findings show that there was a very big gender disparity of mathematics teachers in Kasipul Division Rachuonyo Sub-County with 56.72% female teachers and 38.24% males. It was therefore evident that there were more female class three mathematics teachers than their male counterparts in this region.The average age of female class three mathematics teachers was 43 years compared to the male colleagues' average of 39 years.

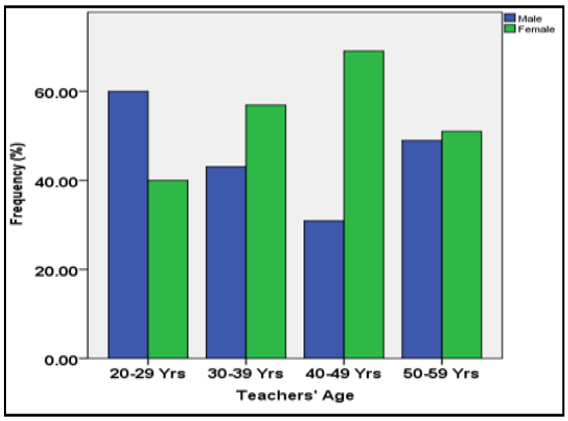

Figure 4.1. Distribution of Age by Gender of the Respondents (n=321).

Source: Data (2014).

63.01% of the mathematics teachers who were 40 years and above were females and 60% of teachers who were 30 years and below were females.

On teacher qualification the study findings are illustrated out as;

Table 4.2. Distribution of teachers by Academic Qualifications (n=321).

Qualification & Training	Male	Female	Total	%
Certificate	72	145	217	67.6
Diploma	17	32	49	15.1
Degree	12	23	35	10.2
Master	7	13	20	6.1
PhD	-	-	-	-
Total	108	213	321	100

Source: Data (2014)

Table 4.4. Percentage responses on effectiveness of Abacus (n=321).

ITEM ON EFFECT USE OF ABACUS	SA	A	N	D	SD
Using Abacus effectively makes many learners acquire mastery of skills in mathematics and problem solving.	23.73	38.56	33.05	4.66	0.00
Using Abacus enhances interaction among learners during mathematics lessons.	22.03	40.68	19.92	17.37	0.00
Using Abacus enhances cognitive growth among learners.	26.27	18.64	50.00	5.08	0.00
Using Abacus enables learners to acquire high level language and articulation skills.	29.24	35.59	31.36	3.81	0.00
Using Abacus motivates learners and develops high speed in calculations and problem solving in mathematics	28.81	43.64	27.12	0.42	0.00
Learners become accurate when using Abacus in solving mathematics problems.	36.02	48.31	15.68	0.00	0.00
Teaching and learning of mathematics using Abacus motivates teachers and learners during the lesson.	18.30	62.98	18.30	0.43	0.00
Using Abacus helps learners to develop creative and innovative thinking in solving mathematics problems.	24.68	43.40	31.06	0.85	0.00
Using Abacus allows the integration of many teaching and learning methods in a classroom situation.	37.87	38.30	19.15	4.68	0.00
Use of Abacus encourages learners' involvement in class activities.	27.23	48.51	19.57	4.68	0.00
Using Abacus encourages many learners to develop personality, self-esteem and confidence in solving mathematics problems.	46.58	31.20	20.09	2.14	0.00
Using Abacus gives learners an opportunity to enhance their understanding of different concepts in mathematics.	29.79	46.38	22.98	0.85	0.00
Using Abacus develops learners' abilities to use teaching and learning resources effectively in solving mathematics problems in class.	46.81	27.66	23.83	1.70	0.00
When Abacus is used learners are made to expand their thinking abilities on how to find solution to problems by themselves.	25.53	27.23	46.38	0.85	0.00
Using Abacus attracts the attention of the learners and promotes high level of concentration in class activities.	20.43	40.00	36.17	2.98	0.43
Using Abacus allows my learners to connect manipulated objects to the real life experiences.	32.75	10.04	44.54	12.23	0.44
Using Abacus supports mathematical thinking among students.	28.82	14.41	41.92	14.85	0.00
Many learners actively participation and play significant roles in mathematics problem solving when using Abacus.	24.89	11.79	47.16	16.16	0.00
Using Abacus enables many learners to develop mental Abacus image in their visual thinking and are able to solve mathematical problems with ease.	23.73	38.56	33.05	4.66	0.00
Using Abacus in solving mathematical problems enables many learners to develop management and leadership skills.	22.03	40.68	19.92	17.37	0.00

Source Author, 2014

The percentage distribution of teachers' professional qualifications are shown in table 4.3 while the summary of teachers' respondents professional qualifications were tabulated and shown in Table 4.3

Table 4.3. Teachers' Gender and Professional qualifications (n=321).

Gender/Qualifications	Certificates	Diploma	Degree	Master PhD
Male	72 22.3%	17 5.23%	12 3.5%	7 2.14%
Female	145 45.2%	32 9.87%	23 6.7%	13 3.97%
Total	217 67.6%	49 15.1%	35 10.2%	20 6.1%

Source: Data (2014).

The findings indicate that, majority (217) of class three mathematics teachers were holders of certificate qualifications (67.6%), no teachers with PhDdegree, 15.1 % had diploma compared to 10.2% degree qualifications and 6.1% master degree holders. The figures demonstrate that, teachers need further training to keep with the global trends.

4.3. The Findings on impact of using Abacus for effective teaching and learning of primary mathematics curriculum.

The effective use of Abacus is illustrated by % responses below.

4.4. Response from the Interview Schedule.

Teachers noted that they face several drawbacks when using Abacus.

Teachers are using other forms of teaching resources instead of Abacus because it is confusing to use. Most teacher participants indicated that they did not command the required skills to use Abacus in teaching mathematics.Below is adescriptive approach on the impact of using Abacus in teaching and learning mathematics.

Table 4.5. Descriptive Statistics.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
20-29 Years	15	70.5000	19.23074	4.96536	59.8504	81.1496
30-39 Years	65	59.5700	33.96107	4.21235	51.1549	67.9851
40-49 Years	107	57.8944	30.56701	2.95502	52.0358	63.7530
50-59 Years	49	58.9886	30.02923	4.28989	50.3632	67.6140
Total	236	59.3843	30.83363	2.00710	55.4301	63.3385
Fixed Effects			30.88610	2.01051	55.4231	63.3455
Random Effects				2.01051	52.9859	65.7826

The descriptive statistics in table 4.6 indicate that the means of effectiveness score were not very different from each other except the age group 20-29 years whose mean (M=70.5; SD=19.23 and SE=4.97) was higher than effectiveness score of other age groups.

To establish whether there were significant age differences on the use of Abacus, the one way Analysis of Variance (ANOVA) was used. Mathematics teachers were divided into four groups according to their ages (20-29 years, 30-39 years, 40-49 years and 50-59 years).

From the test of homogeneity of variances, the Levene's test indicated that the assumption of homogeneity of variance was not violated, F (3, 232) = 2.079, p = .104,hence reading and interpretation was done from the main ANOVA table 4.7.

Table 4.6. ANOVA Results on the impact of using Abacus for effective teaching and learning of primary mathematics curriculum based on Age and Gender.

Score	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2100.818	3	700.273	.734	.533
Within Groups	221316.670	232	953.951		
Total	223417.488	235			

From the test of homogeneity of variances, the Levene's test indicated that the assumption of homogeneity of variance was not violated, F (3, 232) = 2.079, p = .104, hence reading and interpretation was done from the main ANOVA table 4.7. It revealed that there was no statistically significant difference at the p>.05 level in effectiveness scores for the four age groups [F (3, 232) =.733, p=.533]. The effect size, calculated using beta squared was .009, this further reveals that effect of age on effectiveness on the use of Abacus in teaching mathematics is quite negligible. Hence, age differences did statistically and significantly affected the effective use of Abacus by mathematics teachers in Kasipul Division Rachuonyo South Sub-County.

4.5. Gender Factor on the impact of using Abacus for effective teaching and learning of primary mathematics curriculum

The study investigated gender differences in the effective use of Abacus which is illustrated using descriptive statistics as presented in the table 4.7.

Table 4.7. T-test Statistics.

Gender			Mean	Std. Deviation	Std. Error Mean
Score	Female	67	56.9836	30.36423	2.34965
	Male	9	65.1950	31.40724	3.78099

The information presented in table 4.8 indicates that, females had a mean of 56.98% while male teachers had a mean of 65.19% compared to their female counterparts. Inferential analysis using the t-tests was carried out to ascertain whether there are gender differences in the effectiveness on the use of Abacus. The results of the t-tests are presented in table4.8.

The Levene's Test for Equality of Variances was not significant (P =.48), hence the researcher assumed equality of variances. However, the difference of means in effective score among gender was reasonably big (MD=8.211; SED = 4.389). The SSPS output (Table 4.8) indicate that the female and male teachers' score on effectiveness of Abacus use in teaching and learning mathematics differed significantly.

4.6. Findings on the Challenges Facing Mathematics Teachers in Using Abacus in the Teaching and Learning Mathematics

The third objective of this study was to find out that, there are many challenges faced by mathematics teachers in using Abacus in the teaching and learning mathematics in the primary school curriculum in Kasipul Division Rachuonyo South Sub-County. In exploring this challenges construct, items were drawn relating to concepts that are important components of the Abacus challenges considered in this research. They were 'Yes' and 'No' item type questions, in which respondents choose either of the two as indicated below.

All these challenges were attributed to low quality of academic and professional training among teachers, observed by 48.5% (156) of the respondents interviewed.

Table 4.8. Independent Samples Test Results.

Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Upper	Lower
Equal variances assumed Score	.487	.486	-1.871	234	.043	-8.21146	4.38936	-16.85916	.43625
Equal variances not assumed			-1.845	123.14	.048	-8.21146	4.45160	-17.02303	.60011

Table 4.9. Challenges Facing teachers in the Use of Abacus (n=321).

ITEM	Yes	No
I have the challenge of time of using Abacus in class.	54.89	45.11
I don't have adequate knowledge and skills to use Abacus.	47.23	52.77
I find it difficult arranging and organizing groups in class while using Abacus.	32.33	67.67
Children in my class find learning abstract when using Abacus.	27.66	72.34
I find it difficult to choose a topic using Abacus.	17.83	82.17
I find it difficult to teach concepts using Abacus to meet the needs of all learners.	42.13	57.87
I find it difficult to organize concept to be taught in class using Abacus.	33.62	66.38
I find it difficult linking the topics to be taught in class using Abacus.	36.05	63.95
I find it difficult managing a large class while teaching mathematics using Abacus.	44.68	55.32
I find it difficult using Abacus pedagogy in teaching mathematics using Abacus.	39.15	60.85
My learners find it difficult to acquire appropriate mathematical knowledge, understanding and practice when using Abacus since they do not conceptualize it.	42.13	57.87
I find difficulty in evaluating the learners' work while using Abacus in my class.	39.57	60.43

Source: Author (2014).

Table 4.10 Strategies Teachers Employ using Abacus (n=43).

Rating Scale	1	2	3	4	5
When using Abacus teaching mathematics in class teachers manage their time well.	46.7	0.0	27.8	0.0	25.6
Teachers are trained and have adequate knowledge and skills to use Abacus.	35.6	0.0	0.0	0.0	64.4
While using Abacus teachers arrange and organize groups in class.	57.8	13.9	13.9	0.0	14.4
Using Abacus in mathematics lesson makes teaching and learning easy and enjoyable.	18.9	54.4	0.0	0.0	26.7
Using Abacus allows a teacher to choose relevant topics to teach.	0.0	0.0	0.0	35.6	64.4
Teaching many concepts using Abacus meets the needs of all learners.	0.0	54.4	0.0	0.0	45.6
Teachers organize different concepts to be taught in class using Abacus.	35.6	0.0	0.0	18.9	45.6
Abacus is used to link several mathematical topics taught in class.	0.0	0.0	0.0	0.0	100.0
Improvised Abacuses are used for managing a large class.	68.8	0.0	10.0	6.8	4.4
Abacus pedagogy can be used in teaching several mathematics concepts.	35.6	0.0	0.0	18.9	45.6
Teachers are using Abacus to help many learners acquire appropriate knowledge, understanding, practices and experiences.	26.7	0.0	27.8	0.0	45.6
Abacus can be used to evaluate the learners' work in class so regularly.	35.6	0.0	0.0	0.0	64.4

Source: Author (2014).

4.7. Findings on Strategies on the Effective use of Abacus.

The fourth objective investigated the strategies that could ensure effective use of Abacus in the teaching and learning of mathematics. Findings from the table 4.12 show that majority 20 (46.7%) of the teachers manage their time properly when using Abacus in class as a strategy to improve performance in mathematics despite of 68.8 (30) teachers who used locally improvised Abacus in teaching and learning of mathematics.

From table 4.10, it is clear that, a high percentage of teachers agreed that, they utilize they time well when using abacus as reported by 46.7% (149). Most of the teachers have devised several methods of teaching while using locally improvised Abacus.

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

In this chapter, the findings of the study are summarized. Subsequently, conclusions are made in view of the findings and recommendations proposed following the conclusions.

5.2. The impact of using Abacus for effective teaching and learning of primary mathematics curriculum

The finding shows that, using Abacus helps learners to develop creative and innovative thinking in solving mathematical problems. The finding also indicated that, using Abacus motivates learners to develop high speed in calculation when solving mathematical problems as was observed by mathematics teachers who participated in the study.The finding also revealed that, use of Abacus makes learners become accurate in solving mathematical problems which was supported by teachers. There are numerous benefits of using Abacus in teaching mathematics as indicated by the findings.

5.3: Conclusion

Teachers expressed positive desire towards the use of Abacus in teaching mathematics. Therefore, teachers should endeavour to learn and apply new skills and teaching methods that spur success.

5.4. Recommendations

In view of the above conclusions, the following recommendations have been made:

1. Head teachers should organize for inductions and in-service courses for their mathematics teachers on the use of Abacus. 2. The Ministry of Education (MOE) should organize for seminars, workshops and exhibitions for mathematics teachers to gain more skills and knowledge on the effectiveuse of Abacus. 3. The (MOE) should provide enough teaching and learning resources including Abacus. 4.

The Kenya Institute for Curriculum Development (KICD) should infuse more the use of Abacus in the primary school curriculum, closely linking concepts and objectives in teaching of different topics.

5.5. Suggestions for further research

From the study findings, the following areas are suggested for further research:

1.Role of head teachers on the effective teaching of mathematics using Abacus in public primary schools. 2. The role of parents in public primary schools on the effective teaching and learning of mathematics using Abacus 3.The role of quality assurance and standards officers on supervision, implementation and evaluation on the effective teaching and learning of mathematics in public primary schools using Abacus 4.The impact teacher professional and academic qualification in the use of Abacus in teaching and learning mathematics.

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Appendix A: KASIPUL MAP