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Teachers' Perceptions of Their Preparedness to Integrate Information Communication and Technology in Secondary School Mathematics Instruction in Rift Valley Region, Kenya

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Abstract
Policy makers are increasingly focusing on professional development of teachers as a means of improving teaching. Success in learning mathematics is determined by individual's ability not only to read and write, but also to frame and solve complex problems and continually learn new skills. The education system in Kenya is increasingly being asked to provide learners with the skills needed to compete in an increasingly complex international market place. For this to be achieved teachers are an integral part of children's intellectual and social development. Therefore they must know how to teach in ways that help learners reach high levels of competence. A national profile of teacher quality is a necessary tool for tracking our progress towards this goal. In Kenya the students' performance in mathematics at Kenya Certificate of Secondary Education has been dismal over the years and studies have been carried out on students to establish the cause of this failure. Limited research has been carried out to establish whether teacher preparedness influence performance. In this study the researcher sought to address mathematics teachers' perception of their preparedness to integrate ICT in secondary school mathematics Instruction. The study applied an *ex post facto* research (causal comparative design) which was seen to be appropriate since the researcher could not manipulate the independent variable. There is a population of 1500 mathematics teachers in Rift Valley Province. A sample of 300 mathematics teachers drawn from secondary schools in Rift Valley Province participated in the study. The participants were selected using systematic random sampling and stratified random sampling (stratified by qualification and gender). The data was collected using self-report questionnaire. The instruments were pilot tested and reliability coefficient was found to be 0.83, which is above the required threshold value of 0.70 Cronbach alpha in social science research. The collected data was analysed using both descriptive (means) and inferential statistics (ANOVA and t-test) to establish differences in teacher perception of their preparedness to teach secondary school mathematics by Teaching Experience, qualification and Gender. The hypotheses were tested at 0.05 Alpha (α) level. The findings of this study show that teachers perceive themselves to be less prepared to Integrate ICT secondary school mathematics instructions. The findings indicated that there was a statistically significant difference in teachers' perception to integrate ICT in secondary mathematics instruction however there was not statistically significant difference by qualification and gender. The findings are expected to inform policy makers on how to include ICT in both pre-service and in-service teacher training programmes.
Key words: Teachers' perceptions, ICT, Preparedness, Instruction, Mathematics

1.0 Background to the study

Mathematics is known to be of great practical value in scientific and technological fields. The knowledge of mathematics as a tool for use in everyday life is important for the existence of any individual and society (Gibbs & Mutunga, 1999; Githua, 2002). Mathematics takes a significant position in human civilization; it is a medium of social functions in our everyday world (Mondoh, 1994). Ngala (2005) points to the fact that during the training of mathematics and science teachers, the relevance of the subjects needs to be emphasised. He also affirms the need to train interested and committed mathematics and science teachers in effective use of ICT so that these can be applied in schools. Technology is changing in the workplace the home and daily life. Mathematics knowledge is shifting as technology emerges (Suydam, 1990). For a country to compete effectively in the digital world, beginning teachers need to play an important role in integrating computer technology into the curriculum (Magliaro, 2007). The role of ICT in the school classroom is becoming increasingly prominent, both because of the need for children to develop skills that will empower them in modern society and because of the potential value of such technologies as tools for learning. One of the challenges facing teacher educators is how to ensure that graduate teachers have the necessary combination of skills and pedagogical knowledge that will enable them to both effectively use today's technologies in the classroom as well as continue to develop and adapt to new technologies that emerge in the future (Gill & Dalgarno, 2008). The use of technology would encourage facilitative teaching which leads to self-initiated learning.

Keong, Horani and Daniel (2005) in their study on the use of ICT in mathematics teaching reported that teachers use word processing packages, spreadsheets, search engines and presentation packages. They however noted that there was need for teachers to learn to use instructional software such as Java, Amplets, Flash presentation, Graphical applications and simulation programs, which have great potential to encourage exploration and higher order thinking. Teachers' attitudes towards computers play a major role in the successful use of computers in the classroom (Huang & Liaw, 2005; Clark 2001; & Halpin 2002).

Education systems around the world are under increasing pressure to use ICT to teach knowledge and skills learners need in the 21st century. ICT tools have the potential to transform the nature of education; where and how learning takes place and the roles of students and teachers in the learning process (Newhouse, 2002). ICT provides an array of powerful tools that may help in transforming the present isolated, teacher centred and text-bound classrooms into rich, student focused, interactive knowledge environment. Computer integration in the classroom is the application of technology to assist, enhance and extend students knowledge. Teachers do not necessarily need to learn about technology; they need to learn how to use technology to enhance their learners' understanding and critical thinking skills. McNamara (2004) in his study on mathematics teachers learning on the incorporation of ICT in their teaching reported that the development of teachers' pedagogical expertise with ICT was characterised by personalisation. The participating teachers perceived and used the potential of ICT applications in different ways according to their personal view of what an application was capable of and how it could be incorporated into the classroom practice. McNamara's findings indicate that ICT use was found by some teachers to be rewarding in terms enhancing pupils' enjoyment of the lesson and obtaining good results. Muriithi (2005) points out that in Kenya like most developing countries ICT usage is still limited to computer literacy training. The present ICT curriculum merely deals with 'teaching about computers' and not how computers can be used to transform the teaching and learning process in our schools. "Being digital fluent" means not only knowing how to use the technological tools but also knowing how to construct things of significance with those tools. Mathematics Association (2002) identified six ways in which ICT can be used in teaching and learning mathematics.

Learning from feedback: The computer often provides fast and reliable feedback which is non-judgmental and impartial. This can encourage students to make their own conjectures and to test out and modify their ideas.

Observing patterns: The speed of computers and calculators enables students to produce many examples when exploring mathematical problems. This supports their observation of patterns and the making and justifying of generalizations.

Seeing connections: The computer enables linking of formulae, tables of numbers and graphs readily during teaching and learning. Changing one representation and seeing changes in the others helps students to understand connections between them.

Working with dynamic images: Students can use computers to manipulate diagrams dynamically. This encourages them to visualize the geometry as they generate their own mental images.

Exploring data: Computers enable students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis.

Teaching' the computer: When students design an algorithm (a set of instructions) to make a computer achieve a particular result, they are compelled to express their commands unambiguously and in the correct order; they make their thinking explicit as they refine their ideas.

Research done in Canada showed that in-service and pre-service mathematics teachers believe that they are not adequately trained and often are not given appropriate tools to implement educational technology in their classrooms (Hardy, 2003). Bauer (2000) indicated that even though teachers have formal training in instructional technology, most new teachers have limited knowledge on integrating computer technology into their professional practice and curriculum. It has been observed that even in situations where teachers have been trained in the use of ICT, the integration of these technologies in teaching has been weak due to absence of systems management support, lack of ownership by the school, lack of integration into existing curriculum and textbooks, teacher overload and lack of incentives and motivation, lack of ICT based materials that are interactive for teachers to use and shortage of personnel. The absence of policies and management support to the use of ICT in schools is hindering the progress of the use of ICT in the classroom (Omwenga, Waema & Wagacha, 2004).

Albion (1999) indicates that the focus on information technology in education has shifted towards curriculum integration. Consequently teacher education programmes needs to prepare graduates for teaching with IT. Graduates should posses skills in the use and integration of IT into teaching and learning. Ferbar and Trkman (2003) reported that the use of information technology for mathematics education offers students the choice of pathways to acquire knowledge. They however indicated that the main limitation to full utilization of IT in education can be teacher inexperience in using computers and the internet and limited support for teachers to

learn how to use technology to develop enriching learning experiences for students (Woerner, Rivers & Vockel, 1991; McNamara 2004). The use of the internet in teaching is easier because one can include practical examples and project work. This enhances the usefulness of mathematics which in turn increases other positive effects such as clarity, motivation and interest. In a study on the effect of computer assisted instruction in teaching mathematics on a sample of prospective teachers showed that students who work co-operatively out performed those who worked individually.

Jimoyiannis (2010) describe the various parts that make up technological pedagogical content knowledge;

Pedagogical Content Knowledge: The includes pedagogical strategies and techniques, representation and formulation of scientific concepts, knowledge of what makes those concepts difficult or easy to learn, knowledge of students' misconceptions, prior knowledge or cognitive difficulties, knowledge of students' theories of epistemology etc.

Technological Content Knowledge: Incorporates issues of how science subjects are transformed by the specific technological environments. For example, the changes in the nature of science technology brings, new methods and tools used to solve science problems, modelling methods in science, the use of simulation software in physics etc..

Technological Pedagogical Knowledge: Includes the knowledge of how technology can support specific pedagogical strategies in the classroom; for example, fostering inquiry or collaborative learning.

This study set out to establish the state of preparedness of secondary school mathematics teachers in Rift Valley Region, Kenya. The study used self- report questionnaire with a reliability coefficient of 0.83 Cronbach alpha. The questionnaire collected information on teachers' perception of their preparedness to apply ICT in secondary school mathematics instruction.

1.1 Methodology

This study involved 300 secondary school mathematics teachers who were randomly selected from a population of 1500 teachers in Rift Valley province, Kenya. The study applied an Ex-Post study research, causal comparative design. The purpose of the study was to establish whether there were differences in teachers' perception of their preparedness to apply ICT in mathematics lessons by teacher characteristics. The teacher characteristics were teaching experience, qualification and gender. To test for differences in teachers' perception of their preparedness to use ICT in mathematics lesson by teaching experience and qualification Analysis of Variance was used, while t-test was used to establish differences by gender.

1.2 Findings and Discussion

The current study was to establish the differences in teachers' perception of their preparedness to apply ICT in mathematics instruction. The following hypotheses guided the study;

H_o1: There is no statistically significant differences in mathematics teachers' perception of their preparedness to effectively teach secondary school mathematics using ICT by teaching experience

H_o2: There is no statistically significant differences in mathematics teachers' perception of their preparedness to effectively teach secondary school mathematics using ICT by teacher qualification

H_o3: There is no statistically significant differences in mathematics teachers' perception of their preparedness to effectively teach secondary school mathematics using ICT by gender

1.2.1 Teachers' Perception of Their Preparedness to Effectively Teach Secondary school Mathematics Using ICT by Teaching Experience

Table 1 shows the mean scores of teachers' perception of their preparedness to teach secondary school mathematics with ICT. The mean scores show how prepared teachers are to apply ICT in their lessons to teach various topics/activities in mathematics lessons.

Table 1: Descriptive Results Showing Teachers' Perception of Their Differences to Teach Secondary School Mathematics with ICT

	N	Mean	SD
Use calculators to demonstrate mathematics principles.	297	4.0236	1.02475
Use computers to demonstrate mathematics principles.	299	2.5786	1.26770
Use computers to simulation and applications	297	2.4007	1.24570
Use calculators/computers for mathematics learning games.	298	2.7752	1.27384
Use computers to collect and analyse data.	297	2.7845	1.33585
Use the internet in your mathematics for general reference.	295	2.5153	1.35987
Use the internet in your mathematics teaching for data acquisition.	296	2.4561	1.32182
Use the internet in your mathematics teaching for collaborative projects with classes/individuals in other schools.	298	2.2752	1.30453

The results of Table 1 shows that are not adequately prepared to use ICT in teaching mathematics. Te results show that teachers are only prepared to use calculators to demonstrate mathematical principles. Teachers are not prepared to use the other ICT tools such as the internet, Computer simulations among others listed in Table 1.

1.2.2 Differences in Mathematics Teachers' Perception of Their Preparedness to Effectively Teach Secondary school Mathematics Using ICT by Teaching Experience

Table 2 gives the descriptive results on teacher preparedness to use ICT in their mathematics lessons. The table provides the mean scores and standard deviation based on teaching experience.

Table 2: Descriptive Results Showing Teachers' Perception of their Preparedness to Use ICT in Mathematics Lessons by Teaching Experience

Teaching Experience	N	Mean	SD
Below five years	106	2.9585	.88739
five to ten years	90	2.6636	1.02836
Eleven to Fifteen years	47	2.5314	.92951
Over fifteen years	54	2.5769	1.00547
Total	297	2.7322	.97117

The findings indicate that the teachers are fairly prepared to apply ICT to teaching and learning of mathematics in secondary school with an overall mean score of 2.73points out of the maximum score of five. The results however show that teachers' perception of preparedness decreases with increasing teaching experience. These show that ICT being a fairly new field, only the new graduates in the field have been trained to apply these tools in their lessons.

Table 3 gives a report on differences on teachers' preparedness to use ICT in their mathematics lesson by teaching experience. The difference is tested at $\alpha \leq 0.05$level of significance. The groups involved based on experience include; those with below five years teaching experience, five to ten years, eleven to fifteen years and over fifteen years teaching experience.

Table 3: Difference in Mathematics Teachers' Perception of their Preparedness to Effectively Teach Secondary School Mathematics Using ICT by Teaching Experience

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9.051	3	3.017	3.272	.022
Within Groups	270.128	293	.922		
Total	279.179	296			

Critical values $F_{(df=3,293,\ \alpha=0.05)} = 2.60$

The findings shows that the calculated F (3.272) is higher than the critical value of F (2.60) at $\alpha = 0.05$ level of significance. These show that there is a statistically significant difference in the teacher preparedness to apply ICT in their lesson by teaching experience. The results show that there is little application of ICT in secondary school mathematics lessons in Kenya, yet the benefits from the use of ICT are enormous. McNamara (2004) reported that ICT was seen by mathematics teachers as rewarding in terms of enhancing pupils' enjoyment in the lesson and addressing difficulties students had with abstract concepts. Kiboss (2011) also reported that use of electronic mediated instructional programs have the potential of boosting students development of factual knowledge as well as their conceptual understanding of procedural skills. The null hypothesis that states that there is no statistically significant difference in teachers' perception of their preparedness to use ICT in

secondary school mathematics lessons by experience is therefore rejected at $\alpha = 0.05$, level of significance.
Table 4 shows the Post Hoc analysis on teachers' preparedness to apply ICT to teaching of mathematics. The results provided clearly show which particular groups differ significantly. The groups involved based on experience include; those with below five years teaching experience, five to ten years, eleven to fifteen years and over fifteen years teaching experience.
Table 4: Post Hoc Results with LSD Showing the Pairs of Groups that Differ Significantly in Teachers' Perception of their Preparedness to Use ICT in Mathematics Lessons by Experience

(I) Teaching experience	(J) Teaching experience	Mean Difference (I-J)	Sig.
Below five years	five to ten years	.29491*	.033
	Eleven to Fifteen years	.42717*	.012
	Over fifteen years	.38161*	.018
five to ten years	Below five years	-.29491*	.033
	Eleven to Fifteen years	.13226	.445
	Over fifteen years	.08669	.600
Eleven to Fifteen years	Below five years	-.42717*	.012
	five to ten years	-.13226	.445
	Over fifteen years	-.04556	.812
Over fifteen years	Below five years	-.38161*	.018
	five to ten years	-.08669	.600
	Eleven to Fifteen years	.04556	.812

Critical values $F_{(df = 293,\ \alpha = 0.05)} = 3.84$

The findings indicate that there is a statistically significant difference between the teachers of below five years teaching experience and those of more than five years teaching experience. These findings suggest that the older teachers never went through training on the use of ICT and therefore are not in a position to successfully apply the technology in their lessons. This also indicates that there is a need to in-service teachers who have been in the teaching profession long on new research findings and tools of instruction. This findings concurs with the findings of Keong et al (2005) who reported that mere than half (56.8%) of the respondents in their study did not receive any professional training in ICT and 33.3% requested to be trained on how to integrate ICT in mathematics instruction. Newhouse (2002) reports that ICT have a potential to transform the nature of learning, where and how learning takes place and roles students and teachers in the learning process. The present study show that there is limited use of ICT in mathematics classrooms which confirms Muriithi (2005) concern that, in Kenya ICT use is still limited to computer literacy training. There is need therefore for teacher training institutions in Kenya to train both in-service and pre-service teachers on ICT integration in their lessons.

1.2.3 Differences in Mathematics Teachers' Perception of Their Preparedness to Effectively Teach Secondary school Mathematics Using ICT by Qualification

Table 5 present the findings for teachers' preparedness to apply ICT to mathematics teaching based on their qualification. The table provide the mean scores and standard deviation of each category of qualification. The groups involved are teachers with following qualification; Diploma, first degree graduates and those with post graduate qualifications.
Table 5: Descriptive Results Showing the Mean Scores of Teachers' Perception of their Preparedness to Use ICT in Mathematics Lessons by Teacher Qualification

Teaching Experience	N	Mean	SD
Post graduate qualification	27	2.9259	.97706
Bachelors degree	194	2.7203	.96691
Diploma	77	2.6424	.96287
Total	298	2.7188	.96631

The findings indicate that teachers are fairly prepared to use ICT in mathematics lessons with an overall mean of 2.72 points out of the expected maximum of five points. The findings indicate that the of preparedness increases

with increasing qualification. The results show that teachers with post graduate qualification are more prepared to apply ICT in their lessons followed by the Bachelors degree holders and finally the diploma teachers with mean scores of 2.92, 2.72 and 2.64 respectively. These results suggest that teachers with higher qualification perceive themselves to be more prepared to use apply ICT in mathematics lesson. This agrees with the findings of Ogbonnaya (2007) and Cohen and Hill (2001) who reported that students of teachers with higher qualification performed well in mathematics.

Table 6 gives a report on whether the differences are statistically significant at $\alpha = 0.05$ level of significance. The groups involved are teachers with following qualification; Diploma, first degree graduates and those with post graduate qualifications.

Table 6: Difference in Mathematics Teachers' Perception of their Preparedness to Effectively Teach Secondary School Mathematics Using ICT by Qualification

	Sum of Squares	df	Mean Square	F
Between Groups	1.608	2	.804	.860
Within Groups	275.719	295	.935	
Total	277.327	297		

Critical values $F_{(df=2,295,\ \alpha = 0.05)} = 3.00$

The findings show that the calculated value of F (0.860) is less than the critical value of F (3.00) $\alpha = 0.05$ level of significance; hence, there is no statistically significant difference by teacher qualification. The null hypothesis that states that there is no statistically significant difference in teachers' perception of their preparedness to effectively use ICT in secondary school mathematics lessons is therefore retained. These results suggest that there is a need for secondary school mathematics teachers to be trained on ICT use in their lessons. This can be achieved by both pre-service programs and in-service programs providing a course on ICT application to mathematics instruction.

1.2.4 Differences in Mathematics Teachers' Perception of Their Preparedness to Effectively Teach Secondary school Mathematics Using ICT by Gender

Table 7 gives the descriptive results of teachers' perception preparedness to effectively teach secondary school mathematics with ICT. The results give the means scores and standard deviation of each gender.

Table 7: Descriptive results showing mathematics teachers' perception of their preparedness to effectively teach secondary school mathematics using ICT by gender

Gender	N	Mean	SD
Male	229	2.7352	.99255
Female	69	2.7169	.89899

The results indicate that teachers from both groups are fairly ready to apply ICT in teaching secondary school mathematics. It is however shown that the mean score of the male teachers (2.74) is slightly higher than that of female teachers (2.71).

Table 8 gives the differences in teachers' perception of their preparedness to apply ICT to their teaching by gender. A t-test for equality of means is used to establish the difference in teachers' perception of their preparedness to use ICT in mathematics instruction by Gender.

Table 8: The T-Test Results to Show the Differences in Teachers' Perception of Their Preparedness to Teach Secondary School Mathematics with ICT by Gender

	N	t	df	Sig. (2-tailed)
Equal variances assumed	298	.137	296	.891
Equal variances not assumed	298	.145	122.208	.885

Critical values $t_{(df = 296,\ \alpha = 0.05)} = 1.645$

The findings show that the calculated value of t (0.137) is lower than the critical value of t (1.645) and $\alpha \leq$ 0.05level of significance. These show that there is no statistically significant difference in teachers' perception of their preparedness to apply ICT in the teaching of secondary mathematics. The null hypothesis that states that there is no statistically significant difference in teachers' perception of their preparedness to effectively teach secondary school mathematics with ICT is therefore accepted.

1.3 Recommendations

From the findings of this study it is clear there is a statistically significant difference in teachers' perceptions' of their preparedness to apply ICT in secondary school mathematics instruction by teaching experience however there was no difference by teaching experience and gender. Based on the findings of the study the following recommendations are made for education policy makers and researchers.

i. There is need to launch an in-service training for mathematics teachers on the integration of ICT in their lessons in particular on the application of available instructional software.
ii. There is need for Universities and teacher training colleges to launch a course on programming so that both pre-service and in-service teachers will gain skills on developing and applying instructional programs.
iii. A quasi-experimental study needs to be carried out where teachers are trained on the use of ICT in their classes and establish their effectiveness in teaching compared to those who apply conventional approach to teaching.

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