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TEACHERS' PEDAGOGICAL KNOWLEDGE IN INTEGRATION OF INFORMATION COMMUNICATION TECHNOLOGY AND STUDENTS' PERFORMANCE IN MATHEMATICS IN PUBLIC SECONDARY SCHOOLS IN MAKUENI COUNTY, KENYA

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ABSTRACT

Introduction: In many nations, the use of information and communication technology (ICTs) in and for education is increasingly growing, and it is now widely recognized as both a need and an incentive to develop and improve the education provided to people around the world.

Purpose: The intend of this study was to establish the relationship between teachers' pedagogical knowledge in ICT integration and students' performance in Mathematics in public secondary schools in Makueni County, Kenya.

Methodology: The study used correlation research design. The target population was 251 principals, 407 mathematics teachers and 14,752 form three students, giving a total of 15,410 respondents. The study sample consisted of 25 principals, 42 mathematics teachers, and 375 students. The researcher used questionnaires for mathematics teachers, interview schedules for principals and focus group discussions for students. Cronbach's alpha was used to determine the reliability of the questionnaire, giving a correlation coefficient of 0.939. Quantitative data was analyzed using descriptive and inferential statistics, while qualitative data was categorized into themes and thematically analyzed.

Results: The findings revealed a significant relationship between teachers' pedagogical knowledge in ICT integration and students' performance in Mathematics.

Recommendations: The study recommends that mathematics teachers should choose appropriate technologies to incorporate in their teaching methodologies in the actual classroom to enrich what they teach, how they teach, and what students learn.

Keywords: Integration, Knowledge, Pedagogy, Technology

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PUBLIC INTEREST STATEMENT

The authors learnt that many teachers were not integrating Information Communication Technologies (ICTs) while teaching Mathematics, a factor that contributed to poor performance in the subject in national examinations. This study is significant since the authors wanted to find out whether indeed there was any relationship between integration of ICTs and performance in mathematics. The results of the study wanted to inform the Ministry of Education of the poor performance as one of reasons why many students do not enroll in science-oriented courses at the university entry level and hence the need to take the necessary remedial measures.

INTRODUCTION

Teachers' thorough understanding of the methods and procedures of teaching and learning is referred to as pedagogical knowledge (PK). Understanding how students think, general student management skills, curriculum preparation, and student evaluation are also examples of general knowledge. Understanding the cognitive, social, and developmental theories of learning and how they relate to students in the classroom is necessary for pedagogical knowledge (Hardman, 2015). ICTs are widely used in schools in developing countries, and the belief that underpins their use is that they improve student outcomes, especially in mathematics. However, how a computer is used as a learning and teaching instrument, and how the computer influences pedagogical activities, determines the degree to which Information Communication Technologies (ICTs) can do this (Li & Ma, 2011; Hardman, 2015). Kaffash, Kargiban, and Ramezani (2010) found that using ICT in the classroom helped students to master abstract reasoning abilities that could not be measured by simple standard assessments, and that ICT inclusion in mathematics was expected to help students gain concrete skills and be more analytical in their test answers.

Argentin, Comi, Gui, Origo, and Pagan (2015) conducted research in secondary schools in Italy to determine the impact of ICT-related teaching activities on student achievement. Argentin et al. (2015) compared data on standardized test metrics of 10th-grade student success with a specific student-teacher data set containing a broad variety of ICT-related factors on both ICT awareness and ICT-using teaching activities. According to the data, ICT-related teaching activities improved student success as they assisted the teacher in obtaining additional content for his or her lectures or channeled the dissemination of teaching materials used, and raised students' knowledge of ICT. The research also discovered a beneficial impact of ICT when used in conjunction with communication-enhancing activities. Instead, only activities involving a more involved presence of students in class in using ICT were found to have a detrimental impact. As a result, ICT seemed to have a significant effect on the learning process of education by including innovative opportunities for students and teachers, which had an impact on academic success and achievement. The gap in the previous studies was that returns of education using ICT are changing and students are acquiring new skills and new competencies. This implies that the performance of students must deal more with ICT topics and less with knowledge of specific topics and curricula.

In Ghana, Agyei and Voogt (2012) used Technological Pedagogical Content Knowledge (TPACK) as a structure for pre-service teachers' professional development to incorporate technology into the teaching of Mathematics and Science, respectively. In Tanzania, Kafyulilo, Fisser, and Voogt (2014) used TPACK as a framework for pre-service teachers' professional development to integrate technology into the teaching of Mathematics and Science. In terms of Pedagogical Knowledge (PK), a study by Agyei and Voogt (2012) found that in a country like Ghana, access to software is restricted, and classes are typically high. As a result, they wanted to add spreadsheets, which were a widely

accessible software, to pre-service Mathematics teachers. Pre-service teachers created Mathematics lessons that included spreadsheets and used an activity-based learning style that was appropriate for big classes.

Several studies in sub-Saharan Africa, especially Tanzania, indicate that secondary school teachers should be competent in the use of ICT as a pedagogical method for the teaching and learning process (Nihuka & Voogt, 2011; Bingmlas, 2009). In South Africa, research on the impact of ICTs on pedagogy is somewhat contradictory, with three distinct results reported: first, research indicates that ICTs do not alter pedagogy (Cassim, 2010); second, a body of work suggests that ICTs change pedagogy positively (Bosamia, 2013); and finally, research contradicting this finding suggests that ICTs negatively affect pedagogy (Bosamia, 2013). (Hardman, 2015; Baker, 2019).

Mbugua, Kibet, Muthaa, and Nkonge (2012), discovered that problem solving is an endeavor that mathematics teachers must focus on, which this study expressed by ICT incorporation in teaching pedagogy. Integration of ICT in Mathematics education, according to Ogwel (2008), necessitated a re-examination of the curriculum and a move away from a results-oriented pedagogy. As a result, incorporating ICT into Mathematics instruction was said to help students by encouraging them to learn, especially in situations where tasks were demanding, multi-disciplinary, and multi-sensory. It has had the benefit of simplifying philosophical ideas to real-life scenarios, encouraging inquiry and discovery, and allowing students to use what they had learned to solve new problems rather than create new ones (GoK, 2006). As a result, in the sense of this research, teachers' pedagogical knowledge in ICT will help improve students' subject knowledge and acquisition, thus improving their success.

In Kenya, research findings of a study carried out by Kamau (2014) on factors related to technology adoption revealed that secondary school mathematics teachers lacked technology skills. The study also revealed that technology training was low and the time to complete the syllabus and prepare technology-enhanced lessons inhibited teachers' decisions to adopt technology in teaching. This study showed that despite many years now since the introduction of ICT policy in 2006, it seems that what is stated is only paper work and has not been achieved since the level of competence of teachers on the use of ICT as a pedagogical tool was still low and it is on this premise that one may say that ICT integration in teaching in Kenya is not a common practice in many secondary schools. In the study area, ICT may have been integrated, but little has been done to establish the extent and impact of the technological ability of teachers in the integration of ICT on the performance of students in mathematics in national exams. This study shed more light on this.

Teacher's perception is another important aspect of integration of ICTs in the teaching of Mathematics in schools. In Australia, teachers' perceptions of their technological skills (Forgasz, 2006) and their views on the usefulness of ICTs for classroom instruction have been shown to be powerful predictors of the intended and implemented use of these tools (Stols & Kriek, 2011). Although technology has the potential to enhance learning and teaching in Mathematics classrooms (Dawson, Heathcote, & Poole, 2010), ICT tools are often employed on low-level tasks such as online practice that have no significant bearing on student learning outcomes in Mathematics (Cavanagh & Mitchelmore, 2011). Nuruland Zaleha (2008) also identified the attitudes and beliefs of teacher trainees on the math technological pedagogical content knowledge (TPCK) elements. Studies on Pedagogical Content Knowledge (PCK) and integration of ICT in education either quantitatively or qualitatively were seen more towards showing that the technology is part of a pedagogical tool in education. However, this knowledge should be generated along with the content and pedagogical knowledge.

Therefore, several TPACK-related scales have been designed to examine teachers' perceptions of integrating technology, content and pedagogy in areas such as internet use (Lee & Tsai, 2010), pre-service education (Schmidt, et al., 2009), online distance education (Archambault & Crippern, 2009), and science education (Graham et al., 2009). ICT based learning could change students' perception or attitude that Mathematics is a difficult subject because ICT integration could open an opportunity where students and teachers may access a variety of information relevant to solving specific learning difficulties, exposure to more tests and a varied type of questions which the teacher couldn't be able to give to the learners in class. It was therefore found important to understand the concepts in mathematics rather than just follow steps and get satisfied with getting the right answers. This thought was shared by Tsai (2012), who was of the opinion that problem-solving approach in students' collaboration through ICT medium could help students be more confident and more involved in the learning context and in their courses.

The Ministry of Education in Kenya in collaboration with partners developed the Kenya Education Sector Support Programme (KESSP), where ICT featured in 2005 as one of the priority areas identified in this sector programme. With the development and approval of the Ministry's policy through the sessional Paper No. 1 of 2005, entitled 'A Policy Framework for Education, Training and Research' and the approval of the National ICT Policy in 2006, this strategy became a vehicle through which policy objectives can be achieved. This strategy gives a snapshot of what is required for ICTs not only to have an impact in reducing the digital divide but also as a tool for curriculum delivery and learning (MoE, 2006), mathematics included.

Integration of ICTs in education in Kenya is well articulated in the recent Odhiambo report (2012) that led to the Sessional Paper No. 14 of 2012 on reforming education and training sector in Kenya. Both sessional papers provide a policy framework within which the integration of ICTs or modern tools in teaching and learning is to take place in various regions and areas in Kenya. The largest volume of research on the effect of technology use in core subject areas has been conducted on Mathematics instruction. Mathematics instruction also has the longest history of using technology for instructional purposes and boasts several impressive systems (Ungerleider & Burns, 2002).

Various Kenyan education reports show that Mathematics as a subject at secondary level is wide in content and may not be covered adequately within the recommended time frame (KIE, 2005). The results of the national examinations at the form four level, which is the culmination of the Kenya Secondary School Certificate of Secondary Education (KCSE), released by the national examination body, the Kenya National Examinations Council (KNEC), continue to show poor performance in mathematics (KNEC, 2020). This study found that integrating technology into the mathematics curriculum could solve the above-cited problems. It was not clear to what extent Mathematics teachers in Makueni County incorporate pedagogical expertise into their teaching of Mathematics through technology, a gap that this study bridged.

STATEMENT OF THE PROBLEM

Poor mathematics performance among students in public secondary schools in Makueni County has been a major concern for stakeholders in the Ministry of Education. It has demotivated students, caused anxiety among parents, and denied students enrolment in science-oriented courses at the university. It is noted that schools in an attempt to improve performance in the subject, have taken measures such as remedial teaching for low-achievers, guidance and counseling, and encouraging teachers to integrate ICT in their teaching. Teachers' incorporation of ICT into their teaching pedagogies has the ability to accelerate, enrich and enhance abilities, to inspire, and involve students in learning activities for longer durations of time, to assist

them in connecting school experiences to job practices, to promote cooperative learning and support different forms of engagement, and to improve teaching and learning. Despite the significant role that ICT integration plays in education, little is known about the degree to which teachers incorporate ICT and how it relates with students' performance in national examinations in Mathematics, which this study sought to establish. Past Mathematics KCSE results in Makueni County show a major variation compared to the national performance in the subject. Therefore, this study investigated the relationship between teachers' pedagogical knowledge in ICT integration and student performance in mathematics in public secondary schools in Makueni County.

PURPOSE OF THE STUDY

1. Assess teachers' level of pedagogical skills in ICT integration in the teaching of mathematics
2. Establish the relationship between teachers' pedagogical knowledge in ICT integration and performance in mathematics
3. Investigate how teachers' pedagogical knowledge in ICT integration impact on mathematics performance in public secondary schools in Makueni county

RESEARCH QUESTIONS

1. What pedagogical knowledge do teachers possess towards integration of ICT in the teaching of mathematics?
2. To what extent can teachers' pedagogical knowledge to integrate ICT in teaching mathematics influence students' performance in secondary schools in Makueni County?
3. What is the impact of teachers' pedagogical knowledge in ICT integration on mathematics performance in public secondary schools in Makueni County?

HYPOTHESIS

1. There is no statistically significant relationship between teachers' pedagogical knowledge in ICT integration and performance in Mathematics

RESEARCH METHODOLOGY

Research Design

This study adopted the correlation research design. According to Lavrakas (2008), a correlation study is crucial for finding out the relation between variables. Investigations carried out in the past disclosed that the correlational research design unveils a linkage that enables inferences to be made pertaining the causal relationships, and it empowers the researcher to amass more data as opposed to doing experiments (Levin, 2006). In this respect, the correlational research design permitted the researcher to assess the connection between ICT integration and students' performance in Mathematics in public secondary schools of Makueni County, Kenya.

Population and Sample

The target demography was 251 principals, 14,752 from three students, and 407 mathematics teachers, giving a total of 15,410 respondents. The overall sample size for this study was a total of 442 respondents, that is, 375 students, 25 secondary school principals and 42 Mathematics teachers. A sample of 10% was considered appropriate for principals and mathematics teachers for the correlation research (Gay, 1992). To sample the students, the study was guided by the sampling table (Krejcie & Morgan, 1970). Table 1 shows the distribution of the target population and sample sizes for the principals, mathematics teachers and students per sub-county.

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Table 1: The Distribution of Target Population and Sample Size

Sub-county	No. of Schools	No. of Principals		No. of Teachers		No. of Students	
		Population	Sample	Population	Sample	Population	Sample
Nzaui	45	45	4	75	8	2657	68
Makueni	46	46	5	78	8	2806	71
Kibwezi	51	51	5	86	9	2907	74
Mukaa	42	42	4	72	7	2352	60
Makindu	31	31	3	40	4	1593	40
Mbooni	36	36	4	56	6	2437	62
Total	**251**	251	**25**	407	**42**	14752	**375**

The researcher purposively sampled the secondary school principals and mathematics teachers since the interest was in getting specific respondents that bear attributes that can achieve the study objectives (Orodho, 2004). The study stratified the schools into National, Extra-county and Sub-county categories and then adopted simple random sampling to select the students from each of the strata. This was done to enable the respondents have an equal chance to participate in the study. Additionally, due to their large number, this guarded against wild samples and ensured that no sub-population was omitted from the sample (Orodho, 2004). Finally, the number of students in each stratum was proportionately sampled according to the population size from each category.

Instruments for Data Collection

The researcher obtained research permits from the relevant institutions and personally collected data from the schools sampled. First, the researcher informed school principals in advance of the intended study and made familiarization visits to the research area to determine the availability and accessibility of the respondents. This ensured that he developed a close relationship with the respondents for easy administration of the research instruments. During data collection, from each of the schools sampled, the researcher explained the purpose of the study and then personally administered the teacher questionnaire (TQ), conducted interviews with the principals and conducted focus group discussions with the students. Once the questionnaires had been sent to the teachers, the filled questionnaires were collected by the researcher at an agreed later date. The return rate for the questionnaires was 81%. The academic performance in Mathematics was obtained by including the mean scores in Mathematics for both first and second terms respectively.

Methods of Data Analysis

The study yielded quantitative data obtained using questionnaires and qualitative data generated from focus group discussions and interview schedules. Quantitative data was analyzed using descriptive statistics which included frequencies, percentages, mean and variance; and this was based on the study objectives. Statistical Package for Social Sciences (SPSS) computer software version 23 was used as a tool for data analysis. Quantitative data collected through questionnaires was analyzed by first editing and then coding and inputting the coded responses into the computer for analysis. Other tests carried out included analysis of variance (ANOVA) statistics that were used to compare the significant differences in means between the various groups in the study. Qualitative data was categorized into themes and thematically analyzed.

RESULTS

Research Question 1: What pedagogical knowledge do teachers possess towards integration of ICT in the teaching of Mathematics?

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Table 2: Teachers' Pedagogical Knowledge in ICT Integration

Statement	1	2	3	4	5	Mean	SD
I can critically analyze my teaching in relation to theoretical principles	-	23.5%	29.4%	47.1%	-	3.24	0.8
I can provide the mathematical input to the target at an appropriate level.	2.9%	26.5%	20.6%	47.1%	2.9%	3.21	1.0
I can select authentic mathematical resources to suit student needs	5.9%	20.6%	35.3%	32.4%	5.9%	3.12	1.0
select activities which enhance the learners' inter-cultural awareness	9.1%	30.3%	48.5%	12.1%	-	2.64	0.8
Choose an appropriate approach to teach Mathematics to learners	2.9%	14.7%	14.7%	61.8%	5.9%	3.53	0.9
I can plan when and how to use the target language	5.9%	38.2%	44.1%	11.8%	-	2.62	0.8
I can identify mathematical problems experienced by learners.	14.7%	5.9%	5.9%	58.8%	14.7 %	3.53	1.3
I can design Mathematics courses around the requirements of the curriculum.	11.8%	41.2%	35.3%	5.9%	5.9%	2.53	1.0
I am aware of the contextual factors that inhibit/promote Mathematics	17.6%	14.7%	20.6%	41.2%	5.9%	3.03	1.2
I am aware of current research in the field of Mathematics teaching	21.2%	48.5%	18.2%	12.1%	-	2.21	0.9
Can experiment with different methods of teaching mathematics.	23.5%	26.5%	5.9%	41.2%	2.9%	2.74	1.3
TOTAL	**10.5%**	**26.4%**	**25.3%**	**33.8%**	**4.0 %**	**2.94**	**1.0**

Key: Strongly disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly agree (5), Standard Deviation (SD)

Table 1 shows that teachers could critically analyze their teaching in relation to theoretical principles (M=3.24, SD=0.8), teachers could provide target mathematical input at an appropriate level of difficulty (M=3.21, SD=1.0) and that teachers could select authentic mathematical resources to suit student needs (M=3.12, SD=1.0). The findings also showed that mathematics teachers could select activities which enhance the learners' inter-cultural awareness (M=2.64, SD=0.8), they could as well choose an appropriate approach to teach Mathematics to learners (M=3.53, SD=0.9) and could plan when and how to use the target language, including meta-language they needed in the classroom (M=2.62, SD=0.8).

The study further revealed that teachers could identify mathematical problems experienced by learners (M=3.53, SD=1.3), teachers could also design Mathematics courses around the requirements of the curriculum (M=2.53, SD=1.0) and were as well aware of the contextual factors that could inhibit/promote Mathematics teaching (M=3.03, SD=1.2). It was also revealed that teachers were aware of current research in the field of Mathematics teaching (M=2.21, SD=0.9) and teachers were willing to experiment with different methods of Mathematics teaching (M=2.74, SD=1.3). The teachers agreed that they were successful in selecting a suitable approach to teaching Mathematics to learners with a variation of (0.9), and they were also successful in finding mathematical problems encountered by learners with a variation of (1.3), but they performed poorly in their knowledge of recent studies in the

field of Mathematics teaching. Hardman (2015) stated that pedagogical experience necessitates an interpretation of cognitive, social, and developmental theories of learning and how they relate to students in the classroom in relation to theoretical concepts that promote the learners' intercultural awareness.

The degree to which ICTs can achieve success, according to Li and Ma (2011), depends on how a computer is used as a learning and teaching tool: that is, how the computer influences pedagogical activities. As a result, mathematical classes must be built around the curriculum's specifications. Kaffash, Kargiban, and Ramezani (2010), on the other hand, found that the use of ICT in learning (pedagogy) led to mastery of abstract cognitive abilities that could not be assessed by clear standard examinations, and thus ICT incorporation in Mathematics was predicted to cause students to develop concrete skills and be more analytical in their test answers. Secondary school students, according to Nihuka and Voogt (2011), should be proficient in the use of ICT as a pedagogical instrument in the teaching and learning process. Pedagogical interface agents such as machine aided social learning and presented computer simulations to construct an immersive learning environment (Kizlikaya & Askar, 2008). Their research found that when these were used to teach, the students received immediate guidance and inspiration, learning more and faster and remembering more when a test was presented than the control group. Therefore, teachers with pedagogical skills can provide quick feedback and encouragement to students, allowing them to learn better and faster and recall more when a test is given.

Research Question 2: To what extent can teachers' pedagogical knowledge to integrate ICT in teaching Mathematics influence students' performance in secondary schools in Makueni County?

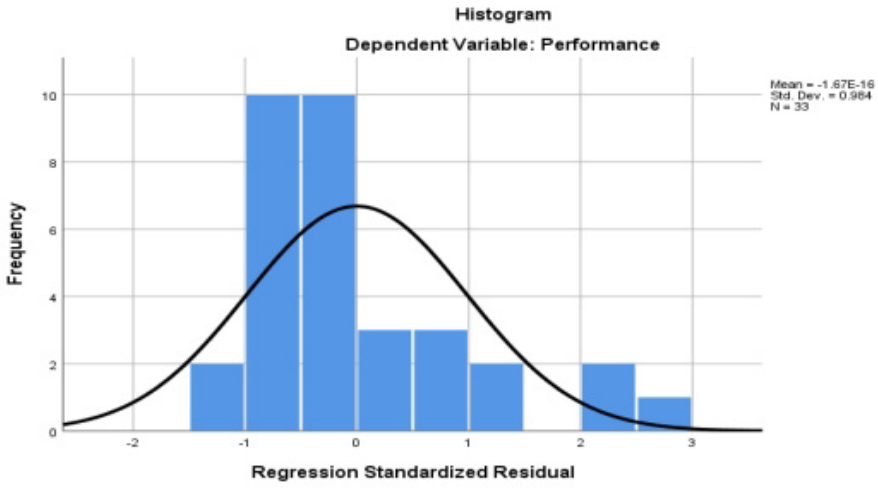

Figure 1: Distribution of Teachers' Pedagogical Knowledge in ICT and Performance

As shown in Figure 1, the average score (Mean, M) was (M=1.67) attained by students in mathematics (data given by a total of 33 teachers), with a standard deviation SD of (0.98) from the first term and the second term as a result of teachers' pedagogical knowledge in ICT. As presented in the Figure 1, the score of mathematics performance was normally distributed.

Research Question 3: What is the impact of teacher pedagogical knowledge in ICT integration on mathematics performance in public secondary schools in Makueni County?

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Table 3: Academic Performance in Terms of Mean Score

Performance	Mean score for the first term	Second Term Mean Score	Mean Score
Mean	3.3727	3.5060	3.4394
Standard Deviation	1.2499	1.2627	1.2563
Minimum	1.7120	1.9230	1.8175
Maximum	6.5670	6.7230	6.6450

As shown in Table 3, the average performance in Mathematics was a mean score of 3.4394 equivalent to D with a variation of 1.26 from the mean; the best score was a mean score 6.5670 equivalent to C+ and the poorest mean score was 1.7120, equivalent to D- From Table 5, schools whose teachers integrated ICT into their teaching had higher mean scores compared to their counterparts who did not.

Hypothesis 1: There is no statistically significant relationship between teachers' pedagogical knowledge in ICT integration and performance in Mathematics

Table 3: Relationship between Teachers' Pedagogical Knowledge in ICT and Performance in Mathematics.

		Performance	Pedagogical Knowledge
Performance	Pearson Correlation	1	.145
	Sig. (2-tailed)		.421
	N	33	33
Pedagogical Knowledge	Pearson Correlation	.145	1
	Sig. (2-tailed)	.421	
	N	33	33

**Correlation is Significant at the 0.01 Level (2 tailed).

The findings in Table 3 show the measure of the strength and direction of association that existed between the two variables. The findings revealed that there was a slight positive correlation between the pedagogical knowledge of teachers in ICT and the performance r (33) =.145, ���<.421) with 33 degrees of freedom at a confidence level of 99%, but without statistical significance. A p-value (probability value) of (.421) was above 0.05 alpha and therefore did not have statistical significance. This meant that there was only a 5% probability that the outcomes of the two factors, teachers' pedagogical expertise in ICT and Mathematics performance, were due to chance. The study was 99 percent confident and assured that the finding parameters fell between a series of values of a certain degree of confidence, as shown by the confidence level.

Table 4 presents model summary for regression analysis for teachers' pedagogical knowledge in ICT and performance in Mathematics.

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Table 4: Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.145[a]	.021	-.011	1.274

a. Predictors: (Constant), Pedagogical Knowledge
b. Dependent Variable: Performance

The findings of the model summary in Table 4 show that performance in Mathematics in public secondary schools in Makueni County were explained by 2.1% of the variability on pedagogical knowledge in ICT integration (R^2=.021) while the rest of the issues that determined the performance in Mathematics could be explained by other factors**.**

DISCUSSIONS

The current study revealed that Mathematics teachers could critically analyze their teaching in relation to theoretical principles, could provide target mathematical input at an appropriate level of difficulty and that they could select authentic mathematical resources to suit students' needs. The findings of this study conform with those of Hardman (2015) which established that pedagogical knowledge necessitates an understanding of cognitive, social, and developmental theories of learning and how they apply to students in the classroom in relation to theoretical principles that enhance learners' inter-cultural awareness, and that teachers could choose authentic Mathematics resources.

The findings also showed that Mathematics teachers could select activities which enhance the learners' intercultural awareness, they could as well choose an appropriate approach to teach Mathematics to learners, and they could plan when and how to use the target language, including metalanguage they needed in the classroom. The extent to which ICTs can achieve performance, according to Li and Ma (2011), is determined by how a computer is used as a learning and teaching tool: that is, how the computer influences pedagogical practices and how students plan when and how to use the target language, including meta-language, in the classroom. Mathematics teachers according to Li and Ma (2011), can choose activities that improve students' inter-cultural awareness. As a result, Mathematics courses must be built around the curriculum's needs.

The study further revealed that teachers could identify mathematical problems experienced by learners, teachers could also design Mathematics courses around the requirements of the curriculum and were as well aware of the contextual factors that could inhibit/promote Mathematics teaching. According to Kaffash, et al (2010), the use of ICT in learning (pedagogy) contributed to mastery of complex cognitive skills that could not be determined by simple standard tests, and thus ICT integration in Mathematics was expected to lead to students acquiring concrete skills and being more analytical in their test responses. Kaffash, et al (2010) went on to say that instructors were able to recognize mathematical issues that students were having and were also aware of the contextual variables that might hinder or enhance Mathematics instruction.

It was also revealed that teachers were aware of current research in the field of Mathematics teaching and were willing to experiment with different methods of Mathematics teaching. Secondary school teachers should have competency in the use of ICT as a pedagogical tool for teaching, according to Nihuka and Voogt (2011), because teachers should be aware of current research in the field of Mathematics teaching and willing to experiment with different methods of Mathematics teaching. The teachers agreed that they succeeded in choosing an appropriate

approach to teach mathematics to learners, they also succeeded in identifying mathematical problems experienced by learners but they performed poorly in the awareness of current research in the field of mathematics teaching. Kizlikaya and Askar (2008) observed that pedagogical interface agents, such as software assisted social learning and presented computer simulations to create an interactive learning environment. Other researchers gave conflicting reports regarding the effect of ICTs on pedagogy, with three distinctly different results reported: first, the research indicates that ICTs do not alter pedagogy (Cassim, 2010); second, a body of work suggests that ICTs change pedagogy positively (Bosamia, 2013) and finally contradicting this finding, there is research suggesting that ICTs negatively impact on pedagogy (Hardman, 2015; Baker, 2019). But at the end, Tamim, et al. (2011) indicated that computer technology that supports instruction of mathematics is more effective than technology that offers direct instruction and these point to the importance of the pedagogical basis of ICT use.

The qualitative findings of the interviews conducted with the principals are in agreement with the study results in Table 2. A principal from Mukaa Sub-county when interviewed had this to say:

> *Some teachers have a higher level of technological competencies than pedagogical competencies in ICT.*

A principal, from Makindu Sub-county, was asked to state whether Mathematics teachers in his school had ICT skills and knowledge, and he had this to say:

> *Majority of teachers have sufficient ICT skills for everyday and routine working practices though many of them have difficulties in finding a meaningful integration of ICT into teaching and learning due to challenges related to limited timeframes and lack of necessary ICT infrastructure.*
>
> *Majority of teachers have undergone "one-off training" and lack the ongoing exposure to ICT. Few teachers have broad expertise in using ICTs in their teaching.*

Principals were asked to state whether they were able to evaluate the extent to which the development of TPACK by teachers and how critical it was to effectively teach Mathematics with technology. The principals had this to say:

> *I was able to asses and evaluate development of TPACK by teachers and realized that some teachers demonstrated more strategic instructional planning skills using ICT technologies upon completion of the training programs organized by the school* (Principal, Kibwezi Sub-county). *If teachers were to teach Mathematics using technology, they needed to have knowledge in ICT, give students a sample of questions and get them to formulate answers on the topic chosen, have background knowledge and level comfort his/her students have with the technology being used* (Principal, Nzaui Sub-county).
>
> *Teachers who had undergone training demonstrated better understanding of planning inquiry based activities. Scenario based (lesson observation) seemed promising in examining changes in teachers' planning and problem solving skills with technology. The challenges however being limited time frames. The method is however compatible with the conceptual framing of TPACK as it attempts to examine TPACK from a holistic perspective, considering the interaction between the knowledge domain in a specific classroom context* (Principal, Mukaa Sub-county)
>
> *TPACK provides a dynamic framework for viewing teachers' knowledge necessary for the design of curriculum and*

instructions focused on the preparation of their students for thinking and learning mathematics with technologies and hence boosting students' performance in the subject (Principal, Makindu Sub-county).

Therefore, teachers with pedagogical skills can provide quick feedback and encouragement to students, allowing them to learn better and faster and recall more when a test is given.

CONCLUSION

Understanding cognitive, social, and developmental theories of learning and how they relate to students in the classroom in relation to theoretical concepts that improve learners' inter-cultural sensitivity is needed for pedagogical knowledge. How a computer is used as a learning and teaching instrument, and how the computer influences pedagogical activities, determines the degree to which ICTs can achieve success. As a result, mathematical classes must be built around the curriculum's specifications.

RECOMMENDATIONS

Based on the findings and conclusions of the study, the following recommendations were made:

1. The Ministry of Education in collaboration with the Teachers Service Commission (TSC) should organize ICT training sessions for teachers to make a technology-integrated curriculum a reality.
2. Teachers should adopt a variety of technologies to assist students in pursuing their education goals and enable them to become active participants in a Mathematics class.
3. Teachers should choose suitable technologies to use in the classroom that improve what they teach, how they teach, and what students learn, and ensure that they teach lessons that correctly blend mathematical ideas, instructional methods, and mathematics culture.
4. To improve their pedagogical skills, teachers should recognize mathematical problems that students face, plan Mathematics courses around the curriculum's specifications, and be mindful of contextual considerations that can hinder or encourage the instruction of Mathematics.

Conflict of Interest

The authors declare no conflict of interest.

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Disclaimer Statement

The journal article has been generated from 1 objective of the author's Thesis, currently under examination, as a prerequisite for graduation. The title of the Thesis is "Relationship between Teachers' Integration of ICT and Students' Performance in Mathematics in Public Secondary Schools in Makueni County, Kenya", presented to the Department of Educational Management, Policy and Curriculum Studies in Kenyatta University, Kenya.

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Francis Nzoka drafted the manuscript, collected, analyzed and interpreted data.

Ephantus Kaugi validated the data collection instruments and proofread the manuscript. Moreover, he assisted in the interpretation and discussion of the study findings.

Elizabeth Katam formulated the items in the instruments and assisted in the interpretation and discussion of the results.

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