



## FACTORS THAT INFLUENCE TEACHERS' PERCEPTIONS OF INFORMATION COMMUNICATION AND TECHNOLOGY (ICT) IN MATHEMATICS TEACHING IN KENYAN SECONDARY SCHOOLS



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### ABSTRACT

*This study investigated the factors that influence mathematics teachers' perceptions of ICT in mathematics teaching in Kenyan secondary schools. Participants for the study came from a population of mathematics teachers in Nairobi and Nyandarua counties in Kenya. The results revealed that mathematics teachers' perceived roles of ICT in the classroom were positive with a large proportion of teachers agreeing that ICT plays a significant role in the teaching-learning process. Additionally, demographic factors such as age, school type, teachers' educational level, principal's subject major, and so on were significantly related to mathematics teachers' perceptions of the roles of ICT in the classroom. The Internet and ownership of laptop computer were found to be useful in shaping mathematics teachers' perceptions; however, this was not true for the availability of computer labs, technology resources, and location of the school (rural or urban). Additionally, limited time to integrate ICT in the lessons and inadequate ICT training in mathematics related software were found to limit mathematics perceptions of the positive roles of ICT in mathematics teaching. The study recommends that mathematics teachers need to be trained on the relevant mathematics software, be provided with reliable Internet connection, and encouraged to acquire laptop computers for instructional use.*

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**Keywords:** ICT, Factors, Perceptions, Activity theory, Chi-square, Kenya, Mathematics, Teaching.

Received: 21 May 2016/ Revised: 1 August 2016/ Accepted: 26 August 2016/ Published: 8 October 2016

### Contribution/ Originality

This study is one of very few studies which have investigated teachers' perceptions of Information Communication and Technology (ICT) in mathematics education. Limited studies have investigated this research problem in the African context. The study used the Chi-square statistics as a lens of identifying the variables in the study.

### 1. INTRODUCTION

The literature suggests that despite most conditions being met to enable ICT integration in schools, there is a need to establish how certain factors are related to mathematics teachers' perceptions of Information and Communication Technology (ICT) integration in the school contexts. Recent studies suggest that in order to fully

implement ICT in teaching and learning there is a need to consider school contexts (Fauske and Raybould, 2005) where ICT integration is seen not just as a matter of applying ICT tools in abstract situations, but also as mediating meaningful human activities to satisfy individual needs (Demetriadis *et al.*, 2003). This implies that in school contexts teachers may develop perceptions about the uses of ICT in the classroom as they evaluate how it may or may not benefit them and the students in teaching and learning, respectively. As such this study integrated the Activity Theory to examine the inter-link between the several dynamics within the school context and teachers' perceptions about the uses of ICT tools in the classroom.

Research shows that ICT integration in schools is a complex phenomenon that is influenced by many dynamics such as the ICT tools, teachers, students, educational curriculum, and school culture (e.g. (Lim, 2002; Tezci, 2011)). It is within this context that Engeström (1987) proposed the concept of Activity Theory, which is based on the activity system as the basic unit. Under the activity system, Lim (2002) explained that all human activity is a conceptualization between the interactions of the following elements: the subject—the target under study, the object—the goals, the tools—the ICTs, the community—the human elements, the rules, division of labor, and the outcome.

Researchers using this framework have found that although teachers may understand the benefits of ICT integration in supporting students' learning, teachers face enormous obstacles during this process. Some of these obstacles may include limited knowledge in choosing worthwhile tasks, a lack of time to integrate ICT in their lessons due to strict curriculum requirements, a lack of confidence using ICT tools, unfamiliar ICT curriculum, a lack of support from school leadership, a lack of technical support, a lack of elaborate ICT infrastructure (e.g. (Demiraslan and Usluel, 2008; Divaharan and Ping, 2010)) and so on.

To help us understand the Activity Theory in ICT integration, Cole and Engeström (1991) described three interactions emerging in educational contexts resulting from ICT integration. These interactions include those: (1) between the subject and the object, mediated by tools, (2) between the subject and the community, mediated by rules, and (3) between the object and the community, mediated by the division of labor. In addition, between any of these two elements there are *contradictions*, which Engeström (1987) considered as obstacles to successful attainment of the goals of the activity system. However, according to Engeström (1987) these contradictions can be useful in understanding the activity system, and can eventually be utilized to make corrections to the system.

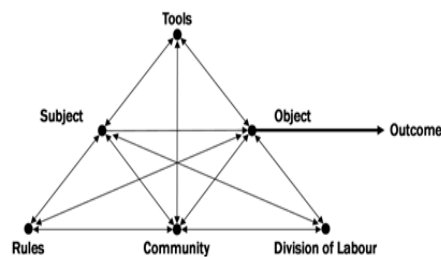


Figure-1. Activity System Diagram (Engeström, 1987)

Therefore the current study will examine the factors related to the mathematics teachers' perceptions about the roles of ICT in the classrooms. The current study will also establish whether teacher demographics, ICT training, school support, and barriers to ICT integration influence mathematics teachers' perceived roles of ICT in mathematics teaching.

## 2. RESEARCH QUESTIONS

1. Is there a relationship between the barriers to ICT integration, availability of ICT resources, knowledge of ICT, and ownership of ICT devices and mathematics teachers' perceived roles of ICT in teaching?

2. Is there a relationship between mathematics teachers' demographics and mathematics teachers' perceived roles of ICT in teaching?
3. Is there a relationship between ICT training and mathematics teachers' perceived roles of ICT in teaching?
4. Is there a relationship between teacher collaboration and mathematics teachers' perceived roles of ICT in teaching?
5. Is there a relationship between school support in ICT integration and mathematics teachers' perceived roles of ICT in teaching?

### 3. SIGNIFICANCE OF THE STUDY

This study provides a way to understand the factors that shape mathematics teachers' perceptions of the role of ICT in the classroom. Drawing on Activity Theory the study may provide teachers, schools, and the ministry of education with the best strategies and remedies for teachers to successfully implement ICT mathematics classrooms, particularly in the developing countries. The findings may also significantly contribute to the body of knowledge in the field of mathematics education literature about ICT integration in teaching and learning mathematics.

### 4. METHODS AND MATERIALS

A cross-sectional survey was conducted to collect quantitative data for this study. Researchers using this research design collect sample data within a short period of time to describe some larger population (Babbie, 1990). Creswell (2008) pointed out that cross-sectional survey design has an advantage of measuring practices, and provides information within a short period of time, unlike longitudinal survey design, which may take many years to complete.

#### 4.1. Participants

This study consists of mathematics teachers from public secondary schools in the Republic of Kenya from Nairobi County and Nyandarua Counties. We selected samples for this study using random sampling procedures. Forty secondary schools were selected where 135 mathematics teachers were asked to complete survey questionnaires between March and June 2013.

#### 4.2. Survey Instrument

The survey instrument consisted of 28 questions categorized into three sections. The first section (section A) asked mathematics teachers how often they integrated ICT and their ICT innovation decision processes. Section B consisted mainly of questions related to factors that influenced them to integrate ICT in the classroom, and section 3 consisted of socio-demographic questions.

#### 4.3. Data Analysis

We applied Chi-square statistical analysis procedures to analyze the data. The assumptions were checked and met (sample size greater than 20 with each cell's expected value greater than 5). The Fishers Exact test was integrated to arbitrate where Chi-square test failed to meet the expected value of 5 for each cell. In addition, descriptive statistics was used to report the findings of the study. The following section reports the results of the statistical analysis based on the research questions set for this study.

### 5. RESULTS AND DISCUSSION

**Research question-1.** *Is there a relationship between the barriers to ICT integration, availability of resources, knowledge of ICT, ownership of ICT devices, and mathematics teachers' perceived roles of ICT in the classroom?*

The results showed that teachers were greatly limited by the lack of computerized textbooks (63%), computerized curriculum (57%), lack of ICT support in classrooms or labs (53%), lack of ICT enhanced classrooms

(47%), and a lack of current software and hardware (45%). On the other hand, a large proportion indicated that the fear of students' accessing inappropriate materials on the internet (28%), time to learn ICT (19.6%), and time to integrate ICT (21%) did not limit the integration of ICT in their teaching.

The results indicated the following ICTs were the most frequently available to teachers: Microsoft Office (65.5%), computer labs for the students (65.4%), the Internet (60.9%), and instructional facilities (not ICT) (52.9%). The following were the most limited ICT resources: ICT equipped classrooms (66.4%), dynamic statistics software (65.6%), graphing calculators (61.4%), dynamic geometry software (61.3%), and a computer algebra system (55.7%).

The results indicated that the amount of time required to integrate ICT was related to mathematics teachers' perceptions about the compatibility of computers and teaching practices ( $\chi^2(1, N = 119) = 6.11, p < .05$ ). Mathematics teachers who indicated that time was a limiting factor in the integration of ICT agreed that ICT fit well with the way they liked to teach (91.5%) when compared to the mathematics teachers who were not limited by time (52.2%). This implies that a large proportion of teachers who planned to integrate ICT in mathematics teaching indicated that time were a limiting factor. This finding is consistent with what we already know from the literature about limited time for teachers to integrate ICT in their lessons. Other barriers did not indicate a relationship on mathematics teachers' perceptions of the roles of ICT in the classroom, implying a 50-50 agreement.

The results showed that knowledge of graphing calculators was related to mathematics teachers' perceptions that ICT fits with the way they liked to teach. The teachers who were knowledgeable with a graphing calculator (90.5%) agreed that ICT fit with the way they liked to teach when compared to those who were not knowledgeable (64.8%) ( $\chi^2(1, N = 112) = 5.306, p < .05$ ). This result suggests that other mathematical software did not fit with the way mathematics teachers liked to teach. This finding may need to be considered with caution because mathematics teachers could have referred to the scientific calculators used by the students in Kenyan secondary schools. In addition, ownership of a laptop computer or mini-laptop was associated with mathematics teachers' perception that ICT helps accommodate student learning of critical concepts ( $\chi^2(1, N = 106) = 6.126, p < .05$ ). The results showed that a higher proportion of mathematics teachers who owned a laptop computer or a mini laptop (90.5%) agreed that ICT helps accommodate student learning of critical concepts when compared to the mathematics teachers that did not own a laptop computer (72.1%). These results indicate that personal ownership of ICT may indeed improve teachers' perceptions about the roles of ICT in mathematics teaching.

The findings revealed that there was a relationship between ownership of laptop computers and mathematics teachers' perceived roles of using ICT in mathematics teaching. A larger proportion of mathematics' teachers who owned a laptop indicated that ICT improves students' learning of critical concepts compared to teachers who did not own a laptop computer. Further, the findings showed that availability of computers at schools and computer labs did not have any influence on mathematics teachers' perceived objective of ICT in the classroom.

Lastly, the results indicated that there was no significant relationship between availability of ICT in schools and the way teachers perceived integration of ICT in the classroom. This confirms what we already know that the availability of ICT in schools may not be related to ICT integration in the classroom (Cuban *et al.*, 2001).

**Research question 2.** *Is there a relationship between mathematics teachers' demographics and mathematics teachers' perceived roles of ICT in the classroom?*

**Age.** Age was significantly related to mathematics teachers' perceptions that ICT promotes the development of communication skills ( $\chi^2(1, N = 122) = 5.261, p < .05$ ). Mathematics teachers aged between 20 and 40 years (87.3%) agreed that ICT promotes the development of communication skills when compared to the mathematics teachers aged between 41 and 60 years (70.6%). Age was also related to mathematics teachers' perceptions that ICT fit well with the way they liked to teach ( $\chi^2(1, N = 115) = 14.876, p < .001$ ). Those aged between 20 and 40 years (85.1%) agreed that ICT fit well with the way they liked to teach compared to mathematics teachers aged between 41 and 60 years (52.1%). Lastly, age was related to mathematics teachers' perception that ICT enhances their professional development ( $\chi^2(1, N = 119) = 6.909, p < .05$ ). Mathematics teachers aged between 20 and 40 years

(94.2%) agreed that ICT enhances their professional development when compared to the mathematics teachers aged between 41 and 60 years (78%). Therefore, there is evidence to suggest that younger mathematics teachers were most likely to perceive ICT in the classroom as beneficial to the students when compared to older teachers.

**School type.** The results indicated that school type was related to mathematics teachers' perceptions of the roles of ICT in the classroom. Mathematics teachers from the national and county schools (91.3%) agreed that ICT gives teachers opportunities to be learning facilitators instead of information providers when compared to the mathematics teachers from district or community schools (78.6%) ( $\chi^2(1, N = 122) = 3.885, p < .05$ ). The results also showed that a higher proportion of mathematics teachers from the national and county schools (90.1%) agreed that ICT promotes the development of communication skills when compared to mathematics teachers' from district and community schools (76.2%) ( $\chi^2(1, N = 123) = 4.298, p < .05$ ). There is evidence to suggest that mathematics teachers from the national and county schools were likely to perceive ICT as a useful tool for the teachers and students compared to teachers from the district and community schools.

**Education level.** The findings indicated that the educational level of mathematics teachers was related to the perceived roles of ICT in mathematics teaching. First, the result indicated that a higher proportion of mathematics teachers with university degrees (89.5%) agreed that ICT could be learned by students on their own, and outside of school when compared to the mathematics teachers who had no university degree (57.1%) ( $\chi^2(1, N = 123) = 15.391, p < .001$ ). Second, the results showed that a higher proportion of mathematics teachers with a university degree (86.3%) agreed that ICT promotes students' collaboration skills when compared to mathematics teachers with no university degree (66.7%) ( $\chi^2(1, N = 122) = 5.492, p < .05$ ). Lastly, the results showed that mathematics teachers with a university degree (87.3%) agreed that ICT promotes the development of communication skills when compared to mathematics teachers with no university degree (70.6%) ( $\chi^2(1, N = 122) = 5.261, p < .05$ ).

**Teaching position.** The results indicated that the type of teaching position held by mathematics teachers influenced their perceptions of the integration of ICT in mathematics teaching. The results showed that a higher proportion of mathematics teachers employed by school boards (e.g. BOM teachers) (94.3%) agreed that ICT promotes students' collaboration when compared to the TSC mathematics teachers (78.3%) ( $\chi^2(1, N = 118) = 4.462, p < .05$ ).

**Class size.** The findings indicated that class sizes taught by mathematics teachers were related to their perceptions of ICT integration. The proportion of mathematics teachers who taught classes of more than 40 students (89.4%) agreed that ICT increases students' achievement when compared to the mathematics teachers with fewer than 40 students (73.7%) ( $\chi^2(1, N = 123) = 4.973, p < .05$ ). This was a surprising result because we expected teachers handling smaller classes would perceive that ICT could increase students' academic achievement.

**Principal's subject major.** School's principal subject major was related to mathematics teachers' perceived roles of ICT integration in mathematics teaching. First, the results indicated that mathematics teachers whose principal was a math/science major (88.6%) agreed that ICT promotes students' collaboration when compared to the mathematics teachers whose principal's subject major was in the arts (72.9%) ( $\chi^2(1, N = 118) = 4.77, p < .05$ ). Second, the results showed that a higher proportion of mathematics teachers whose principal was a math/science major (91.5%) agreed that ICT increased students' achievement when compared to the mathematics teachers whose principal was in the arts (75%) ( $\chi^2(1, N = 119) = 6.11, p < .05$ ). Third, mathematics teachers whose principal's subject major was in math/science (91.4%) agreed that ICT gives teachers opportunities to be learning facilitators instead of information providers when compared to the mathematics teachers whose principal's subject major was in the arts (77.6%) ( $\chi^2(1, N = 119) = 4.533, p < .05$ ). Clearly, mathematics teachers who taught in schools where the school principal was in math/science perceived technology as beneficial to the students learning.

The findings suggest that mathematics teachers seem to agree that the role of ICT in the classroom is beneficial to them and to the students. However, these results revealed that age and education level have some influence on mathematics teachers' perceived roles of ICT in mathematics teaching. For instance, a large proportion of younger

teachers perceived ICT as beneficial to them, in terms of professional development and compatibility with the way they taught, in addition to developing students' communication skills compared to older teachers. These findings are not surprising because younger teachers are associated with more usage of ICT compared to older teachers (e.g. Ocak (2005)).

**Research question 3.** *Is there a relationship between ICT training and mathematics teachers' perceptions of the roles of ICT in the classroom?*

This table reveals that 26.9% of mathematics teachers were not trained in Internet skills compared to Microsoft Office (29.6%) and mathematics software application (73.2%). This section will discuss the relationship between training on these ICTs and teachers' perceived roles of ICT in mathematics teaching.

**Word.** Training in Microsoft word was related to the mathematics teachers' perceptions of ICT in mathematics teaching. First, the results showed a higher proportion of mathematics teachers with some training in Microsoft word (84.8%) agreed that ICT promotes the development of communication skills when compared to mathematics teachers who had no training in Microsoft word (65.4%) ( $\chi^2(1, N = 118) = 4.861, p < .05$ ).

**Table-1.** Frequency of ICT Training for some ICT Tools (percentages)

ICT Tools	None	Roughly Once a term	Appr. once a month	About once a week	Nearly daily
1. Word (or equivalent software)	23.6	30.1	17.1	10.6	18.7
2. PowerPoint (or equivalent software)	32.5	35.5	15	10	6.7
3. Excel (or equivalent software)	32.8	33.6	6.9	9.5	.9
4. Graphing Calculators	65.8	9.9	12.6	2.7	9.0
5. Dynamic Statistics Software	80.7	8.8	6.1	2.6	1.8
6. Dynamic/Interactive Geometry Software	76.1	11.5	9.7	2.7	0.0
7. Computer Algebra Systems	70.5	11.6	11.6	1.8	4.5
8. The Internet	26.9	12.6	17.6	13.4	28.6
9. Interactive Whiteboards	73	13.5	7.2	1.8	4.5

Source: Data analysis results

Second, mathematics teachers who had training in Microsoft word (87.9%) agreed that ICT could be learned by students on their own, and outside of school when compared to the mathematics teachers who had no training in Microsoft Word (63%) ( $\chi^2(1, N = 118) = 4.482, p < .05$ ). Third, the results showed that mathematics teachers with some training in Microsoft Word (78.4%) agreed that ICT was compatible with the way they liked to teach when compared to mathematics teachers who had no training in Microsoft Word (47.8%) ( $\chi^2(1, N = 111) = 8.473, p < .05$ ). Fourth, the results showed that a higher proportion of mathematics teachers with some training in Microsoft word (93.3%) agreed that ICT enhanced their professional development when compared to mathematics teachers who had no training in Microsoft word (68%) ( $\chi^2(1, N = 115) = 11.744, p < .05$ ).

**PowerPoint.** The results also showed that training in PowerPoint was related to mathematics teachers' perceptions of students' learning. First, mathematics teachers with some training in PowerPoint (87%) agreed that ICT promotes students collaboration when compared to mathematics teachers who had no training in PowerPoint (71.1%) ( $\chi^2(1, N = 115) = 4.342, p < .05$ ). Second, a higher proportion of mathematics teachers who had training in PowerPoint (93.6%) agreed that ICT was a valuable instructional tool when compared to the mathematics teachers who had no training in PowerPoint (78.9%) ( $\chi^2(1, N = 116) = 5.505, p < .05$ ). Third, mathematics teachers who had training in PowerPoint (87.2%) agreed that ICT could be learned by students on their own, and outside of school when compared to the mathematics teachers who had not training in PowerPoint (71.1%) ( $\chi^2(1, N = 116) = 4.482, p < .05$ ). Lastly, mathematics teachers who had training on PowerPoint (86.1%) agreed that ICT promotes the

development of students' communication skills when compared to the mathematics teachers who had no training in PowerPoint (67.6%) ( $\chi^2(1, N = 116) = 5.43, p < .05$ ).

**Excel.** There was evidence to show that training in Excel was related to mathematics teachers' perceptions of the roles of ICT in the classroom. The results indicated that mathematics teachers with some training in Excel (80.8%) agreed that ICT was compatible with the way they liked to teach when compared to (56.3 %) ( $\chi^2(1, N = 111) = 5.238, p < .05$ ). Second, mathematics teachers with some training in Excel (94.5%) agreed that ICT makes teachers feel more competent as educators when compared to mathematics teachers who had no training in excel (80%) ( $\chi^2(1, N = 108) = 5.453, p < .05$ ). Third, mathematics teachers with some training in Excel (88%) agreed that ICT promotes the development of students' communications skills when compared to mathematics teachers who had no training in excel (66.7%) ( $\chi^2(1, N = 111) = 7.217, p < .05$ ).

**Mathematical software.** The results indicated that training in mathematical software such as the computer algebra systems (CAS), graphing calculators, dynamic geometry software, and the IWB were related to mathematics teachers' perceptions of the roles of ICT in the classroom. First, the results showed that mathematics teachers with some training in CAS (96.9%) agreed that ICT promotes the development of communication skills when compared to mathematics teachers who had no training in CAS (77.6%) ( $\chi^2(1, N = 108) = 6.004, p < .05$ ). Second, the mathematics teachers who had some training in CAS (90.3%) agreed that ICT fit with the way they taught when compared to mathematics teachers who agreed, but had no training in CAS (63.9%) ( $\chi^2(1, N = 103) = 7.9485, p < .05$ ). Third, the results indicated that a high proportion of mathematics teachers with some training in graphing calculators (97.3%) who agreed that ICT motivates students to get more involved in learning activities when compared to mathematics teachers who had no training in graphing (82.9%) ( $\chi^2(1, N = 107) =, p < .05$ ). Fourth, the results showed a higher proportion of mathematics teachers with some training in the dynamic geometry software (92.6%) agreed that ICT fit with the way they taught when compared to mathematics teachers who agreed, but had no training in dynamic geometry software (64.1%) ( $\chi^2(1, N = 105) = 7.977, p < .05$ ). Lastly, the results showed that a higher proportion of mathematics teachers who had training in IWB (92.6%) agreed that ICT fit well with the way they taught when compared to the mathematics teachers that had no training in IWB (64.4%) ( $\chi^2(1, N = 100) = 7.780, p < .05$ ).

**The Internet.** The results indicated that Internet training was significantly related to mathematics teachers' perceptions of the roles of ICT in mathematics teaching. The results indicated that the proportion of mathematics teachers who agreed that ICT had a positive impact on their teaching and students learning were high compared to when teachers had no training on the internet. I have summarized the Chi-square results as follows: ICT enhanced their professional development ( $\chi^2(1, N = 111) = 15.117, p < .001$ ); ICT gives teachers the opportunities to be learning facilitators instead of information providers ( $\chi^2(1, N = 113) = 4.961, p < .05$ ); ICT makes teachers feel more competent when compared to the mathematics teachers ( $\chi^2(1, N = 110) = 5.451, p < .05$ ); ICT improves students' learning of critical concepts and ideas ( $\chi^2(1, N = 113) = 5.328, p < .05$ ); ICT helps accommodate students' personal learning styles; ( $\chi^2(1, N = 110) = 8.163, p < .05$ ); ICT promotes the development of communications skills ( $\chi^2(1, N = 114) = 8.670, p < .05$ ); ICT motivates students to get more involved in learning activities ( $\chi^2(1, N = 114) = 13.937, p < .001$ ); ICT promotes students collaboration when ( $\chi^2(1, N = 113) = 8.827, p < .05$ ); ICT could be learned by students on their own and outside of school ( $\chi^2(1, N = 114) = 12.616, p < .001$ ); ICT is a valuable instructional tool ( $\chi^2(1, N = 113) = 9.223, p < .05$ ).

However, a more conspicuous result showed that a higher proportion of mathematics teachers who had training on the Internet (81%) agreed that ICT fit well with the way they taught when compared to the mathematics teachers who had no training on the Internet (46.4%) ( $\chi^2(1, N = 107) = 12.255, p < .001$ ). It appears that mathematics teachers who had been trained on the Internet were approximately twice as likely to think that ICT fit well with their teaching styles compared to teachers who had no training on the Internet. These findings are consistent with Whattananarong (2004) findings that Internet-based classroom instruction was more effective compared to traditional

instructional styles in terms of summarizing students' work, referencing sources of students' work and reduced the time of covering topics.

**Research question 4.** *Is there a relationship between collaboration and mathematics teachers' perceived roles of ICT in mathematics teaching?* There was a relationship between collaboration efforts and mathematics teachers' perceived roles of ICT in the classroom. Evidence revealed that teachers who indicated they sometimes collaborated with administration (55.7%) agreed that ICT was compatible with the way they taught when compared to 32.9% who often collaborated with administration and 11.4% who did not ( $\chi^2(1, N = 111) = 10.146, p < .05$ ). There was also evidence that teachers who sometimes or rarely collaborated with teachers in the field (48.1%) agreed that ICT was compatible with the way they taught when compared to those who indicated often (40.5%) and never (11.4%) ( $\chi^2(1, N = 111) = 6.199, p < .05$ ). Lastly, teachers who indicated that they had collaborated with ICT experts sometimes or rarely (57.7%) indicated that ICT was compatible with the way they taught when compared to those who indicated often (32.1%) and never (10.1%) ( $\chi^2(1, N = 110) = 12.795, p < .05$ ). This result indicates mathematics teachers who had collaborated with administration, teachers in the field, and ICT experts agreed that ICT was compatible with the way they taught.

However, collaboration between students, colleagues at school, family, and friends did not reveal any significant relationship. These findings are consistent with those of Demiraslan and Usluel (2008) who found limited collaboration between teachers, students, teachers in the field, and the school administration.

**Research question 5.** *Is there a relationship between school support on ICT integration and mathematics teachers' perceived roles of ICT in the classroom?*

The analysis of the results focused on two parts of the Likert-type scale items that reflected support within the school community (1) my school provides enough opportunities for teachers to meet and share ideas (59.4% agreed), and (2) my school encourages teachers to observe exemplary teachers in ICT-based instruction within or between schools (51.2% disagreed). The result indicated that there was a relationship between the teachers who responded that their schools encouraged teachers to observe exemplary teachers and their perception of ICT integration in the classroom. First, the results indicated that teachers who agreed that their schools encouraged observing exemplary teachers (91.8%) also agreed that ICT increases academic achievement when compared to the teachers who disagreed that their schools support them, and 76.3% agreed that ICT increases academic achievement ( $\chi^2(1, N = 120) = 5.429, p < .05$ ). Second, the results also indicated that teachers who agreed that their schools encourage observing exemplary teachers (89.8%) agreed that ICT helps accommodate students' personal learning styles when compared to the teachers who disagreed that their schools encourage observing exemplary teachers (75.9%) ( $\chi^2(1, N = 117) = 4.027, p < .05$ ). Third, the results also indicated that the teachers who agreed that their schools encourage observing exemplary teachers (84.5%) agreed that ICT was compatible with the way they would teach when compared to teachers who disagreed that their schools encourage observing exemplary teachers (57.9%) ( $\chi^2(1, N = 115) = 9.932, p < .05$ ). Lastly, the results indicated that teachers who agreed that their schools encouraged observing exemplary teachers (96.7%) agreed that ICT enhances their professional development when compared to those who disagreed that their school encouraged observing exemplary teachers (75.9%) ( $\chi^2(1, N = 118) = 10.891, p < .05$ ).

Further results showed no relationship between supporting teachers in terms of providing opportunities for teachers to meet and share ideas about the integration of instructional ICT and mathematics teachers' perceptions on the integration of ICT. This suggested that there was almost a 50-50 agree-disagree relationship between the variables and therefore we cannot tell the difference whether agreeing or disagreeing about school support in terms of opportunities for teachers to meet and share ideas about instructional ICT would result in teachers' agreeing or disagreeing on the integration of ICT. The findings also suggest that schools that support teachers observing exemplary teachers had a high proportion of teachers on average perceived ICT equally useful to them and to the students. In regards to the students' learning, these teachers perceive ICT as a tool that may increase academic



achievement and accommodate students' learning styles. In regards to the teachers' these teachers perceive ICT as compatible to the way they teach, and as a tool for professional development.

These findings reflect those of Divaharan and Ping (2010) who found that when the school principal did not have a clear ICT implementation plan and did not make efforts towards encouraging ICT use in the whole school, teachers' perceived a lack of visible involvement of the principal and hence the teachers did not see the importance of ICT integration in the school curriculum as well as they did not know the expectations since there were no procedures to be followed. Divaharan and Ping suggested that the school principal has to create an awareness, be a role model to teachers, and facilitate the translation of expectations into action during the process of ICT integration.

## 6. DISCUSSION

### 6.1. Subject

The overall findings from this study suggested that mathematics teachers seem to agree that the integration of ICT in the classroom is beneficial to the students and the teachers. However, the results from this study have revealed that age and education level has influence on mathematics teachers' perceived objectives of using ICT in mathematics teaching.

In terms of age/with regard to age, it appears that a large proportion of younger teachers are most likely to perceive ICT to benefit them in terms of professional development and fitting well on the ways they teach, in addition to developing students' communication skills compared to older teachers. These findings are not surprising because younger teachers are associated with more usage of ICT compared to older teachers.

Interestingly, more educated teachers who had university degrees perceived ICT as more beneficial to the students in terms of supporting students to become independent learners, collaboration, and developing communication skills compared to how ICT would benefit them as teachers.

### 6.2. ICT Tools

The finding revealed that there was a relationship between ownership laptop computers and mathematics teachers' perceived objectives of using ICT in mathematics teaching. A larger proportion of mathematics' teachers who owned laptop tools indicated that these ICT improves students' learning of critical concepts compared to teachers who did not own a laptop computer. Interesting findings showed that availability of computers at schools and more so computer labs did not have any influence on mathematics teachers' perceived objective of integrates of ICT. In fact among the barriers that relate to ICT resources, none that had a relationship with the ways mathematics teachers perceive the integration of ICT.

However, training mathematics teachers' on certain technologies had the most profound influence on the way mathematics teachers perceived the integration of ICT in mathematics classroom. The findings indicated that a large proportion of teachers had no training on mathematics software for teachers averaging 73.2%, compared to Microsoft office (30.6%), and the Internet (26.9%). The findings showed that most teachers had training in Microsoft office and the internet when compared to training of mathematical software. There was evidence to show that the teachers who were trained in Microsoft office mostly agreed that ICT was compatible with their teaching style, made them facilitators and not tellers, aided them in professional development, and was a valuable tool. On the other hand these teachers indicated that ICT was useful to the students in making them independent learners, developing communication skills, and collaboration with other students.

On the other hand, training in computer algebra systems (CAS), graphing calculators, dynamic geometry software, and the IWB were related to mathematics teachers' perceptions of objectives of ICT in mathematics classroom. The results that large proportion of mathematics teachers who agreed that ICT fitted well with way they taught and could promote development of students' communication skills had training on CAS. These teachers were most likely referring to GeoGebra online software. The teachers who agreed that they had training on graphing

calculator a large proportion indicated that ICT motivates students' learning while those who had training in IWB a large proportion agreed that ICT fits well they taught. It is discouraging to find that these teachers did not perceive many other benefits on the integration of ICT beneficial to students' learning of mathematics ideas.

Lastly, training of the Internet was related to mathematics teachers' perceptions of ICT integration in classroom teaching. On the side of the students' learning, mathematics teachers who had internet training seemed to agree that ICT had many benefits to students' learning such as promoting independent learning, collaboration with other students, motivation, and students' personal learning styles. On the benefits of ICT to the teacher, these teachers agreed that ICT gives teachers opportunities to become learning facilitators and ICT fitted with the way they taught. It appears that training of the Internet is playing a greater role in promoting mathematics teachers' perceptions on the integration of ICT for students' learning.

The study did not find the lack of computerized textbook computerized mathematics curriculum, and teaching models to have any influence on mathematics teachers' perceptions on the objectives of ICT in mathematics teaching.

### 6.3. Division of Labor

Collaboration efforts between the school administration and ICT experts revealed some relationship on how teachers perceived objectives of ICT in the classroom. The finding indicated mathematics teachers who collaborated with teachers in the field, ICT experts, and the school administration perceived ICT as compatible with the way they taught. It is discouraging that the results did not reveal that collaboration efforts were not related to mathematics teachers' perceived perception that ICT could benefit students learning. This suggests that collaboration efforts is mainly to benefit teachers or teachers collaborate to gain skills and not sharing big ideas about how ICT might help students to learn. These results indicated that collaboration between students and mathematics teachers is limited.

### 6.4. Community

A school community consists of teachers, students, head teacher, heads of departments, teachers outside the school, ministry of education, teacher employer, parents, and so on. In this regard there is evidence that there is a relationship between encouraging teachers to observe exemplary teachers and the perceptions of mathematics teachers on the integration of ICT.

There appears to be unanimous agreement that when schools encourage teachers to observe exemplary teachers integrate ICT, that support is related on teachers' positive perceptions about meeting some of the objectives of ICT in the classroom. These teachers perceive ICT as a tool that would increase students' academic achievement and accommodating students learning styles, and that ICT fits well with the teachers' instructional style and ICT as a tool for professional development. This finding suggest although schools might be encouraging teachers to observe teachers, teachers need to focus more on what they perceive would benefits the students learn mathematics rather than themselves. However, I feel that lack of ICT skills among the teachers makes them look for learning opportunities from experienced to learn basic ICT skills rather than understand how ICT may be integrated for students' learning.

The finding also indicated that the type of schools where mathematics teachers taught had a relationship with the way mathematics teachers' perceived ICT integrates in the classroom. Teachers from national and county schools are likely to perceive ICT as useful to them in terms of changing them to become lesson facilitators and promoting students' communication skills. National and county schools are well equipped with instructional facilities when compared with the district or community schools. In this regard, these findings are as expected, however, the findings are discouraging because there appears teachers' limited perceptions of the benefits of ICT in the classroom.

The teachers' employed by certain groups appeared to have a relationship with mathematics teachers' perceptions of ICT integrate in the classroom. A higher proportion of teachers employed by the parents and the schools board agreed that ICT helps student in collaboration when compared to teachers employed by the ministry of education. This finding was surprising because TSC mathematics teachers are employed and trained by the

government as opposed to PTA teachers who are employed on contract basis and may not be trained. This may suggest that TSC teachers are not adequately trained to integrate ICT in the classroom. At the same time, there is low perceptions of ICT integrates in the classroom from the teachers employed by the two groups of employers.

The number of students in classes was also related to how teachers' perceived ICT integrate in the classroom. The results revealed that a larger proportion of mathematics teachers who taught classes more than 40 students agreed that ICT increases students' academic achievement compared to the teachers who taught less than forty students. This finding suggests that teachers handling classes that have more than 40 students may view the integration of ICT in the classroom as a remedy to the problems of large classes of students.

### 6.5. Rules and Regulations

The roles of schools principals in the implementation of ICT in schools is critical because they foresee every step of this process by ensuring teachers are attending training and teachers are using ICT as required. The findings from the study suggested that principal's subject major is related to the ways teachers perceive ICT as an instructional tool in the classroom. A higher proportion of teachers from schools where school principal's subject major was in mathematics and sciences perceived ICT to play significant role in promoting students' collaboration, increasing students' academic achievement, and enabling teachers to become facilitators of lessons rather other providers of knowledge when compared to teachers from schools where the principle had arts subject major. This suggested that schools where the principal has a math science major, the school and the teachers were likely to lead in ICT awareness and integration efforts most likely because the principal encourages teachers to learn ICT.

## 7. CONCLUSION

The current study revealed that a lack of time inhibited mathematics teachers from using ICT. A large proportion of teachers who agreed that ICT was compatible with the way they taught, also indicated that time was a limiting factor. Time has been mentioned extensively in studies as a limiting factor to ICT integration, such as [Karasavvidis \(2009\)](#).

The findings in this study suggested that mathematics teachers had positive perceptions about utilizing ICT in teaching. This finding is consistent with that of [Tella et al. \(2007\)](#). However, this study revealed that a lack of ICT training significantly altered perceptions on the roles of ICT in the classroom. ICT training was related to how teachers' perceived the benefits of ICT in teaching and learning mathematics. The findings indicated a large proportion of teachers had no training on mathematics software averaging 73.2%, compared to Microsoft office training (30.6%), and Internet training (26.9%). There was evidence to show that teachers who were trained in Microsoft office mostly agreed that ICT was compatible with their teaching style, made them facilitators and not tellers, aided them in professional development, and was a valuable tool. In addition these teachers also indicated that ICT was useful for students in making them independent learners, developing their communication skills, and in collaboration with other students.

Further, training in computer algebra systems (CAS), graphing calculators, dynamic geometry software, and the IWB were related to mathematics teachers' perceptions of roles of ICT in mathematics classroom. A large proportion of mathematics teachers who agreed that ICT fit well with the way they taught, and could promote development of students' communication skills, had training on CAS. These teachers were most likely referring to the GeoGebra online software. A large proportion of teachers who agreed that they had training on a graphing calculator indicated that ICT motivates students' learning, while those who had training in IWB had a large proportion that agreed that ICT fits well with how they taught. It is discouraging to find that these teachers did not perceive many other benefits in the integration of ICT as beneficial to students' learning of mathematics.

Lastly, training of the Internet was related to mathematics teachers' perceptions of ICT integration in classroom teaching. Mathematics teachers who had Internet training seemed to agree that ICT had many benefits for students,

such as promoting independent learning, collaboration with other students, motivation, and tailoring to students' personal learning styles. In addition, these teachers agreed that ICT gives them opportunities to become learning facilitators rather than knowledge providers, and that it fit well with the way they taught. It appears that Internet training plays a significant role in promoting mathematics teachers' perceptions of the integration of ICT for students' learning.

A large proportion of TSC teachers disagreed that ICT helps students to collaborate compared to teachers employed by the board governors and parent associations. This was a contradictory finding from what we expected the study to reveal. In this regard, the training of teachers employed by the government needs to be reviewed.

Teacher characteristics were also related to teachers' perceived roles of ICT integration in mathematics teaching. Younger teachers and teachers with university degrees appeared to be more positive about ICT integration in mathematics teaching compared to older teachers and those with no university degrees. These results suggest that teacher training needs to target certain groups of teachers. This can be done during pre-service or during in-service training.

Schools where mathematics teachers taught revealed a relationship with the perceived roles of ICT in the classroom. A large proportion of teachers from national and county schools were more optimistic about certain roles of ICT in mathematics instruction compared to teachers from district and community schools. More teachers from district and community schools need to be trained on ICT integration and the benefits accrued when ICT is integrated in mathematics teaching. These schools also need to be equipped with ICT facilities (although these facilities did not appear to be related with mathematics teachers' perceptions of ICT integration).

**Funding:** This study received no specific financial support.

**Competing Interests:** The authors declare that they have no competing interests.

**Contributors/Acknowledgement:** All authors contributed equally to the conception and design of the study.

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