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ICT competence level of in service mathematics teachers and how it is incorporated into classroom practices in the cape coast metropolis of Ghana

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Abstract
This study was set out to examine the barriers to ICT integration into Mathematics teaching and learning in selected Senior High Schools in the Cape Coast Metropolis of the Central Region of Ghana. Specifically, the study aimed to examine the effects of internal barriers (constructive teaching beliefs, teaching experience, attitudes toward computer and technology competence) and external barriers (access to technology use, level of training in the use of technology, time adequacy, as well as the culture of the teacher's institution) in predicting in-service teachers' usage of ICT in the teaching and learning of Mathematics.
The study employed the descriptive survey design to answer the research questions of the study. A 5-point Likert Scale questionnaire was the instrument for data collection. Both purposive and convenience sampling techniques were used to select 185 in-service teachers for the study. The multiple regression analysis was used to estimate the factors influencing ICT integration.
The study revealed that in-service teachers' ICT integration in the teaching of Mathematics was fairly low. Both internal and external factors had significant effects on ICT integration; but the internal factors had stronger predictability of ICT integration than the external factors. The study recommended that Ghana Education Service should carry out a review of the Mathematics Curriculum to make the timetable more flexible to enhance teachers' willingness to integrate ICT in the teaching and learning of Mathematics.

Keywords: Technology acceptance model (TAM), pedagogy, cape coast metropolis, in-service teacher

1. Introduction
1.1 Background to the Study
Educational systems are based on teacher and curriculum concepts. Effectiveness and efficiency of an educational system may rely on these two inter-related concepts and the harmony between them. Any problems appearing in either of these concepts will decrease the qualities of the educational system, as a result affecting the learners. For this reason, the quality of an educational system should be parallel to the quality of teachers trained. Moreover, the quality of a teacher will be in harmony with the curriculum focused knowledge, skills and the attitudes acquired by the teachers.
Technological and computer competencies of teachers are important dimensions of this quality. Due to large investments of technology in many educational institutions, teachers are required to integrate technology into curriculum and classroom activities (Yasemin, 2008) [38]. For this reason, teacher education programs are reshaped and enhanced with the courses trying to infuse the use of various technologies. This enhancement includes the knowledge and skills necessary to use and integrate Information and communication technology (ICT) effectively. Besides, teachers' attitudes and beliefs toward technology usage should result in a positive one (Yasemin, 2008) [38]. Therefore, teachers should be designated in such a way that besides knowing how to use ICT effectively, they have to be empowered to integrate ICT into teaching and learning of mathematics so as to develop learners understanding and to support constructivism, cooperative learning and problem-based learning (Royer, 2002) [25].
Despite the increased availability and support for ICT integration, relatively few teachers intend to integrate ICT into their teaching activities (Ertmer, 2005) [12]. Since the introduction of educational technologies into classroom settings, teacher education has faced the

challenge of improving in service teacher education for successful integration of educational technologies into their teaching and learning practices (Sang, Valcke, Braak, & Tondeur, 2009) [26]. ICT integration in mathematics education provides mathematics teachers with integrative teaching methods that motivate students learning, support their independent learning and active participation in the discovery of mathematical concepts and topics and as a result, helps them have deeper understanding of the mathematical ideas (Nimer, & Wajeeh, 2013) [20]. Therefore, the integration of ICT in the teaching and learning of mathematics, as a result of ICT educational affordances, helps students have better achievement in mathematics, (Nimer, and Wajeeh, 2013) [20].

Undeniably, Integration of ICT in education has increasingly become an important concern in education not only in developed countries, but in developing countries as well including Ghana. A recent study (Agyei & Voogt, 2012) [2]; indicate that, the influence of technological advancement has necessitated the need for a curriculum that can develop the mathematical power of students. This includes a shift from a curriculum conquered by memorization of secluded facts and procedures to one that emphasizes on conceptual understanding, computational skills, problem solving and the pedagogical integration of ICT. From the early 1990s, education stakeholders in Ghana have been concerned about how teachers and students use computers in schools and how their use supports learning (Boakye & Banini, 2008) [5].

At the beginning of the millennium, education authorities in Ghana embarked on a number of projects to introduce Information and Communication Technologies into Ghanaian education set up at all levels of education. For instance, in the middle of the 1990s, educational providers realized that Ghanaian professionals could not compete on the global market for jobs, because they were limited in skill, especially in the area of Information Technology (Nyarko, 2007) [21]. The Ministry of Education, Science and Sports opined that "the integration of ICT into Education will result in the creation of new possibilities for learners and teachers to engage in new ways of information acquisition and analysis. ICT may enhance access to education and improve the quality of education delivery on equitable basis" (Ministry of Education, Science and Sports, (MOESS, 2007).

1.2 Statement of the Problem

The lack of integrating ICT in the teaching of Mathematics among In-Service Teachers in the Cape Coast Metropolis is a common phenomenon and this has resulted to poor performance in Mathematics due to the use of the old traditional way of teaching mathematics by the In-Service Teachers instead of the new modern technologies that are emerging and this gap is what the research sought to fill.

Education stakeholders and policymakers in Ghana have made good strive towards the introduction of ICT so as to help contribute to knowledge production, communication and information sharing among teachers and other stakeholders in the educational system. To date, however, there has been only limited research to investigate Ghanaian teachers' use of technology in teaching and learning and the factors that support or inhibit their effective integration into classroom practice. Mereku, *et al* (2009) [18], asserted that for Ghana, and Africa as a whole, to be able to fully integrate ICT into teaching and learning there is the need for frequent collection and analysis of data on ICT usage.

Mereku, *et al*, (2009) [18], further pointed out that full pedagogical integration of ICT into the educational system is a distant goal unless there is reconciliation between teachers and computers despite the many importance of pedagogical integration of ICT in mathematics education. Ward (2003) goes further to claim that there is limited use of ICT in classroom practices. This, the in-service teachers need to have an understanding of how pedagogical integration of ICT can be fused into the teaching and learning of mathematics rather than just as a publication and research tool. One of the challenges facing education is how to ensure that graduate teachers have the necessary combination of skills 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) [14].

1.3 Objectives of the study

This study intends to:

1. Establish the level of ICT integration by the in-service teachers during their mathematics class.
2. Bring to light the internal barriers (constructivist teaching beliefs, teaching experience, technology competence and attitudes) toward computers on in-service teacher's ICT integration in the teaching and learning of mathematics.
3. Examine the effect of in-service teachers' external barriers (access to technology use, training, time and culture) toward computers on in-service teacher's ICT integration in the teaching and learning of mathematics.

1.4 Research Questions

1. What is the level of in-service teachers' ICT integration in their mathematics classrooms?
2. To what extent is in-service teachers' ICT integration in teaching mathematics influenced by perceived internal barriers of ICT?
3. To what extent is in-service teachers' ICT integration in teaching mathematics influenced by perceived external barriers of ICT?
4. To what extent do internal and external barriers of ICT predict in-service teachers' ICT integration levels in the mathematics classroom?

1.5 Significance of the Study

The study is significant because it could provide insights into in-service mathematics teachers' pedagogical use of ICT at the SHS level of the educational ladder within the Cape Coast Metropolis and beyond that could be sustainable and transferable to other educational institutions. The study also sought to provide evidence on the barriers mentioned above and the influence of each on pedagogical integration of ICT use, to examine the inter relationship between the internal barriers and the external barriers and their possible influence on pedagogical integration of ICT into mathematics teaching practices and above all, the study will add to the existing literature on barriers affecting ICT integration in mathematics classroom and the possible consequences it may have on the teacher's attempt in integrating ICT into teaching mathematics at SHS level in Cape Coast Metropolis and Ghana as a whole.

2. Literature Review

2.1 Conceptual Framework for the Study

Technology Acceptance Model (TAM) was the conceptual framework used because new technologies such as personal computers are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form attitudes and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using. Attitudes towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions. (Bagozzi, Davis & Warshaw, 1992) [3].

Recent studies employing the TAM as the framework have also showed perceived usefulness and perceived ease of use to be significant predictors of attitude towards technology use and intention to use (Teo, 2008a; Teo, Lee, & Chai, 2008) [29, 28]. Some researchers have also ignored attitude toward use and/or intention to use (Venkatesh, Davies, Morris & Davis, 2003) [32], and instead focused on the direct effect of ease of use and usefulness on system usage.

These theories including the TAM represent an important theoretical contribution toward understanding the use of ICT by teachers and ICT acceptance behaviours. Chen (2004) [6] found that teachers increased their confidence in using computer technology by having experiences from a previous computer course. Chen (2004) [6] asserts that "teachers need to have the confidence and positive attitudes towards computers that will motivate them to integrate ICTs into their instructional strategies".

In all, Ertmer (2005) [13] has categorized some of these factors hampering ICT implementation in the classroom into two: external (first-order) barriers which include access to technology, technology use, effective training, technology competence and culture. Internal barriers are related to a teacher's philosophy about teaching and learning; they are veiled and deeply rooted in daily practices (Ertmer, 1999; 2005) [12]. Examples of these internal barriers are teacher's constructivist teaching beliefs, perceived usefulness of computers, teacher technology competence and teacher attitudes. Also, Gorder (2008) [15] reported that teacher experience is a Factor influencing teachers' adoption and integration of ICT.

Hence, the study considers internal barriers as teacher's constructivist teaching beliefs, perceived usefulness of computers, teacher attitudes and teaching experience which is a combination of Ertmer's (2005) [13] internal factors, Davis' (1989) [32] perceived usefulness and that of Gorder (2008) [15] teaching experience which can as well be referred to as the 'teacher factor'. Also, the external factors are; access, technology use, training, technology competence and culture, Ertmer (2005) [13]. As a result, a particular theory may not be applicable to this study, hence, no single existing overarching theory can be chosen as a framework to guide the conduct of this study since the study intend looking at the inter-play of the combined effects of both the external and internal barriers on the integration of ICT.

Therefore, This study related Ertmer (2005) [13] factors to Davis (1989) [32] as well as Gorder (2008) [15], conditions for some critical barriers affecting pedagogical integration of ICT into mathematics teaching and used these critical factors as the standard barriers: internal (teacher's constructivist teaching beliefs, perceived usefulness of computers, teacher attitudes and teaching experience) and external (access, technology use, training, technology competence and culture) barriers to examine in detailed the current work. In the study, literature on these internal and external barriers and their effect on pedagogical integration of ICT into mathematics teaching practices is presented in threefold and summarized below:

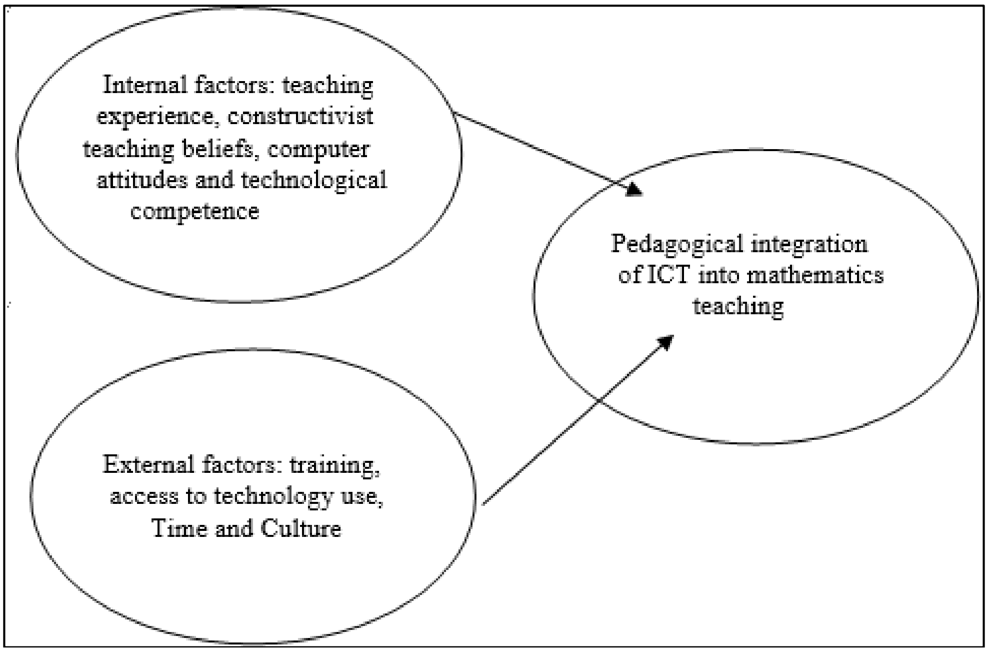

Fig 1: Threefold presentation of pedagogical integration of ICT into mathematics teaching practices

2.2 Pedagogical Integration of ICT

Pedagogy in this work focuses on the thinking and practice of teachers who look to accompany learners; care for and about them; and bring learning into life (real life situation). Teaching is just one aspect of their practice and a pedagogy is simply seen as the art and science (and maybe even craft) of teaching (Rouse, 2014) [24]. Integration on the other hand generally means combining parts so that they work together or form a whole and ICT (information and communications technology-or technologies) is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as video conferencing and distance learning, (Rouse, 2014) [24]. Hence, pedagogical integration of ICT is the art and science of using ICT to teach.

Adoption of technology is conceived as a process that develops through different stages. From being aware and informed about the possibilities of ICT in education to a more routine utilization of ICT in classroom practice and finally to creative uses of technology for teaching and learning (Christensen, 1997; Christensen & Knezek, 2002) [7, 8]. The use of ICT in the mathematics classroom has long been a topic for consideration by mathematics educators. Some examples of ICT use in mathematics include: portables, graphic calculators and computerized graphing, specialized software, programmable toys or floor robots, spreadsheets and databases (Agyei & Voogt, 2010) [1].

Furthermore, Keong, Horani and Daniel (2005) [16] conducted a survey to investigate the use of technology and the barriers of integrating technology into the teaching of mathematics. Their findings indicated that the level of technology used by teachers in their instruction was low. Majority of the mathematics teachers use technology for word processing (71.1%), spreadsheets (51.2%), internet activity (44.1%), search engines (44.1%), presentation software (36.9%) and databases (21.6%). Out of the 111 mathematics teachers surveyed, 39.6% of the respondents stated that they had not used technology at all and 32.1% of them stated that they use technology infrequently. On the other hand, 22.6% of them responded that they had integrated technology into specific areas of instructional units and 5.7% stated that they had fully integrated technology into their instructional programs.

Similarly, a study conducted by Boakye and Banini (2008) [5] to investigate teachers' readiness for the use of technology in Ghanaian schools indicated that, 71% of the teachers did not use technology in classrooms, 49% of teachers use technology to prepare lesson notes, 55% of teachers have some knowledge of web browsing, 71% use email, and 78% tried to make an effort to learn how to use the computer. These low figures imply that effective integration of technology into Ghanaian classroom instruction is yet to be realized and utilized.

3. Methodology

3.1 The Study Area

The research site was Senior High Schools (SHS) doted within the Cape Coast Metropolis. Some of the well renowned SHS within the Cape Coast Metropolis which the research covered are: St. Augustine's College, Mfantipim, Adisadel College, Ghana National College, Wesley Girls' College and Aggrey Memorial School. Cape Coast is endowed with many schools across the length and breadth of the Metropolis, ranging from basic to tertiary institutions. These schools attract people from all over the country and the West Africa Sub-region, who pursue various levels of academic and professional education.

The city Cape Coast was the first National Capital of the Gold Coast colony until 1877 and now the administrative capital of the Central Region of Ghana. Cape Coast is the hub of tourism in Ghana. It is the centre for the Pan African Festival dubbed, PANAFEST. The Metropolis is endowed with an enviable potential that predisposes the area to tourism development. The celebration of the annual festival of the people, the Fetu Afahye, has always attracted people from within and outside the shores of the country and has developed over the years into a grand cultural celebration which has enhanced tourism in the Metropolis.

Paramount worth mentioning also is the Kakum National Park and the Cape Coast Castle, which also raises lots of revenue from tourists for the Metropolis.

The Metropolis is bounded to the South by the Gulf of Guinea, to the West by the Komenda Edina Eguafo Abrem Municipality, to the East by the Abura Asebu Kwamankese District, and to the North by the Twifu Heman Lower Denkyira District. It is located on longitude 1°15ˈW and latitude 5°06ˈN. It occupies an Area of approximately 122 square kilometres. From the 2010 National Population and Housing Census, the Metropolis has a total population of 169,894 consisting of 82,810 males (48.7%) and 87,084 females (51.3%). The Metropolis is predominantly urban with three-quarters (130,348) of the population residing in urban areas compared to 39,546 (23.3%) in rural settlements.

The people of Cape Coast are part of a larger group of people known as Fantes found in the central part of Southern Ghana and are among the Akans ethnic group of Ghana. The language spoken by the people is Fante. People belonging to other ethnic groups are also found in the Metropolis. The entire Metropolis constitutes one traditional area with the Oguaa Omanhen as the Paramount Chief. Christianity has long been the dominant religion in the Metropolis, although there a significant number of Muslims and traditionalist.

3.2 Research Design

The study used survey research design with mixed-method approach. Survey research designs because it provides quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviours, or characteristics of the population (Creswell, 2012) [9].

The study also used the mixed-method approach which combines both qualitative and quantitative methods of research. Tashakkori and Teddlie (2003) [28] argue that multiple methods are useful if they provide better opportunities for a researcher to answer research questions and where the methods allow a researcher to better evaluate the extent to which the research findings can be trusted and inferences to be made from them.

3.3 Population

According to Seidu (2012) [22], population is the entire group of people, objects or animals which the researcher wants to study. In the case of this research, the population is all practicing SHS mathematics teachers (in-service) in the Cape Coast enclave.

3.4 Sample and Sampling Technique

Non-probability sampling was used, in particular convenience and purposive sampling. Purposive because, the sample must involve the selection of participants who have key knowledge or information related to the purpose of the study and in this study, only Mathematics teachers at the SHS level was the targeted group. According to Vanderstoep and Johnston (2009) [31], convenience sampling often involves people whom the researcher knows or people who live close to the research site, therefore for proximity purposes, the researcher used the convenience sampling.

A total of about one hundred and eighty-five (185) SHS mathematics (in-service) teachers were involved, out of which one hundred and thirty-six (136) were men whiles forty-nine (49) were females. In all, about seven (7) Senior High Schools in the Metropolis were visited and data taken after randomly selecting these schools, since all the schools in the Metropolis cannot be used due to limited time and resources.

Table 1: Gender distribution of the Sample Size

Target Groups	No. of Respondents	Percentage (%)
Male SHS mathematics teachers	136	73.5
Female SHS mathematics teachers	49	26.5
Total	185	100%

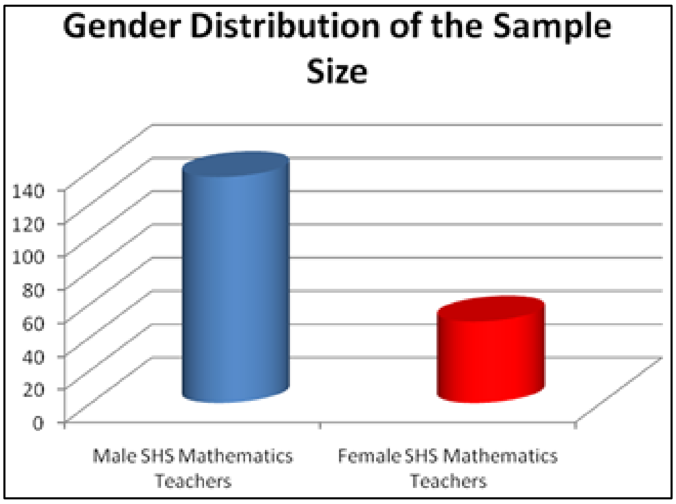

Fig 2: Graphical Gender Distribution of the Sample

3.5 Data Collection Procedures

The researcher visited the selected Institutions and permissions sorted from the administrations of these institutions to help get access to the in-service mathematics teachers, for data to be taken from teachers of these institutions. Questionnaire was administered personally to the participants to enable me ensure to a larger extent the independency of the responses by the various respondents. It also to a very large extent encouraged the respondents not to be intimidated by anybody as I am seen as a neutral person rather than their own colleagues administering the questionnaire. A period of about six weeks was used to collect the data for this study.

4. Data Analysis

The study employed mainly statistical tools for the determinants of ICT integration. Statistical Product and Service Solution (SPSS) version 22 was used for the analysis. Descriptive Statistics using mean, median, standard deviation, frequency and percentages were employed in the first instance just to help describe, show or summarize data in a meaningful way. The results were presented in Tables and interpreted appropriately.

Multiple regression analysis was used to estimate the effects of internal and external factors on the integration of ICT (dependent variable). According to Cohen, *et al*. (2007), multiple regression technique allows for modelling and analyzing several variables, when the focus is on the relationship between dependent variable and one or more independent variables. It further helps to understand how the typical value of the dependent variable (criterion variable) changes when any one of the independent variables is varied while the other independent variables are held fixed. T-test was conducted to test whether ICT integration differ by age and teaching experience of in-service teachers in the selected schools.

4.1 Demographic Information of Respondents

The research is based on a field data from a sample of 185 in-service teachers in the Cape Coast Metropolis in the Central Region of Ghana. The objective is to examine the factors influencing ICT integration in mathematics teaching and learning. The average age of respondent is 37 years (i.e. Mean = 37.37); the youngest person was 23 years (Min = 23) and the oldest respondent is 55 years (Max = 55). Most of the respondents are 40 years of age (i.e. Mode = 40); and half of the total respondents are below 38 years, whilst the other half are above 38 years (i.e. Median = 38). Table 2 presents the age distribution of the respondents it can be observed that 50 (27%) of the respondents are between 23-32 years of age, 83 (44.9%) are between 33-42 years, 42 (22.7%) are between 43-52 years; and only 10 (5.4%) are between 53-62 years of age. About 72% of the respondents were between 23- 42 years of age (as seen from the cumulative percentage = 71.9).

Table 2: Age distribution of Respondents

Age categories	Frequency	Percentage	Cumulative Percentage
23-32	50	27.0	27.0
33-42	83	44.9	71.9
43-52	42	22.7	94.6
53-62	10	5.4	100.0
Total	185	100.0	

Source: Field data (2018)

Empirical evidence suggests that ICT integration is related to years of teaching experience, but the direction of the effect of experience on ICT integration is inconclusive. Some studies observed that more experienced teachers are more likely to integrate ICT in teaching and learning of mathematics than teachers with less experience (Rosen & Maguire, 1990). In other studies, it was observed that less experienced teachers are more likely than more experienced teachers to integrate ICT in mathematics. In order to contribute to the debate, this study attempts to examine years of teaching of mathematics and technology integration among in-service teachers in the selected schools in the Cape Coast Metropolis. Most of them have been teaching for 7 years now (i.e. mode = 7.0); and each teacher had an average of about 9 years of teaching experience (i.e. mean =

8.89). Table 3 below presents the distribution of years of teaching of mathematics among respondents.

Table 3: Distribution of years of teaching mathematics

Years of teaching	Frequency	Percentage	Cumulative Percentage
1-5	74	40.0	40.0
6-10	51	27.6	67.6
11-15	26	14.1	81.6
16-20	29	15.7	97.3
21-25	5	2.7	100.0
Total	185	100.0	

Source: Field data (2018)

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Total	185	100.0	

Source: Field data (2018)

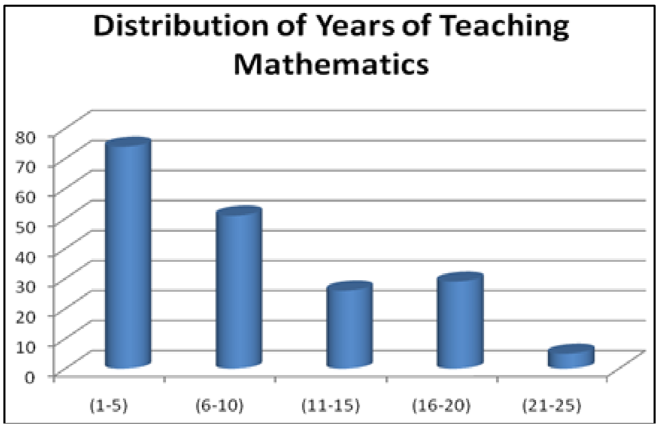

Fig 3: Graphical distribution of years of teaching mathematics

As observed in the table above, out of the 185 respondents from whom data was analyzed, 74 (40%) have been teaching mathematics for between 1-5 years now; 51 (27.6%) have been teaching for between 6-10 years; 26 (14.1%) and 29 (15.7%) have been teaching for between 11-15 years and 16-20 years, respectively. Only 5 (2.7%) have been teaching for between 21-25 years. As observed in the cumulative percentage column, more than one-half of the respondents (i.e. 67.6%) have been teaching for between 1-10 years.

Table 4: Independent t-Test of Age and Experience on ICT Integration

Factor	Categories	N	Mean	Std.	df.	t	p-value
Age	23 - 42	133	2.98	0.95	183	3.75	0.000***
	43 - 62	52	2.59	1.07			
Experience	Less than 10 years	108	2.95	0.99	183	2.76	0.007**
	10 or More	77	2.51	1.01			

Source: Field data (2018); **p< 0.05; ***p<0.001

It is deduced from the above table that, mathematics teachers with less age (23-42) use ICT during the teaching of mathematics than those who are old (43-62). It is further evidential that, 108 (53.4%) of the mathematics teachers with less teaching experience (less than 10 years) integrate ICT more in teaching mathematics.

Whether teachers would integrate ICT in their teaching or not depends largely on the availability of technology resources at their disposal. As a result, technology resources available in the selected schools were examined. Table 5 presents the distribution of technology resource availability for teaching and learning of mathematics.

Table 5: Distribution of technology resources available to Teachers (N= 185)

Availability of technology resources	Yes		No	
	N	%	N	%
1. Personal computer and internet access at home	139	75.00	46	25.00
2. General computer lab at my school	140	75.70	45	24.30
3. Special computer lab for mathematics lessons	0	0.00	185	100.00
4. Projectors are readily available for mathematics lessons	43	23.20	142	76.80
5. Broadband internet connection at school	37	20.00	148	80.00
6. Graphical calculators for use by mathematics teachers during lessons	74	40.00	111	60.00
7. Enough computers with appropriate mathematics software at school	25	13.50	160	86.50
8. Enough scientific calculators for use during mathematics lessons	150	81.00	35	19.00

Source: Field data (2018)

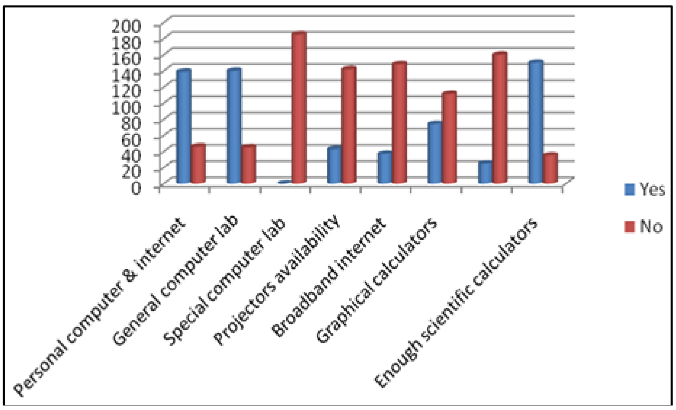

Fig 4: Graphical Distribution of technology resources available to Teachers (N= 185)

As observed from table 5, majority of in-service teachers have personal computers with internet at their homes (75%), their schools have general computer labs (75.70%) and graphical calculators (60%) and scientific calculators (81%). However, many indicated that their schools do not have special computer lab for mathematics lessons; projectors are not available for use during mathematics lessons (76.80%), most schools do not have enough computers with appropriate mathematics software (86.50%), and most schools did not have broadband internet connections in their schools (80%). This indicates that majority of schools have some technology resource at their disposal but lack the appropriate software and access to internet that promote effective technology use in teaching.

4.2 Mathematics Teachers' Rating of their Level of ICT Integration

In-service mathematics teachers' level of ICT integration was explored using means of responses gathered. This was an attempt to answer the research question one of the study. Ten statements comprising the use of computer, calculator and the internet were used to solicit the needed information. The research question one is stated and analysed as follows.

Research Question 1: What is the level of in-service teachers' ICT integration in their mathematics classrooms? Table 6 presents in-service teachers' rating of the level of the use of ICT (i.e. ICT integration) in mathematics lessons. The results in Table 1 show that the overall teachers' usage of ICT in teaching mathematics is fairly low (mean = 2.87, std. = 0.49). However, it was found that in-service teachers often teach students the effective use of calculators (mean =3.68, std. =0.19), make students submit assignments online (mean = 3.72, std. = 0.52), use Geometer's Sketchpad during construction lessons (mean =3.61, std. =1.19), as well as teach students how to attach files to email messages (mean = 3.84, std. = 0.24). In addition, respondents indicated that they barely use PowerPoint presentations during lessons (mean =2.49, std. = 0.31), draw scatter diagrams for bivariate distributions (mean = 2.92, std. = 0.32), investigate nature of graph of functions (mean = 2.76, std. = 0.22) and teach students how to search for information on the internet (mean = 2.95, std. = 1.17). However, respondents rarely taught students the use of Excel for statistical plots (mean = 1.45, std. = 0.44), as well as the use of multimedia operations during lessons (mean = 1.27, std. = 0.34). These results indicate that although in-service teachers use ICT in teaching mathematics they mostly limit themselves to the use of only simple applications involving Microsoft Word and unsophisticated technology resources.

Table 6: In-service Teachers' use of ICT in Mathematics N = 185)

Item	Teachers' rating of the use of ICT in mathematics lessons	
	Mean	**Standard Deviation**
Teach students effective use of calculators	3.68	0.19
Use PowerPoint presentations during lessons	2.49	0.31
Students submit assignments online	3.72	0.52
Use multimedia operations (digital video) during lessons	1.27	0.34
Teach students with the use of Microsoft Excel for statistical plots	1.45	0.44
Use Geometer's sketchpad during construction lessons	3.61	1.19
Teach students how to attach files to email message	3.84	0.24
Draw scatter diagrams for bivariate distributions	2.92	0.32
Investigate the nature of graph of functions	2.76	0.22
Teach students how to search for relevant information on the internet	2.95	1.17

Source: Field data (2018), overall mean (= 2.87, Std. = 0.49)

4.3 Multiple Regressions of the Determinants of ICT Integration

Multiple regressions were employed to estimate the determinants of ICT integration into mathematics teaching and learning among in-service teachers in the Cape Coast Metropolis. The influencing factors were conceptualized as perceived internal and external factors. Three (3) separate models were estimated in all and the estimation was based on the responses received from 185 in-service teachers. The estimation was an attempt to answer the research questions two, three and four of the study. These research questions are analyzed as follows.

Research Question 2: To what extent is in-service teachers' ICT integration in teaching mathematics influenced by their perceived internal factors?

The internal factors include teachers' constructive teaching beliefs, attitudes towards computer, technology competence and teaching experience. Analysis of the means of the internal factors was conducted and the results are presented as follows; the first internal factor explored in this study was teachers' constructive beliefs. Table 7 presents the distribution of teachers' level of constructive beliefs.

Table 7: Distribution of teachers' constructive belief (N = 185)

Item	Teachers' mean rating of their Constructive Belief	
	Mean	**Standard Deviation (Std.)**
Students work together without my direction	4.24	0.92
I believe that expanding on students' ideas is an effective way to build my curriculum	4.17	0.64
I prefer to cluster students' desk so they work together	4.10	0.71
I prefer to allow students learn and work on their individual pace	3.98	0.94
I always allow students to use try and error to create their own concept	3.82	0.76

Source: Field data (2018); overall mean (= 4.06, Std. = 0.79)

The overall teachers' constructive beliefs score is high (mean = 4.06, std. = 0.79). Specifically, the results indicated that, teachers are perceived to allow students to work together without being directed during teaching and learning of mathematics (mean = 4.24, std. = 0.92); they believed that the effective way to build a curriculum is to expand on students' ideas (mean = 4.17, std. = 0.64); and most preferred to cluster students' desks to work together in the class room (mean = 4.10, std. = 0.71); and they reported that, students use try and error to create their own concepts (mean = 3.82, std. = 0.76). This result indicates that in-service teachers in the Central Region of Ghana have high constructive beliefs and are expected to have high level of technology integration in teaching and learning of mathematics.

The second internal factor examined in this study was computer attitudes. A strong relationship between computer-related attitude and computer use has been established by the literature. Respondents were asked to rate their attitudes towards computer. Table 8 presents the mean rating of teachers' computer attitudes.

Table 8: Distribution of computer attitudes of respondents (N = 185)

Item	Teachers' Computer Attitudes	
	Mean	**Standard Deviation (Std.)**
Computer liking	3.99	1.00
The use of computers in teaching mathematics is worthwhile	4.28	0.90
Self-confidence is enhanced when working with computers	3.66	1.08
Working with computer is enjoyable and stimulating	4.20	1.06
Using computers is interesting	4.15	1.14
Computer is helpful for learning new mathematics concepts	4.05	0.76
Use of computers is helpful in performing differentiation	3.58	1.07
Perceived Usefulness	3.91	1.04
Mathematics learning process becomes efficient when using computers	3.96	1.05
Using computer to teach mathematics enhances my presentations	4.04	0.76
Computers help students do their mathematics task and home works	4.00	0.95
Computers assist students with learning difficulties	3.55	1.24
The use of computer helps students to get better understanding in mathematics	4.01	1.19
Perceived control	3.23	1.05
I use my computer to learn most of the things I need to know	3.51	1.30
I make my computer do whatever I want it to do during lessons	3.65	1.19
If I get problems on my computer, I can usually solve them in one way or another	2.45	0.61
I have complete control when I use my computer to teach mathematics	3.29	1.08
Affective components	4.15(R)	0.96
I cannot think of any way to use computer (ICT) to teach mathematics as a tutor	3.96 (R)	0.35
Employing ICT in mathematics is very hard for me	3.51(R)	0.20
I get a sinking feeling when I think of trying to use ICT to teach mathematics	4.19 (R)	1.36
I hesitate to use computer for fear of making mistakes that I cannot correct	4.29 (R)	1.45
I feel very nervous when I am using a computer and for that matter ICT	4.77 (R)	1.46

Source: Field data (2018); Overall mean (= 3.82, Std. = 1.02); R = rescaled value

The results as depicted in table 8 above show that, the overall in-service teachers had a strong positive attitude toward the use of computers (mean = 3.82, Std. = 1.02). Thus, the teachers like using computers (mean = 3.99, Std. = 1.00); they reported high perceived usefulness (mean = 3.91, Std. = 1.04) of computers; had perceived control on the use of computers (mean = 3.23, Std. = 1.05); and they were not anxious working with computers (mean = 4.15, Std. = 0.96). Specifically, respondents agreed that the use of computers in teaching mathematics is worthwhile (mean = 4.28, std. = 0.90), working with computers enhance their self-confidence (mean = 3.66, std. = 1.08), working with computers is enjoyable and stimulating (mean = 4.20, std. = 1.06), using computers is interesting (mean = 4.15, std. = 1.14), computers are helpful for learning new mathematics concepts (mean = 4.05, std. = 0.76), and that the use of computers is helpful in performing differentiation among students (mean = 3.58, std. = 1.07). The results indicate a high level of computer liking attitudes among in-service teachers in the Cape Coast Metropolis and they are expected to integrate ICT in their teaching of mathematics.

The third internal factor investigated in the study was technology competence. Technology competence is crucial in enhancing ICT integration, that is, the ability of a person to perform a specific task with computers determines his/her ICT integration. In-service teachers were asked to rate their technology competence with regard to some technology related activities. Table 9 shows the mean rating of respondents' technology competence.

Table 9: Distribution of teachers' technology competence (N = 185)

Item	Teachers' mean rating of the level of Technology Competence	
	Mean	**Standard Deviation (Std.)**
Communication with colleagues and students on the internet	3.62	1.06
Creating Spreadsheet (MS Excel)	2.26	1.03
Making PowerPoint presentations	3.62	1.16
Draw graphs, logarithmic and trigonometric functions	2.59	1.07
Draw scatter plots for bivariate distributions	3.75	0.96

Using calculator to express recurring decimals to common fractions	3.64	1.25
Using calculator to compute the mean, median and standard deviation	3.89	1.02
Use the calculator to work depreciation of an item over a period	2.37	0.74

Source: Field data (2018); Overall mean (= 3.22, Std. = 1.02)

The overall score for teachers' technology competence is fairly high (mean = 3.22, Std. = 1.02). As observed from Table 9 above, respondents were proficient when it comes to the use of the internet to communicate with their colleagues and students (mean = 3.62, std. = 1.06), making PowerPoint presentations (mean = 3.62, std. = 1.16), drawing scatter plots for bivariate distributions (mean = 3.75, std. = 0.96), using calculator to express recurring decimals to common fractions (mean = 3.64, std. = 1.25) and the use of calculator to compute the mean, median and standard deviation (mean = 3.89, std. = 1.02). However, the in-service teachers were less proficient in the use of Microsoft Excel to create spreadsheet (mean = 2.26, std. = 1.03), draw graphs, logarithmic and trigonometric functions (mean = 2.59, std. = 1.07), and use the calculator to work depreciation of an item over a period (mean = 2.37, std. = 0.74). The results imply that in-service teachers in Cape Coast Metropolis appear to have high technology competence but their competency level is limited in the use of Excel, the use of calculator to perform logarithmic, trigonometric functions, as well as computing depreciation of an item over time.

In an attempt to answer research question three, the researcher did analysis on the external barriers on ICT integration in the following section.

Research Question 3: To what extent is in-service teachers' ICT integration influenced by perceived external barriers?

The perceived external barriers explored in the study included training, access to computer, time adequacy and school culture. Effective training opportunities for teachers in the use of ICT is the first external barrier to be considered and have been identified in literatures as one of the critical barriers to the use of ICT in the classroom (Pelgrum, 2001; Beggs, 2000) [4]. Aside the need to give pedagogical training to teachers, it is also necessary to train them in specific ICT skills. In an attempt to examine in-service teachers' level of training in ICT, teachers were asked to rate their level of training on some specific ICT skills and pedagogical skills. Results are presented in Table 10.

Table 10: Distribution of teachers' level of training in the use of ICT (N = 185)

Level of training in the following areas	Teachers' mean rating of their level of Training in ICT related areas	
	Mean	Standard Deviation (Std.)
Use of internet to select websites, discussions, etc.	4.38	0.31
Creating database using Microsoft Access	2.23	1.17
Use of graphical calculators	4.06	1.32
Use of scientific calculators	3.87	0.71
Use of Geometer's Sketchpad	3.73	1.29
The use of multimedia operations (such as digital video)	2.47	1.07
Subject specific training with learning software	2.16	0.68

Source: Field data (2018); Overall mean (= 3.27, Std. = 0.94)

The overall mean score for the level of training in the use of ICT is barely high (mean = 3.27, std. = 0.94). As shown in Table 10, the respondents have had high level of training in the use of the internet to select websites and discussions (mean = 4.38, std. = 0.31), the use of graphical calculators (mean = 4.06, std. = 1.32), scientific calculators (mean = 3.87, std. = 0.71), and the use of Geometer's Sketchpad (mean = 3.73, std. = 1.29). However, with regard to the use of Microsoft Access to create database, the teachers had low level of training (mean = 2.23, std. = 1.17), the use of multimedia operations such as digital video (mean = 2.47, std. = 1.07), and subject specific training with learning software (mean = 2.16, std. = 0.68). This result suggests that although the in-service teachers are computer literate, their level of training in the use of ICT is entirely moderate and can be linked to non-availability and accessibility of the technology resources in the various schools.

Lack of access to computer has been identified as one of the external barriers to ICT integration among in-service teachers. Accessibility means the ease with which teachers come by the computers to be used in their teaching. In-service teachers were asked to rate their level of accessibility to computer-related technologies and the mean rating of the responses is presented in Table 11.

Table 11: Distribution of teachers' level of computer accessibility (N=185)

Level of Access to Computer Technology	Teachers' mean rating of their level of Computer Accessibility	
	Mean	Standard Deviation (Std.)
Access to personal computer with internet at home	4.42	1.50
Access to general computer lab	3.71	1.35
Ability to book computer lab in advance of mathematics lessons	3.02	0.09
Access to special mathematics computer lab	1.32	0.52
Access to projectors for mathematics lessons	1.37	0.38
Access to broadband internet	1.44	0.27
Access to graphical calculators	3.90	1.52
Access to appropriate mathematics software	2.24	1.57

Source: Field data (2018); Overall mean (= 2.68, Std. = 0.90)

The overall mean score for computer accessibility is poor (mean = 2.68, std. = 0.90). As shown in Table 11, the teachers' level of computer accessibility was high with regard to their access to personal computers with internet connections at their homes (mean = 4.42, std. = 1.50), access to general computer laboratory in their schools (mean = 3.71, std. = 1.35), access to graphical calculators (mean = 3.90, std. = 1.52) and barely have access to book computer labs in advance of mathematics lessons (mean = 3.02, std. = 0.09). Teachers rarely had access to special mathematics computer labs (mean = 1.32, std. = 0.52), projectors for mathematics lessons (mean = 1.37, std. = 0.38), and broadband internet connections (mean = 1.44, std. = 0.27). It was also revealed that respondents had difficulty in accessing appropriate mathematics software (mean = 2.24, std. = 1.54).

The vision, plans, norms and values shared by school members (i.e. school culture), which is an external factor also influence ICT integration. Evidence suggests that effective ICT integration depends on the perception and vision of school leaders rather than teachers' ICT skills (Pelgrum & Law, 2009) [23]. In-service mathematics teachers were asked to rate the extent to which the school management encourages teachers to integrate ICT into teaching and learning of mathematics. Table 12 shows the average rating of school culture.

Table 12: School culture in promoting ICT integration (N = 185)

Item	Teachers' mean rating of School Culture in promoting ICT integration	
	Mean	Standard Deviation (Std.)
I am allowed to use ICT lab for teaching when necessary	4.23	1.38
My school provides opportunity to use ICT for teaching mathematics	3.98	1.43
The School Management encourages the use of ICT tools in teaching and learning of mathematics	3.46	0.32
ICT literacy is a requirement for appointment to teach mathematics	2.49	0.36
My school regularly undertake assessment of ICT usage in teaching mathematics	2.25	0.43
Teachers who use ICT tools to teach mathematics are rewarded by School Management	2.36	1.42

Source: Field data (2018); Overall mean (= 3.13, Std. = 0.89)

The overall mean score (mean = 3.13, std. = 0.89) implies that schools in the Cape Coast Metropolis have relatively favourable culture toward the use of ICT in teaching mathematics. As depicted in Table 12, the respondents agreed that they are allowed to use ICT for teaching when the need arises (mean = 4.23, std. = 1.38); and their school management encourages the use of ICT tools to teach mathematics (mean = 3.46, std. = 0.32). However, the respondents disagreed that their schools regularly undertake assessment of ICT usage in the work (mean = 2.25, std. = 0.43), and that there is no special reward from school management for teachers who use ICT tools to teach mathematics (mean = 2.36, std. = 1.42). Similarly, respondents disagreed that ICT literacy was a requirement for their appointment to teach mathematics in their schools (mean = 2.49, std. = 0.36.

Adequacy of time available to teachers is crucial to their use of ICT tools in teaching mathematics. An attempt was made by the researcher to examine whether or not in-service teachers have enough time to integrate ICT in their work. Table 13 shows teachers rating of time adequacy for ICT integration.

Table 13: Distribution of teachers' time adequacy for ICT use (N = 185)

Item	Teachers' mean rating of Time adequacy for ICT integration	
	Mean	Standard Deviation (Std.)
I have enough time to plan and integrate ICT in my mathematics lessons	3.67	1.02
I can complete the syllabus if I integrate ICT in my mathematics lessons	3.23	0.86
There is little time on the time table to plan and integrate ICT in my lessons	2.29	1.03
The school time table gives enough room for ICT integration in teaching mathematics	2.27	0.52
My busy schedule does not allow me to integrate ICT in teaching mathematics	2.10	0.62
Even if I integrate ICT in my lessons, I still have time to complete the syllabus	4.43	0.39

Source: Field data (2018); Overall mean (= 2.99, Std. = 0.74)

The overall mean score on time scale is fairly low (mean = 2.99, std. = 0.74). As shown in Table 13, the teachers agreed that they have enough time to plan and integrate ICT in mathematics lessons (mean = 3.67, std. = 1.02), and that even if they integrate ICT in lessons, they will still have time to complete the syllabus (mean = 4.43, std. = 0.39). However, respondents disagreed that the school time table gives enough room for ICT integration (mean = 2.27, std. = 0.52), and also disagreed that their busy schedule does not allow them to integrate ICT in lessons (mean = 2.10, std. = 0.62).

Research Question 4: To what extent do both internal and external barriers influence ICT integration?

The effects of both internal and external determinants of ICT integration into mathematics teaching were analyzed using the overall means and standard deviations of the relevant factors. Table 14 presents the overall means for both barriers.

Table 14: Distribution of scores for internal and external barriers on ICT integration (N = 185)

Items	Means	Standard deviation (std)
Internal factors (overall mean)	3.70	1.02
Constructive beliefs	4.06	0.79
Computer attitudes	3.82	1.02
Technology competence	3.22	1.02
External factors (overall mean)	3.13	0.85
Culture	3.13	0.89
Training	3.27	0.94
Time	2.99	0.74

Source: Field data (2018)

The overall mean scores for both internal barriers (mean = 3.70, std. = 1.02) and external barriers (mean= 3.13, std. = 0.85) show fairly high in influencing in-service teachers' use of ICT to teach mathematics. The mean score for teachers' constructive beliefs (mean = 4.06, std. = 0.79) as depicted in Table 7 revealed that teachers who are perceived to have student-centered beliefs are good integrators of ICT. Also, teachers who have positive attitudes towards computers are more likely to integrate ICT into the teaching of mathematics (mean = 3.82, std. = 1.02).

Teachers who are believed to have the skills with the use of ICT are more likely to integrate ICT (mean = 3.22, std. = 1.02). The more pronounced external factors that enhance ICT use are school culture, level of training and time adequacy. Thus, teachers who find themselves in schools that have the visions and values for the promotion of ICT use are more likely to be good integrators (mean = 3.13, std. =0.89). Teachers who have had training in the use of ICT are more likely to be good integrators (mean = 3.27, std. = 0.94). The overall mean score for time adequacy was fairly low (mean = 2.99, std. 0.74). Thus, teachers who are limited by time to plan for technology lessons are less likely to integrate ICT into the teaching of mathematics.

The effects of both internal and external barriers of ICT integration into mathematics teaching were further investigated using multiple regression analysis. The weight of each parameter and their relationships with ICT integration were determined. The results indicate that the R-square (R^2) from the model with only internal barriers was 0.165, which means that 16.5% of the variance in ICT integration was accounted for by in-service teachers' perceived internal barriers. The F test ($F = 5.005$, $p < 0.01$) associated with the independent variable (Internal barriers) was significant, indicating that the independent variable predicted the dependent variable if only internal barriers scale was considered in the model. In addition, adding the external barriers measure improved the predictability for ICT integration from approximately 16.5% to approximately 29.6%. The F test ($F = 12.045$, $p <0.01$) associated with the two independent variables was significant at 5% level of significance. However, the results revealed that the internal barriers measure was stronger in predicting ICT integration than the external barriers measure (as shown by R^2 change =. 131).

Table 15: Estimates of the effects of internal and external barriers on ICT integration (N = 185)

ICT integration	R	R-square	F-value(sig)
Perceived Internal barriers	0.405	0.16	5.005(0.000***)
Perceived External barriers	0.544	0.296	12.045(0.000***)

Source: Field data (2018)

5. Conclusions and Recommendations
5.1 Conclusions
Base on the major findings of the study, the researcher makes the following conclusions:

- The use of ICT among in-service teachers in Central Region was low as most of them used applications involving Microsoft Word and simple technology such as calculators. The use of spreadsheet techniques (Excel) as instructional tools to support Mathematical concept formation was a challenge.
- Teachers' perceived internal factors influence ICT integration in Mathematics Education. That is, teachers perceived to have student-centered pedagogical beliefs, those perceived to be competent in the use of computers and those who have control and like to work with computer were more likely to integrate ICT into Mathematics education. In-service teachers in Central Region are not anxious with the use of ICT tools.
- Teachers' perceived external barriers influence their use of ICT in teaching Mathematics. That is, teachers who find themselves in schools that have plans, vision and values for technology, and are allowed enough time in the curriculum, and have enough training in the use of technology were more likely to integrate ICT into Mathematics education.
- Teachers' perceived internal barriers are more influential than external barriers in predicting ICT integration.
- Young teachers are more likely to integrate ICT into mathematics teaching than their older peers. In addition, less experienced teachers are more likely to integrate ICT than the more experienced teachers.

5.2 Recommendations
Taking cognizance of the findings of the study, the following policy recommendations are proposed for enhancing the use of ICT in teaching and learning of Mathematics:

- The government, through the Ghana Education Service (GES) should carry out research to review critically the Mathematics Curriculum and revise the syllabus to include the necessary ICT tools and how to use them in teaching and learning. The review must focus on making timetable flexible and enhance willingness to change existing traditional teaching approaches.
- The Parent Teachers Association, school management, together with, the school boards must endeavor to put priority on the provision of ICT facilities in schools (e.g. mathematics labs, appropriate mathematics software, computers, projectors) to facilitate and increase ICT accessibility.

- The study revealed that favorable school culture enhances the use of ICT in teaching Mathematics. The study therefore recommends that the Ghana Education Service strengthen and enforce policies regarding practical use of ICT for educational practices in the curriculum. A clear articulation of the policy could ensure better grounding of teaching and learning using ICT.
- The heads of departments should organize regular in-service training in professional development courses for teachers. The integral part of the design of the professional development must be geared towards increasing teachers' competencies and decreasing their anxiety.
- The Universities and for that matter the teacher training institutions should as a matter of urgency, review the course contents to include among other things the necessary mathematical tools in the teaching and learning of mathematics.

5.3 Suggestions for Further Research

Further studies could investigate the same issue using a comparative analysis between public and private schools to improve the work. In addition to this, qualitative approach to research can be conducted to unearth the reasons why people may not use ICT in teaching. Also, socioeconomic determinants of ICT integration can also be considered by future studies as they are crucial factors for the use of ICT in teaching Mathematics in schools.

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