Original Research Article

School Mathematics Teachers' Perception of the integration of Information and Communication Technologies (ICTs) in Teaching and Learning: A Survey

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ABSTRACT

Aim: The study Sought to investigate school mathematics teachers use of ICT in teaching and the perceived barriers and challenges of ICT integration in the teaching and learning of mathematics.

Study Design: The study used descriptive cross-sectional survey research design.

Methodology: In this study, cluster sampling technique was used to select one hundred and twenty (120) teachers in junior and senior high schools in the keta municipality of the Volta region. Out of the one hundred and twenty (120) teachers selected in the Keta municipality of the Volta region, one hundred and five (105) teachers presented back the questionnaire with a response rate of 87% of which descriptive statistics was used for analysis. Of the one hundred and five (105) teachers, 72% were males and 28% were females.

Results: The study indicated that the extent to which mathematics teachers use ICT in teaching mathematics was very little. However, mathematics teachers often use ICT for general computer applications such as finding information on the internet for teaching, communicating with colleagues and students, sending emails and preparing notes for teaching etc.

It was revealed that, Respondents do not have adequate training and access to instructional technology.

Respondents perceived that, the scarcity of printers and presentation equipment in schools may limit their ability to integrate ICT in the teaching and learning process.

Conclusions: Most mathematics teachers do not use ICT in their teaching because of lack of technical know-how and inadequate ICT tools. However, those teachers with little knowledge of ICT prefer to use ICT for general purposes rather than teaching.

Keywords: perception, skills, teaching and learning, mathematics; integration; Information and Communication Technology.

1.INTRODUCTION

The world is now a global village as per the current trends of information and communication technology (ICT). The importance of ICT in the lives of people and students in particular cannot be exaggerated. This is true because ICT enables rapid and easy access to a wide range of information in the world. In fact, it is now difficult to imagine a world without information technology for which Ghana is not an exception. Agreeing to the fact that the world today has become a global village with all parts of human existence comprehensively reliant on computers and advanced communication systems for its functioning, it has become essential for our teachers to learn how to acquire the ICT skills to be effective teachers [1] because, there is the conception that ICT can play a key role in enhancing teaching and learning [2]

Consequently, the new educational reforms in Ghana which was launched in June, 2007 placed much importance on the integration of ICT tools in all subject areas and most importantly emphasis on ICT as a tool for teaching mathematics. For example, the syllabus for teaching mathematics at the Senior High School level put emphasis on the use of spreadsheet in drawing graphs and calculating mean, mode, median and standard deviation and also make use of the calculator and the computer for problem solving and investigations of real-life situations [3].

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The government of Ghana recognizes the need for teacher support for mathematics teachers in various ways. He considers ICT literacy as an engine for accelerated development as enshrined in the Ghana Information and Communication Technology for Accelerated development [4]. According to the ICT4AD policy, Ghana's educational system is expected to improve by using ICT to: (i) improve and expand access to educational training and research resources; (ii) improve the quality of education and training and (iii) make the educational system responsive to the needs and requirements of the economy and society with specific reference to the development of the information and knowledge-based economy and society [5]. Comprehensive research studies have revealed that technology plays important role in teaching and learning mathematics. For example, Yidana [6] argue that technology develops the way mathematics should be taught and enriches students understanding of basic concepts. As a result, there has been substantial effort by the Government in the introduction of ICT in teacher education as well. Furthermore, University of Education, Winneba (UEW) and the University of Cape Coast (UCC), the two teacher training universities in Ghana have made enormous investment in technological facilities and infrastructure over the years to increase accessibility of ICT facilities and equipment to students and lecturers for effective ICT instruction [7].

There is a widespread agreement that teachers' knowledge and skills in ICT plays a significant role [8] As a result, the government and other institutions have put in huge sums of money in the procurement of computers and creation of computer laboratories in most junior and Senior high schools. Nevertheless, it is still uncertain whether these computers are being used effectively by teachers in their routine lesson delivery. This brings about a question of whether mathematics teachers need any additional backing to be able to incorporate efficiently the use of ICT in their everyday teaching schedules. It was therefore imperative to conduct an empirical study that would investigate the mathematics teachers' perceptions on practices of ICT integration in the Ghanaian educational system.

1.1 Purpose of the Study

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The study sought to investigate the mathematics teachers' perceptions on the practices of ICT in the teaching and learning of mathematics in some selected junior and senior high schools in Ghana.

1.2 Research Questions

The following research questions guided the study:

1. To what extent do JHS and SHS mathematics teachers use ICT in teaching?
2. What are the barriers and challenges to ICT integration in the teaching and learning of mathematics as perceived by mathematics teachers?

2.LITERATURE REVIEW

Literature review for this study was organized around the following headings:

(a) The practices of ICT in the teaching and learning of mathematics

(b) Skills of ICT in the teaching and learning of mathematics

(c) Effect of ICT in teaching and learning of mathematics

(d) Perception of the usefulness of ICT in teaching and learning of mathematics

(e) Barriers to ICT integration in the teaching and learning of mathematics

2.1 The practices of ICT in the teaching and learning of mathematics

The integration of Information and Communications Technologies (ICT) into professional practice places great pressures and demands on teachers to provide students with the opportunity to develop the skills required to engage in a progressive society and become life-long learners [9], as well as enhance the learning of current curriculum content. To exploit the potential of ICT fully, resulting in improved student outcomes, there is the need for educators to incorporate those new technologies into their teaching practice [10].

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Reynolds (2001) suggests schools are using ICT as a supplement to classroom activity by accessing existing information and knowledge, rather than as an integral part of pedagogical practice and Ward [11] goes further to claim that there is limited use of ICT in classroom practices. This indicates a need for teachers to gain an understanding of how ICT can be used to extend students' thinking and problem-solving skills, rather than just as a publication and research tool.

Hook [12] indicates that the use of ICT in the teaching and learning of mathematics permits students to conjecture and to validity of their conjectures, to prove and convince others that their conjectures are true and to critique or disprove conjectures thereby improving the problems solving and critical thinking skills of students. According to Becta [13] summarizes the key benefits of ICT in mathematics instruction: (i) ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. (ii) ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation.

In addition, there are several reasons for incorporating ICT into mathematics instruction. As indicated by Keong, Horan and Danie [14] the use of ICT in teaching mathematics can make the teaching process more effective as well as enhance the students' abilities in understanding basic concepts. According to the National Council of Teachers of Mathematics electronic technologies furnish visual images of mathematical ideas, they facilitate organizing and analysis of data, and they compute efficiently and accurately. Electronic technologies can support investigations by students in every area of mathematics by allowing students to focus on decision making, reflection, reasoning, and problem solving NCTM [15].

Research shows that the teaching and learning of mathematics with the use of ICT raises student's mastery and enjoyment of the subjects at all levels. The use of interactive white boards (IWB) for teaching and learning mathematics facilitate understanding, concentration, assists easy remembering, and thinking process of student when they use IWB in presenting information and mathematics games as reported by Wall, Higgins & Smith [16]. Similarly, Clements and McMillen [17] argues that, the use of computer programmes by students in mathematics instruction

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encouraged discussion, problems solving, and supported the development of conceptual knowledge.

2.2 Skills of ICT in the teaching and learning of mathematics

To use technology to facilitate student learning, teachers need additional knowledge and skills that depends on a consideration of the interactions among technology, content, and pedagogy. That is, technology integration requires that pre – and in – service teachers understand: (a) the technology tools themselves, combined with (b) the specific affordances of each tool that, when used to teach content, enable difficult concepts to be learned more readily, thus resulting in the achievement of meaningful student outcomes [18].

Teaching with technology requires teachers to expand their knowledge of pedagogical practices across multiple aspects of the planning, implementation, and evaluation process. For example, when using technology as an instructional tool teacher must know how to: develop plans for teaching software to students, select appropriate computer applications to meet the instructional needs of the curriculum and the learning needs of their students and manage computer hardware and software [19].

2.3 Effect of ICT in teaching and learning of mathematics

Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well [15]. Besides, students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. Consequently, teachers must attempt to make mathematics easy for students to understand the various concepts taught with ease. Also, ICTs have great potential for knowledge dissemination, effective learning, and the development of more efficient educational services. Moreover, the adoption of ICT by education has been seen as a powerful way to contribute to educational change, better prepare students for the information age, improve learning outcomes and competencies of learners, and equip students with survival skills for the information society. Therefore, teachers are expected to integrate ICT into their teaching and learning processes. In

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this fast moving and technologically reliant society, students are now faced with the need for a solid understanding of mathematical skills and concepts. Research indicates that technology plays essential role in the teaching and learning of mathematics as it influences the mathematics that is taught and enhances students' learning [15].

Technology influences the skills taught and enhances students' learning. Technology should therefore be used to support the learning of mathematics. In so doing, [15] recommends that technology must be embedded in the mathematics program, rather than provided as a supplemental element.

2.4 Perception of the usefulness of ICT in teaching and learning of mathematics

In mathematics teaching and learning, teachers' beliefs about mathematics learning with or without using technology are considered to be important because it could influence teaching and learning, and curriculum reform. Just as teachers hold beliefs about mathematics that may influence how they teach or structure the learning environment, teachers also hold beliefs about the use of technology. Notwithstanding the apparent benefits of the use of ICT for educational purpose, studies show that in many cases, the learning potential of ICT is deprived as many teachers who are ICT literate do not use it in their teaching [20]. Barak [21] reveals that teachers abuse ICT for their own learning but they are cautious about integrating advanced technologies in their instruction. According to Barak, while teachers recognize the potential of technology in stimulating students' learning and making school studies relevant to real-life contexts, they do not think that ICT is preferable for class-based instruction or for promoting cooperation and reflection in learning.

2.5 Barriers to ICT integration in the teaching and learning of mathematics

Lately, literature evolving on the use and implementation of ICTs in classrooms has identified teacher knowledge in ICT to be an important factor determining whether or not teachers use ICTs in their classrooms and the ways in which they use the ICTs to support learning [22].

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According to Jones [23] seven barriers existed while integrating ICT into mathematics lessons. These barriers were (i) lack of confidence among teachers during integration (ii) lack of access to resource, (iii) lack of time for the integration, (iv) lack of effective training, (v) facing technical problems while the software is in use, (vi) lack of personal access during lesson preparation and (vii) the age of the teachers.

These finding confirms the finding of a research by [14] that identified six major barriers faced by some teachers in the implementation of ICT into their mathematics classroom. These barriers were lack of time in the school schedule for projects involving ICT, inadequate teacher training opportunities for ICT projects, lack of adequate technical support for ICT projects, lack of knowledge about ways to integrate ICT to enhance the curriculum, integrating and using different ICT tools in a single lesson and the absence of access to the necessary technology at the homes of students. Saye [24] characterized the barriers in integrating ICT in mathematics instruction into three; teacher anxiety, lack of knowledge and skills, and pedagogical belief systems.

As indicated by Raju [25], some of the problems in integrating ICT in the instructional process include:

a. Teachers' lack of ICT Skills: Lack of teachers equipped with ICT skills is a problem for the use of ICT in education. The institutions where ICT is going to be used in education, first of all their tutors must be well trained about ICT tools in education. Before going to teach to students, teachers must know about how and when to use ICT tools to achieve particular purposes.

b. Resistance to change: Managing the change is one of the biggest problems, as teachers don't want to accept change easily. In general, a large number of teachers in educational institutes are non-ICT proficient, and resistance to change.

c. Leadership problem: Integrating ICT in education is not an easy task, as it requires a wide range of support from administrators. Therefore, it is necessary to properly convince them for their support. Leadership is necessary before, during and after ICT in education implementation.

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The challenges to the integration of ICT in mathematics instruction in Ghana are enormous. However, in a study conducted by Malcolm and Godwyll [26] in four Ghanaian schools to find out the diffusion of ICT in Ghana, it was found that in addition to being under-paid, over-worked or struggling in poor resourced environments, some mathematics teachers often confront opposition to changes in classroom practice from fellow teachers, school administrators and parents yet they manage to find the extra time and energy required to integrate ICTs in schools.

3. METHODOLOGY

This study used cross-sectional survey research design. According to Muijs [27] cross-sectional survey involves collecting information at just one point in time from a sample that has been drawn from a predetermined population by administering questionnaire or ability to test individuals to find out specific characteristics of the group.

The main instrument used was the questionnaire, which were self-administered consisted of close ended format and rating scale type of questions. The usage of the likert scale, according to Boakye and Banini [28] Likert scale looks interesting to respondents and people often enjoy completing this type of scale.

The questionnaire focused on three (3) main parts (A-C).

Part (A) contained six (6) items that solicited for information on the demographic of the respondents. The variables in part (A) covered respondents' gender, age, highest qualification, teaching experience, computer experience and computer usage.

While the second part (B) consisted of six (6) items (i.e. 25 – 30), that solicited for information on respondents' ICT use in teaching and learning of mathematics, with rating

Scale: Almost always (3), Frequently (2), Often (1), Never (0)

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The last part (C) consisted of fourteen (14) items (i.e. 31 - 44) that solicited for information on respondents' perceptions of Barriers and Challenges in ICT integration in teaching and learning of mathematics, with rating Scale: Strongly Agree (SA = 5), Agree (A = 4), Neutral (N = 3), Disagree (D = 2), Strongly Disagree (SD = 1).

The population of the study comprised of all public Senior and Junior High School Mathematics Teachers in the Volta region of Ghana. Cluster sampling technique was used to select one hundred and twenty (120) teachers in junior and senior high schools in the keta municipality of the Volta region. Fraenkel and Wallen [29] explain cluster sampling as a type of sampling method where the researcher divides the population in separate groups called clusters. Out of the one hundred and twenty (120) teachers selected, one hundred and five (105) teachers presented back the questionnaire. The response rate was 87.5% which is statistically a good return rate valid for analyses [8] of which descriptive statistics was used for the data analysis.

4. DATA PRESENTATION AND ANALYSIS

4.1 Research Question One

To what extent do JHS and SHS mathematics teachers use ICT in teaching?

Table 1 indicates how mathematics teachers' rate their frequency of ICT use in the teaching and learning of mathematics.

Item	All most always N (%)	Frequently N (%)	Often N (%)	Never N (%)	TOTAL
25. I use ICT in giving class instruction	8 (8)	18 (17)	11(11)	68 (65)	105
26. I use ICT in communicating with students	8 (8)	14 (13)	18 (17)	65 (62)	105

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27. I use ICT in organizing class discussions, demonstrations and presentations	0 (0)	22 (21)	14 (13)	69 (66)	105
28. I use ICT in assessing students learning through test	14(13)	12 (11)	11 (11)	68 (65)	105
29. I use ICT in sending feedback to students	6 (6)	8 (8)	17(16)	74 (71)	105
30. I use ICT in supporting collaboration among students	0 (0)	14 (13)	15 (14)	76 (72)	105

Table 1. Teachers frequency of ICT use in the teaching and learning of mathematics.

Majority of the respondents (76%, n = 79) indicated that they never use ICT in giving class instruction, 79% (n = 83) indicated that they never use ICT in communicating with students, 79% (n = 83) indicated they never use ICT in organizing class discussions, demonstrations and presentations, 76% (n = 79) of the respondents indicated they never use ICT to assess students learning through test, 87% (n = 91) of the respondents indicated they never use ICT in sending feedback to students and 86% (n = 91) of the respondents indicated they never use ICT in supporting collaboration among students. The result above indicates that basically mathematics teachers do not use ICT in their teaching.

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4.2 Research Question Two

What are the barriers and challenges to ICT integration in the teaching and learning of mathematics as perceived by mathematics teachers?

Table 2 indicates respondents perceived barriers of ICT integration in the teaching and learning of mathematics.

Table 2. Teachers' perception of barriers and challenges in ICT integration in teaching and learning of mathematics

Item	SA N (%)	A N (%)	N N (%)	D N (%)	SD N (%)	TOTAL
31. I have adequate training and access to instructional technology	14 (13)	52 (50)	20 (19)	8 (8)	11 (11)	105
32. Using technology for instruction is cheap in Ghana	6 (6)	10 (10)	4 (31)	31 (30)	25 (24)	105
33. There are training opportunities for teachers on the field to acquire new computer knowledge or skills	8 (8)	54 (51)	19 (18)	8 (8)	16 (15)	105
34. I own a computer that I use for teaching	18 (17)	17 (16)	7(7)	38 (36)	25 (24)	105
35. My school has a computer laboratory	47 (45)	30 (29)	4 (4)	14 (13)	10 (10)	105
36. I have access to my school's computer laboratory	27 (26)	28 (27)	9 (9)	27 (26)	14 (13)	105
37. There are sufficient computers in computer laboratories	14 (13)	26 (25)	6(6)	31 (30)	28 (27)	105
38. There sufficient presentation equipment	8 (8)	19 (18)	7(7)	40 (38)	31 (30)	105
39. There are sufficient input devices in computer laboratories	4 (4)	5 (25)	5 (5)	40 (38)	30 (29)	105
40. There are sufficient output devices	0 (0)	25 (24)	9 (9)	43 (41)	28 (27)	105
41. There is frequent technical support in my school	0 (0)	21(20)	17 (16)	28 (27)	39 (37)	105

42. There is sufficient time to develop instructional materials that use computers in my school	0 (0)	22(21)	20 (19)	36 (34)	27 (26)	105
43. my expertise in computer skills will help me in using instructional technology	14 (13)	55 (52)	11 (11)	7 (7)	18 (17)	105
44. Professional development courses related to the integration of ICT are organized frequently in my school	0 (0)	26 (25)	9 (9)	20 (19)	50 (48)	105

Out of 105 respondents 63% (n=66) of them generally agreed that they have adequate training and access to instructional technology, (53%, n=56) of the respondents generally disagreed that using technology for instruction is cheap in Ghana, (59%, n=62)) of the respondents generally agreed that there are training opportunities for teachers on the field to acquire new computer knowledge or skills, 60% (n= 63) of the respondents generally disagreed that they have personal a computer they use for teaching, (73%, n=77) of the respondents generally agreed that their school has a computer laboratory, (52%, n=55) of the respondents generally agreed that they have access to their school's computer laboratory, 56% (n=59) out of the 105 respondents generally disagreed that there are sufficient computers in computer laboratories, 68% (n=71) generally disagreed that there are sufficient presentation equipment, 67% (n=70) generally disagreed that there are sufficient input devices, (68%, n=71) of the respondents generally disagreed that there are sufficient output devices, 64% (n= 67) of the respondents perceived that there is no frequent technical support in their schools, (60%, n= 63) most of the respondents perceived that there is no sufficient time to develop instructional materials that use computers in their school, respondents agreed (66%, n=69)) that their expertise in computer skills will help them in using instructional technology and (67%, n= 70) of the respondents perceived that there are no professional development courses related to the integration of ICT organized frequently in their schools.

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5.DISCUSSION

Results indicated that the extent to which mathematics teachers use ICT in teaching mathematics was very little. However, mathematics teachers often use ICT for general computer applications such as finding information on the internet for teaching, communicating with colleagues and students, sending emails and preparing notes for teaching etc. This result is consistent with the findings of [30] who established that majority of the teachers in SHS level in Ghana do not use ICT in classrooms but often use technology to prepare lesson notes, browse the web and send emails.

Similar studies carried out in different countries also confirm the result. For example, [31] established that even though teachers show great interest and motivation to learn about the potential of ICT, in practice, the use of technology is moderately low and it is concentrated on a narrow range of applications, with word processing being the predominant use. Also, a study conducted by [32] to examine the extent of ICT use in instruction revealed that very few teachers are serious users of computers in the classroom.

Again, it was revealed that:

- Respondents saw that they do not have adequate training and access to instructional technology
- Respondents perceived that, the scarcity of printers and presentation equipment in schools may limit their ability to integrate ICT in the teaching and learning process.
- Respondents perceived that, there are insufficient computers in computer laboratories
- Training of Mathematics teachers regularly can help them to use ICT in instructing Mathematics [23].

These results are in consistent with the findings of other studies, which revealed that lack of training for teachers especially in the use of mathematics software, lack of ICT resource in

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schools, insufficient time to integrate ICT due to overloaded mathematics syllabus, lack of knowledge and skills required by teachers to integrate ICT in the teaching and learning process are some of the problems in integrating ICT in mathematic teaching and learning e.g.,[23];[22]; [25]

Conversely, a number of conditions that may enhance the use of computers in the classroom were suggested by [33]. These include (i) allocation of time in the school schedule for students to use computers as part of class assignments, (ii) availability and convenient access to ICT facilities and equipment, and (iii) teachers' personal philosophies that support a student-centered, constructivist pedagogy.

6. CONCLUSION AND RECOMMENDATIONS

In view of the findings of the study, most mathematics teachers do not use ICT in their teaching because of lack of technical know-how and inadequate ICT tools. However, those teachers with little knowledge of ICT prefer to use ICT for general purposes rather than teaching. The following decisions or actions are therefore recommended in the study:

1. The Curriculum Research Development Division (CRDD) of the Ghana Education Service in collaboration with the related agencies in the Ministry of Education should carry out research to review critically the mathematics curriculum and revise the existing syllabus to explicitly state what ICT tools must be used and how it should be used in the teaching and learning process.
2. In collaboration with some NGOs the district or regional education service can donate computers to less equipped schools and also as a way of motivation, teachers can be given laptops in a form of loan packages.

3. The heads of the institutions in collaboration with the Heads of Departments should emphasize the use of computer laboratory by each teacher at least once a week in both

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J.H.S and S.H.S level, to encourage the use of ICT in the teaching and learning of mathematics.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was funded by personal efforts of the authors.

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