





Research Article

Investigating Pre-service Elementary Teachers' Use and Perceptions about ICT Integration in Mathematics Education

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Abstract: This study investigates the extent to which pre-service teachers of colleges of education (CoEs) in Ghana perceive ICT integration as a useful instructional strategy in teaching concepts in primary school mathematics curriculum. The study also explores the impact of college-based education programs on pre-service teachers' ability and preparedness to integrate ICT, and their overall perception about ICT integration in teaching mathematics. The study also assessed the availability of ICT tools in the Ghanaian primary schools in terms of the types of ICT tools available for use by practicing teachers. The study employed the cross-sectional survey design in which both quantitative and qualitative data were collected from 326 final year pre-service elementary teachers from four public colleges of education in Ghana. The quantitative data obtained from questionnaires administered was analysed using descriptive statistics while the qualitative data was analyzed thematically. The findings showed that pre-service elementary teachers perceive ICT integration as a useful instructional strategy in mathematics education. The findings also showed that pre-service elementary teachers are not in strong agreement about how the courses they took, in ICT integration at the college level, shaped them to effectively and efficiently to integrate ICT in their future mathematics lessons. Nonetheless, most pre-service elementary teachers intend to integrate ICT into their future mathematics lessons. The implications of these findings for practice and research are discussed.

Keywords: technology; ICT; pedagogy; primary school; mathematics; colleges of education

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1. Introduction

ICT integration into instructional delivery is a topical issue in recent times, as the world is moving towards the hybrid system of education. Stakeholders in education, all over the world, would agree that the outbreak of Covid-19, which was declared a Public Health emergency of international concern on the 10th of January 2020, and its devastating effects on face-to-face instructional delivery has made it more compelling to integrate ICT into instructional delivery now and going forward. According to the United Nations Education, Scientific and Cultural Organization (UNESCO), more than 1.5 billion learners representing about 90% of the world's registered learners, were left without education in 2020 due to the outbreak of COVID-19 pandemic worldwide (UNESCO, 2020). Moreover, many empirical studies in the area of ICT integration in instructional delivery found positive effects on students' academic achievement and overall learning outcomes in mathematics (Mensah & Nabie, 2021; Tay & Mensah-Wonkyi, 2018; Gambari et al., 2015).

ICT integration, as an instructional strategy, in education was previously considered a thing of developed countries but now a topical issue in developing countries as well (Agyei, 2013; Mensah & Nabie, 2021). The situation in Ghana is not different, as the country has made significant effort to make ICT integration a key component in its educational delivery. This effort is evident in several policies and documents such as: The Ghana ICT for Accelerated Development Policy of 2003; ICT in Education Policy of 2008; ICT in Education of 2015; and several others. It is therefore not surprising that the new standards-based

mathematics curriculum for the basic schools require teachers to integrate ICT into their instructional delivery (Ministry of Education, 2018; 2021a; 2021b; 2021c).

However, there is no clear-cut national policy on teacher preparedness for these sectors of the educational ladder. Consequently, every teacher education institution in the country has the sole responsibility to design their respective curricular to make sure their products are equipped with the requisite skills to carry out the task of integrating ICT into their instructional deliveries. This calls for consistent assessment of pre-service teachers, who will be implementing the curriculum at the pre-tertiary levels, to ascertain their use and preparedness to use technology in their future instructional practice. There is a pool of literature (Mensah & Nabie, 2021; Sam et al., 2022; Asiedu-Addo et al, 2016) on the state of ICT use in mathematics at the pre-tertiary level of education in Ghana. However, there seems to be scarcity in literature with respect to the state of ICT use among pre-service teachers and their preparedness to use ICT in their future mathematics lessons. This study sought to fill this gap by exploring the state of ICT use among pre-service teachers at the Ghanaian CoEs and their preparedness to use various ICT tools in their mathematics lessons in the near future.

However, the issue regarding ICT integration in mathematics is not so topical at the basic level of education in Ghana. Despite numerous studies concerning ICT integration at the primary level in developed countries, same cannot be said for developing countries such as Ghana. This is a worrying situation as the basic level is the foundational level of education and must be of grave concern to researchers.

The current study aims to investigate the perceptions of pre-service elementary teachers, who have completed their three years college-based education and are ready for a semester off-campus teaching practice, about ICT integration in mathematics instruction. The study also aims to ascertain the extent to which the courses undertaken by pre-service teachers in ICT integration impact their preparation towards future instructional practices.

1. To what extent do pre-service teachers perceive ICT integration as a useful instructional strategy in mathematics?
2. What are the perceived impact of college based pre-service education programs concerning ICT integration on pre-service teachers' future instructional practice?
3. What are pre-service teachers' perceptions about ICT integration in teaching primary school mathematics?

2. Literature Review

2.1. ICT Integration Component of the CoEs Curriculum

To effectively implement the new standards-based curriculum that has been rolled out in the Ghanaian basic schools in the year 2019, CoEs in the country have a new mandate to produce teachers who are up to the task. Subsequently, all colleges of education (CoEs) in Ghana are to enroll their students in a four-year Bachelor of Education (B.Ed) programs, of which the first cohort graduated in the year 2022. The aim of the new B.Ed curriculum is to produce highly qualified teachers who will in turn implement the new basic school curriculum to improve the learning outcomes of all learners (Ministry of Education, 2018; 2021a; 2021b; 2021c).

To achieve the vision of the four-year B. Ed curriculum of transforming initial teacher education (ITE) to produce highly qualified teachers for the basic level, Supported Teaching in School (STS) has since been a major course taken by all prospective teachers to give them hands-on field experiences throughout their study. STS is integrated into teaching and learning across the four years of the training of prospective teachers aimed at guiding student teachers to apply and develop the skills, knowledge, and understanding they gain in college-based training (MoE, 2018). Through the STS program, pre-service elementary teachers get support from their supervising tutors, lead mentors, mentors and other stakeholders throughout the entire duration of their training in terms of field experience.

One cross-cutting issue in the STS program, and the four-year B.Ed curriculum in general, is ICT integration in teaching and learning. consequently, ITE course manuals have been developed for various courses by a team consisting of members from CoEs and four universities (University of Ghana, Kwame Nkrumah University of Science and technology, University of education, Winneba, and University for Developmental Studies) in line with the STS program to enable prospective teachers link the theory they learn in class to practice during field practices. Course manuals developed for mathematics courses are not different. In fact, all the method and assessing course manuals in mathematics for colleges affiliated the

afore-mentioned universities, have topics on ICT integration in the instructional process.

In all, primary education students in colleges affiliated to these universities are expected to take four courses (Year 2 – semester 2, Year 3 – semester 1, Year 3 – semester 2, and Year 4 – semester 2) each of which has a component of ICT integration in teaching and learning of mathematics before they graduate. This suggests that after student teachers have gone through the STS program and these courses in mathematics education, they should be equipped with the necessary skills and knowledge in integrating ICT into their instructional delivery.

2.2. ICT Integration as a Useful Instructional Strategy in Mathematics

The usefulness of ICT integration in teaching and learning of mathematics, especially at the secondary and tertiary levels of education, cannot be overemphasized. Many research studies in this area revealed significant usefulness of ICT integration as a teaching strategy on students' achievement, motivation, and other variables. Mensah and Nabie (2021) found a significant impact of ICT integration, as a teaching strategy, on the achievement and motivation of Ghanaian senior high school (SHS) students in mathematics. This study employed quasi-experimental methodology using pre-test, post-test as means of collecting data from control and experimental groups under study. The findings from this study show positive impact of integrating specific ICT tools (PowerPoint presentation) on the learning outcomes of high school learners in geometry. Similarly, a cross-sectional survey of 126 prospective university mathematics teachers in Ghana, revealed positive perceptions about their willingness to integrate ICT into their teaching process (Osafo-Apeanti, 2014).

In a recent study, Arhin, Boateng, Akosah, and Gyimah (2024) investigated the perceptions of 90 high teachers about their perceptions about the usefulness of ICT in mathematics and their readiness to use same. The findings revealed that most of the teachers agree that ICT integration, as an instructional strategy, enhances students' understanding of mathematical concepts and as such a useful tool in the teaching and learning of mathematics. This suggests that mathematics teachers at all levels of the educational ladder may be aware of the potential of ICT integration to change the instructional processes and improve students' learning outcomes.

Beyond the borders of Ghana, Aslan and Zhu (2015) investigated the link between perceptions of 782 Turkish pre-service teachers about ICT integration and their teaching practices. The authors employed cross-sectional survey in which 782 prospective mathematics teachers in selected Turkish universities were the subject of the study. The findings with regard to pre-service teachers' perceptions about ICT integration, revealed that most of the participants perceive ICT as an important tool in the teaching and learning process. In the same year, a qualitative study involving 125 pre-service teachers in the United States revealed that pre-service teachers perceive technology integration in instructional delivery as a useful strategy of presenting mathematical concepts to elementary students (Herron, 2010). These studies, even though conducted in different geographical areas, relate to the current studies as similar participants, pre-service mathematics teachers, are being studied. However, the current study used participants from Ghanaian CoEs, which are mandated to train teachers for the basic level of education, instead of analogous universities.

Furthermore, Rodríguez-Jiménez, Cruz-Campos, Campos-Soto, and Ramos-Navas-Parejo (2023), systematically reviewed eleven (11) recent literature on the role of ICT integration in teaching and learning mathematics in primary schools. The findings revealed among other things that the papers that investigated the use of ICT in primary schools found improvement in students' achievement, motivation, and problem-solving skills. The study also found scarcity in publications of papers relation to the use of ICT in mathematics education at the primary school level. This suggests that limited studies exist, especially in developing countries, with regards to ICT integration in teaching primary or elementary school mathematics.

Despite this important usefulness of ICT in mathematics education, there is evidence of low integration practices by mathematics teachers in Ghana, especially at the SHS level (Agyei et al., 2023; Mensah & Nabie, 2021). The story is not different at the primary school level. Furthermore, ICT integration in mathematics education is a topical area at the secondary and tertiary levels of education unlike at the primary school level.

2.3. Perceived Impact of Teacher Education Programs on ICT Integration in Elementary Schools

ICT integration in education in general, and mathematics education specifically, is a topical issue in education all over the world. With regards to pre-service teachers, ICT

integration is seen as an important concept as teacher training institutions are mandated to equip their graduates with the necessary skills and knowledge to enable them effectively use ICT tools in their future teaching and learning processes (Mensah & Nabie, 2021). The Mathematics curricula for the four-year B.Ed program for CoEs have significant number of ICT integration courses to prepare prospective teachers to integrate ICT into the instructional process. Hence, the CoEs in Ghana, whose core mandate is to train teachers for the basic level of education, have a responsibility of equipping prospective teachers with the necessary knowledge and skills in ICT integration before they are ready for service.

There are mixed findings with regards to views of pre-service teachers about the impact of courses offered in ICT integration, either directly or indirectly, in their various training institutions on their future practice. While some found positive impact of teacher education programs on ICT integration, others found no significant impact of teacher education programs on prospective teachers' knowledge and skills to integrate ICT. The findings of a tracer study on 48 practicing mathematics teachers from the University of education, Winneba found that about 96% of the teachers agreed that they have acquired the necessary knowledge and skills to integrate ICT into their instructional delivery (Asiedu-Addo et al., 2016). Chao (2015) also found that, mathematics teachers have the potential to employ ICT into the teaching and learning process more than other subject teachers in educational institutions. Furthermore, data collected from synthesis of existing literature on pre-service teachers' perceptions about the support their teacher education program provides for their development of knowledge and skill in technology integration revealed a positive correlation (Baran et al., 2017).

On the other hand, a study conducted by Aslan and Zhu (2015) in Turkey revealed that pre-services teachers were of the view that they did not acquire the necessary skills to enable them integrate ICT effectively in their teaching and learning processes. According to the respondents, their inability was as a result of insufficient number of courses in ICT integration and lack of competent instructors in instructional technologies. These findings suggest that courses being offered in the various tertiary institutions may not have the desired impact on the ICT integration skills of their products. This calls for thorough assessment into the perceptions of our students about the impact of the courses in ICT integration on their skills and competence in integrating ICT in their future instructions.

2.4. Conceptual Framework

Based on the purpose of this study, the theory of Technology Acceptance Model (TAM) by Davis (2003), as cited in Ghavifekr and Wan Rosdy (2015), has been adapted and used as the conceptual basis underlining this study (see Figure 1). The original TAM has two variables, namely; Perceived Usefulness and Perceived Ease of Use that explain the processes that users of technology go through to come to accept and use technology. The TAM model also suggests that when people come to light with new technologies, there are a number of factors that influence the timing of their use. The TAM has been widely adapted and used in numerous previous studies (Ghavifekr & Wan Rosdy, 2015; Sedega, et al. 2018) as means to conceptualize how users actually come to accept and integrate ICT into the instructional process. In the current study, "Perceived ease of Use" has been changed to "Perceived Impact on Instruction" in order to suit the purpose of the study and provide answer to the research questions. The adapted model is shown in Figure 1 below.

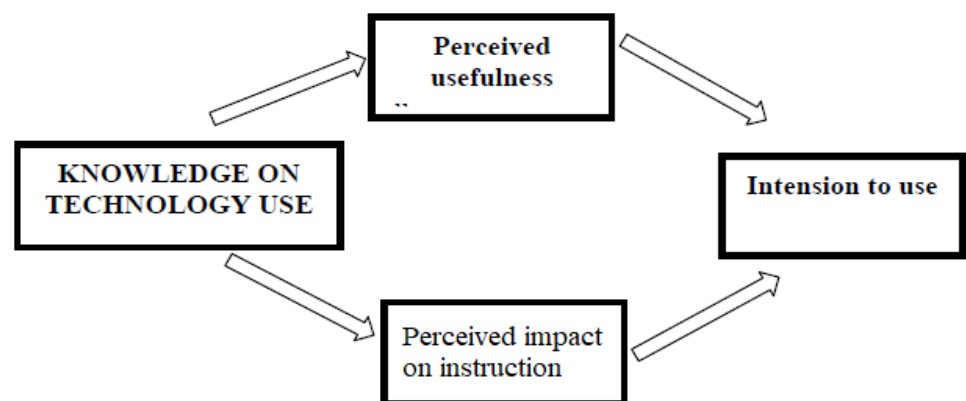


Figure 1. Conceptual framework of the study.

Source: adapted from Ghavifekr and Wan Rosdy (2015).

The adapted framework contains the various variables that are directly associated with the purpose of the study with respect to how the knowledge acquired by the pre-service teachers could affect their perceived usefulness of ICT integration and perceived impact on instructional delivery (see Figure 1). This conceptual framework suggests an interrelatedness in the variables; pre-service teachers' knowledge on technology use, their perceived usefulness and impact on instruction in mathematics as a consequence of their intension to actually use this teaching strategy.

3. Materials and Methods

3.1. Research Design

In this study, a cross-sectional survey employing the mixed methods design was used to collect and analyze data from the study participants. By this method, the researchers were able to collect both quantitative and qualitative data to answer specific research questions. As asserted to by Creswell (2012), this method enables researchers to use qualitative data to answer specific research questions in a quantitative study or vice versa.

3.2. Study Participants

The participants of the study include all final year B.Ed in Primary pre-service-teachers from four public CoEs in Ghana. There are basically two types of curricula that are currently run in the CoE, depending on the mentoring university that a college is affiliated to. All CoE affiliated to any of the four universities – University of Education, Winneba, University of Ghana, Kwame Nkrumah University of Science and Technology, and University for Developmental Studies – use the same curriculum while the other colleges affiliated to the University of Cape Coast use a different curriculum. Two colleges were selected from each of these two categories and all the final year B.Ed. Primary Education students in these colleges were given the opportunity to participate in the study. In all, a total of 326 pre-service teachers, who responded to the online questionnaire, participated in the study.

3.3. Sample and Sampling Technique

The population consist of all final year B.Ed Primary Education student-teachers of public CoEs in Ghana for the 2023/2024 academic year, who have just completed their three year on-campus studies and are ready for their practicum the following semester. The sample consist of 326 final year pre-service teachers, comprising 152 males and 174 females, from four CoEs in Ghana. Purposive and convenient sampling techniques were used to select the four CoEs based on proximity and/or the researchers being mathematics tutors in these colleges. The sample was selected based on availability and willingness to respond to the online questionnaires.

3.4. Instrument

A survey questionnaire, developed by the researchers, was used to collect data from participants. The questionnaire consists of a total five sections (sections A - D), in line with the research questions. Each section of the questionnaire has specific items in respect of a specific research question.

Section A of the questionnaire consists of demographic information about the respondents. Section B consists of five (5) items based on a 5-point Likert scale ranging from: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree. This section of the questionnaire aims at investigating pre-service teachers' perceptions about the usefulness of ICT integration in mathematics using five items. These five items has Cronbach Alpha of .830 which exceed the value of .70 suggesting that the internal consistency of the items is good and appropriate to measure the usefulness of ICT integration as instructional strategy.

Section C consists of eight (8) items based on a 5-point Likert scale ranging from: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree, aimed at investigating pre-service teachers' perceptions about the usefulness of college-based courses taken in ICT integration on their instructional delivery with Cronbach Alpha of .877. This Cronbach alpha indicates that the items measured what they intended to measure. Sections D contains open-ended questions measuring pre-service teachers' general perceptions about ICT integration in teaching primary school mathematics.

3.5. Administration of the Questionnaire

The questionnaire was administered to the pre-service teachers online. The participants



were pre-informed about the intended study a week before the link to the google form containing the questionnaire was sent to their WhatsApp group platforms for them to respond. The online administration was most appropriate at the time of administration because the participants had just completed their semester and were preparing for their off-campus teaching practice. The researchers, being tutors in some of the colleges where data were collected, had the opportunity to offer clarifications to the pre-service teachers on their WhatsApp group platforms. Participants were given two weeks to respond to the questionnaire after which the forms were closed for analysis.

4. Results

4.1. Demographic information

The demographic information provided by respondents in this study include sex, age category, and type of college. Table 1 shows the demographic information of the respondents.

Table 1. Demographic information on respondents.

Category		N	Percent	Total
Sex	Male	152	46.6%	326
	Female	174	53.4%	
Age	Below 20	3	0.09%	326
	20-25	201	61.7%	
	26-30	104	31.9%	
	Above 30	18	5.5%	
College	A	269	82.5%	326
	B	57	17.5%	

From Table 1, the study participants consist of 152 males representing 46.6% of the sample size and 174 females representing 53.4%. also, majority of the respondents (61,7%) are within the age category of 20-25, representing a very youthful sample size. It is also clear from Table 1 that majority of the study respondents (82.5%) come from college category A. This is because majority of the 46 public CoEs in Ghana fall under this category.

This section presents the results of the study based on the research questions. The questionnaire instrument was designed such that each section solicits for respondents' views with regard to a particular research question.

4.2 Presentation of Results

The data collected from respondents were analysed based on the research questions that guided the conduct of the study. The findings from the analysis are presented in this section in line with the research questions.

Research Question 1: To what extent do pre-service teachers perceive ICT integration as a useful instructional strategy in mathematics?

This research question sought to obtain information from the pre-service teachers' perspective about the usefulness of ICT integration in mathematics as an instructional strategy. To answer this question, five questions were presented in section A of the questionnaire based on a 5-point Likert scale ranging from: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree, and 1 = Strongly Disagree. Pre-service teachers tend to strongly agree to ICT integration as a useful instructional strategy (M = 4.1706, SD = .66499). The employment of ICT in teaching of mathematical concepts are key to attainment of learning outcomes. The responses of the respondents were further analysed and the results presented in Table 2.

Table 2. Pre-service teachers' perceived usefulness of ICT integration as an instructional strategy in mathematics.

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
a) ICT enhances the mathematics teachers' capacity and ability in the classroom	139 (42.6%)	148 (45.4%)	24 (7.4%)	8 (2.5%)	7 (2.1%)
b) ICT integration provides a conducive	128 (39.3%)	162	14 (4.3%)	17	5 (1.5%)



environment for teaching and learning mathematics	(49.7%)			(5.2%)	
c) ICT integration increases pupils' interest in mathematics	124 (38.0%)	152 (46.6%)	31 (9.5%)	14 (4.3%)	5 (1.5%)
d) ICT integration affords the opportunity for pupils' self-paced learning	104 (31.9%)	186 (57.1%)	14 (4.3%)	15 (4.6%)	7 (2.1%)
e) The use of ICT in teaching mathematics leads to better student learning outcomes.	119 (36.5%)	159 (48.8%)	26 (8.0%)	19 (5.8%)	3 (0.9%)

From Table 2, a very high proportion of the respondents (88%) either strongly agree or agree that ICT integration in the classroom enhances the teacher's ability to teach mathematics. Only few of the respondents (4.6%) disagree that ICT integration enhances mathematics teachers' ability in the classroom, while the remaining 7.4% were indifferent. With regards to the question that sought to find out from pre-service teachers' perspective on the kind of teaching environment that ICT integration provides, a whopping 89% of the respondents agree that ICT integration, into mathematics education, provides a conducive teaching and learning environment. Also, 84.6% and 89% of the respondents agree that ICT integration increases students' interest in mathematics and offers opportunity for students' own pace learning respectively. Furthermore, 85.3% of the respondents agree that ICT integration into teaching and learning of mathematics leads to better students' outcome.

The above results imply that pre-service elementary teachers, from CoEs in Ghana, perceive ICT integration, as an instructional strategy in mathematics, very useful. It is clear from Table 2 that, in all the questions that were asked with respect to the statement that ICT integration is a useful instructional strategy, more than 80% responded in the affirmative.

Research Question 2: What is the perceived impact of college-based education programs in ICT integration on student-teachers' future instructional practice?

This research question sought to investigate pre-service elementary teachers' perceptions about the impact of college-based programs – STS program and ICT integration courses in mathematics – on their future instructional practices. The questions in section B of the questionnaire instrument sought to provide answers to this research question. The result from the analysis is shown in Table 3.

Table 3. Perceived impact of college-based programs on pre-service teachers' future practice.

Statement	Strongly Agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly Disagree (1)
a) My teacher education program provided me with the general knowledge of possible uses of ICT in my future instructional practice.	133 (40.8%)	143 (43.9%)	20 (6.1%)	23 (7.1%)	7 (2.1%)
b) The ICT related courses at my college have helped me to upgrade my ICT integration skills.	116 (35.6%)	143 (43.9%)	21 (6.4%)	32 (9.8%)	14 (4.3%)
c) My teacher education program prepared me to use ICT tools in my instructional delivery without technical support.	79 (24.2%)	148 (45.4%)	35 (10.7%)	55 (16.9%)	9 (2.8%)
d) The ICT integration related lessons I had in my mathematics courses will help me integrate technology into my teaching and learning process.	99 (30.4%)	164 (50.3%)	22 (6.7%)	32 (9.8%)	9 (2.8%)
e) At least 50% of my college mathematics faculty members (tutors) integrate ICT into their teaching.	77 (23.6%)	162 (49.7%)	28 (8.6%)	50 (15.3%)	9 (2.8%)
f) I sometimes acquire some knowledge and skills in the use of ICT in instructional delivery indirectly when my	83 (25.5%)	163 (50.0%)	31 (9.5%)	37 (11.3%)	12 (3.7%)

mathematics tutors integrate ICT into teaching.					
g) The teacher mentor on my STS program modelled effective use of ICT in his/her teaching.	47 (14.4%)	142 (43.6%)	40 (12.3%)	79 (24.2%)	18 (5.5%)
h) The STS program provided me with a valuable experience to integrate technology in my future instructional practice.	87 (26.7%)	143 (43.9%)	36 (11.0%)	44 (13.5%)	16 (4.9%)

Note: M = 3.8090, SD = .78719

The results from Table 3 show that pre-service teacher tend to agree to the provision of knowledge on the uses of ICT in future instructional deliveries by college-based courses on ICT integration, as more that 80% of them agree to the question on this. Also, about 79% of the respondents agree that the ICT related courses offered at their respective colleges have helped them to upgrade their ICT integration skills.

Generally, the results suggest a positive impact of teacher education programs (college-based courses) on pre-service teachers' ICT integration competences and skills in teaching concepts in mathematics (M = 3.8090, SD = .78719). However, it is worth indicating that though many of the respondents agree to the positive effects on the courses offered on their ICT skills and competence, a significant number are not in strong agreement. That is, they are not in strong agreement to how the courses they took in school, have shaped them to effectively and efficiently integrate ICT into their future mathematics lessons.

Research Question 3: What are pre-service teachers' perceptions about ICT integration in teaching primary school mathematics?

This research question sought to explore pre-service mathematics teachers' perceptions about ICT integration in teaching and learning of primary school mathematics based on certain parameters. Section C of the questionnaire contains questions to address this research question. The first part of the sections sought to find out whether pre-service teachers are willing to integrate ICT into their mathematics lessons, during their teaching practice program, and into their future mathematics lessons, or not. The results show that 295 representing 90.5% of the respondents said YES, they will while 31 representing 9.5% said NO, they won't. For those who said YES, Table 4 represents the reasons and its associated proportions for their choice. Respondents were allowed to select as many reasons as may apply.

Table 4. Reasons Respondents will integrate ICT into their future mathematics lessons.

Reason	N-295	Percent
a) I will be required by the curriculum to integrate ICT into my teaching.	65	22.0%
b) I enjoy teaching mathematics using this teaching approach.	37	12.5%
c) Integrating ICT will make my teaching interesting for my pupils.	89	30.2%
d) Integrating technology will improve my pupils' performance.	62	21.0%
e) Twenty-first century requires the use ICT in teaching mathematics.	50	16.9%
f) Other reason	9	3.1%

From Table 4, the result shows that 65, representing 22% and 89, representing 30.2% of the pre-service teachers who said they will integrate ICT into their future mathematics lessons are of the view that ICT integration is a curriculum requirement and make teaching interesting to pupils respectively. Also, 37 respondents representing 12.5% assert that they enjoy teaching mathematics using this approach while 50 representing 16.9% think that they are required as twenty-first century teachers to use ICT in their instructional delivery. Furthermore, 9 respondents representing 3.1% have other reasons why they will integrate ICT into their future instructional practices.

Similarly, for the respondents who said NO, Table 5 represents the reasons and its associated proportions for their choice. Respondents were allowed to select as many reasons as may apply.

Table 5. Reasons Respondents will not integrate ICT into their future mathematics lessons.

Reason	N=31	Percent
a) I will not be required by the curriculum to integrate ICT into my teaching.	6	19.4%
b) I don't enjoy teaching mathematics using this teaching approach.	7	22.6%
c) I am not confident in my ability to integrate technology in my teaching.	11	35.5
d) Integrating technology will waste the time allotted for lesson.	3	9.7%
e) I cannot complete the syllabus if I use this teaching strategy.	6	19.4%
f) I do not feel my teacher education program prepared me to utilize ICT in my teaching.	5	16.1%
g) Other reason	10	32.3%

From Table 5, the result shows that majority of the respondents (35.5%), who said they do not intend to integrate ICT into their future teaching processes, do not have confidence in their ability to integrate ICT. Also, only few of the respondents (9.7%) think that integrating ICT into their future instructional practice would be time wasting while 32.3% have other reasons for not wanting to integrate ICT into their future instructional practices. This result is an indication that there are still some pre-service teachers who do not intend to use technology in teaching and learning of mathematics due to varied reasons.

5. Discussion

In this study, we examined the perceptions of pre-service teachers, who were about to start their practicum for the 2023/2024 academic year, about the usefulness of ICT integration as instructional strategy, the impact their teacher education programs had on their ability to integrate ICT in mathematics lessons and the reasons they will or will not integrate ICT into their future instructional deliveries.

5.1. Perceived ICT Integration as a Useful Instructional Strategy in Mathematics

The findings from the study showed that pre-service teachers in Ghana strongly agree that ICT integration is an effective instructional strategy for teaching mathematics. The findings revealed that the majority of respondents agreed or strongly agreed that ICT integration enhances mathematics teachers' capacity and ability in the classroom, provides a conducive environment for teaching and learning mathematics, increases pupils' interest in mathematics, affords the opportunity for pupils' self-paced learning, and leads to better student learning outcomes, among others. These findings agree strongly with the findings of several empirical studies (Arhin et al., 2024; Osafo-Apeanti, 2014; Aslan & Zhu, 2015; Heron, 2015; Sedega et al., 2018; Rodríguez-Jiménez et al., 2023), who in separate studies found their participants or respondents perceive ICT integration as a useful instructional strategy in mathematics education.

These results suggest that pre-service teachers in Ghana recognize the benefits of using ICT in mathematics instruction. The use of ICT can enhance the quality of education and provide students with opportunities for active learning, which can lead to better learning outcomes. The findings also indicate that the integration of ICT can create a positive classroom environment that promotes engagement and interest in learning mathematics.

4.2. Impact of College-Based Pre-Service Education Programs on ICT Integration

The integration of ICT in education has been an increasingly important aspect of modern teaching and learning practices. The findings on the impact of college-based programs, particularly the STS program and mathematics courses in ICT integration, on pre-service elementary teachers' future instructional practice in mathematics were discussed.

The findings indicate that pre-service elementary teachers perceive the positive impact of teacher education programs and ICT integration courses on their future instructional practice in mathematics. However, there is still room for improvement in preparing pre-service teachers to effectively and efficiently integrate ICT in their lessons without technical support. This finding is in line with the findings of the studies (Asiedu-Addo et al., 2016; Chao, 2015; Baran et al., 2017), which found positive impact of teacher education programs with regard to ICT integration on student teachers' future instructional practices.

It was also revealed that some mathematics tutors and mentors on the STS program do

not integrate ICT into their instructional deliveries. These findings support the findings of a study by Aslan and Zhu (2015), that some pre-service teachers perceive their teacher education programs as not equipping them with adequate skills to integrate ICT. This is a worrying development since some of the respondents assert that they learn some ICT integration skills from the way their tutors and mentors model effective use of ICT in the classroom. This implies that inappropriate or lack of ICT integration by these role models may have a serious negative consequence on teaching of pre-service teachers in the future. Teacher educators should lead the way of effective and efficient ICT integration.

4.3. Pre-Service Teachers' Perceptions about ICT Integration in Teaching Elementary school mathematics

The study examined the perceptions of pre-service elementary teachers regarding the integration of ICT in teaching and learning of primary school mathematics. The study focused on certain parameters such as willingness to integrate ICT, reasons for integration, and reasons for not integrating ICT into their future mathematics lessons.

The findings of the study revealed that a majority of the pre-service teachers (90.5%) were willing to integrate ICT into their mathematics lessons. This indicates that pre-service teachers recognize the importance of using technology in teaching and learning. Among the reasons given for their willingness to integrate ICT, the most commonly cited reasons were that integrating ICT would make teaching interesting to pupils and that it was a curriculum requirement. This suggests that pre-service teachers perceive that the use of ICT can enhance the effectiveness of their teaching practices and meet the expectations of the curriculum. Nevertheless, these are intentions and have to be followed to see whether it manifests in their instructions.

Moreover, a significant proportion of respondents (16.9%) believed that the use of ICT in teaching mathematics was a requirement for twenty-first-century teaching. This finding suggests that pre-service teachers understand the role of ICT in preparing their students for a future that is increasingly technology-driven. This perception aligns with the increasing demand for technology integration in education and the growing importance of digital literacy in today's society.

On the other hand, some pre-service teachers (9.5%) were not willing to integrate ICT into their mathematics lessons. Among the reasons cited for their reluctance to use ICT, the most commonly mentioned reasons were a lack of confidence in their ability to integrate technology into their teaching practices (35.5%) and not enjoying teaching mathematics using this approach (22.6%). This suggests that some pre-service teachers may not have had adequate exposure to technology integration during their teacher education program, which may have resulted in a lack of confidence in using ICT.

The study also found that some pre-service teachers (16.1%) believed that their teacher education program did not adequately prepare them to utilize ICT in their teaching practices. This finding highlights the need to ensure that teacher education programs provide pre-service teachers with the necessary skills and knowledge to integrate technology effectively in their teaching practices.

6. Conclusions

The findings of the study provide evidence of pre-service teachers' positive perception of the usefulness of ICT integration in mathematics instruction. The findings suggest that ICT integration can enhance mathematics instruction and improve students' learning outcomes.

It was revealed that pre-service teachers at the CoEs perceive ICT integration as a very useful instructional strategy in teaching primary school mathematics. In fact, more than 80% of the respondents gave a positive indication of the usefulness of this teaching strategy. This finding has an important implication for teacher education and professional development in the Ghanaian CoEs and in other higher educational institutions. This suggests that teacher education programs need to incorporate ICT training to equip mathematics teachers with the necessary skills to integrate technology into their teaching practices. Professional development programs should also be designed to support mathematics teachers' ongoing learning and development in the area of ICT integration in instructional delivery. While general courses on ICT integration are essential, it's necessary to consider mathematics specific ICT integration courses. We conclude that it is essential to continue to explore and promote the integration of ICT in education, especially at the CoEs, to support effective

teaching and learning practices

Secondly, it was also revealed in this study that some of the respondents said they acquired some skills and knowledge in ICT integration from the effective modelling of ICT use by their mathematics tutors and mentors. It is therefore recommended that Ghana Tertiary Education Commission (GTEC) in collaboration with other stakeholders at the CoEs level, as a matter of policy, should ensure that all faculty members, particularly mathematics tutors, model effective use of ICT in their teaching, and that mentor teachers in the STS program do same. Such improvements could lead to better-prepared pre-service teachers who are equipped to integrate ICT into their lessons effectively and efficiently, thereby improving student learning outcomes.

Furthermore, the study's findings indicate that there is a need for Ghanaian elementary teachers to be equipped with the necessary ICT skills and knowledge to enable them to integrate ICT into their teaching and learning process effectively. This could be achieved by providing adequate training and technical support to teachers and ensuring that they have access to ICT tools. The study also provides evidence that indicate that a majority of pre-service teachers are willing to integrate ICT into their mathematics lessons, primarily because they recognize the importance of technology in enhancing teaching practices and meeting the expectations of the curriculum. However, some pre-service teachers still have reservations about integrating ICT due to a lack of confidence and inadequate preparation during their teacher education program. In this regard, we recommend adequate training and support for pre-service teachers to facilitate the integration of ICT into their teaching practices effectively.

We recommended that the study is be replicated in other CoEs or tertiary institutions in Ghana and other jurisdictions to establish the generality of the findings. Also, other studies could investigate the influence of other factors such as gender and locality on pre-service teachers' perceptions about ICT integration at the elementary levels.

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